State of the Bay

analysis of the environmental conditions of Santa Monica Bay

2010

Santa Monica Bay Restoration Commission

THE BAY RESTORATION PLAN: 2008 UPDATE

The original Bay Restoration Plan was developed in 1995 in recognition of the need to restore and protect Santa Monica Bay's priceless natural resources. The Santa Monica Bay Restoration Commission and its partners have achieved several historic milestones while making remarkable progress towards implementing a majority of the seventy-four priority actions outlined in the original Plan. However, many of the objectives listed in the original Bay Restoration Plan have not yet been met, and several new issues and challenges have emerged over the last thirteen years that need to be addressed with new strategies.

The 2008 update of the Bay Restoration Plan is a complete overhaul of the 1995 Plan and the result of months of public workshops, online input, and one-on-one meetings with stakeholders. The updated Bay Restoration Plan lays out the most effective strategies for making progress toward restoring the Bay over the next ten to twenty years. The updated Bay Restoration Plan includes new and revised goals, objectives, and milestones that address ongoing issues and emerging challenges, and the Plan reflects the consensus of the Commission's partners on the best strategies to protect and restore the precious resources of the Bay and its watershed.

The goals, objectives, and milestones included in the updated Bay Restoration Plan are organized in three sections, which align with our mission to "improve water quality, conserve and rehabilitate natural resources, and protect the Bay's benefits and values." The full Bay Restoration Plan: 2008 Update is available on our website: http://www.santamonicabay.org.

Priority Issue: Water Quality

Goal 1: Improve water quality through treatment or elimination of polluted discharges.
Goal 2: Improve water quality through pollution prevention and source control.
Goal 3: Address potential impacts of emerging contaminants.

Priority Issue: Natural Resources

Goal 4: Create and support policies and programs to protect natural resources.
Goal 5: Acquire land for preservation of habitat and ecological services.
Goal 6: Manage existing invasive species and prevent additional introductions.
Goal 7: Restore wetlands, streams, and riparian zones.
Goal 8: Restore coastal bluffs, dunes, and sandy beaches.
Goal 9: Restore intertidal and subtidal habitats.
Goal 10: Protect and restore open ocean and deep water habitats.

Priority Issue: Benefits and Values to Humans

Goal 11: Protect public health.
Goal 12: Maintain or increase natural flood protection through ecologically functioning floodplains and wetlands.
Goal 13: Increase public access to beaches and open space.
Goal 14: Conserve water and increase local water supply.

LProtopapadakis

Table of Contents

TABLE OF CONTENTS

PREFACE……………………………………………………i

AT A GLANCE………………………………………………ii

1. INTRODUCTION …………………………………1

2. ACCOMPLISHMENTS ……………………………2
- Wastewater Treatment
- Beach Water Quality
- Habitat Protection

3. HABITAT CONDITIONS…………………………11

4. FOCUS ON WATER QUALITY……………………25
- Pathogens and Indicator Bacteria
- Trash
- Water Resources

5. FOCUS ON NATURAL RESOURCES……………39
- Habitat Restoration
- Control of Invasive Species
- Remediation of Contaminated Sediments on the Palos Verdes Shelf
- Species of Special Interest
- Fish, Fishing, and Fishery Management
- Marine Protected Areas

6. LOOKING AHEAD………………………………68
- Climate Change
- Harmful Algal Blooms
- Atmospheric Deposition
- Contaminants of Emerging Concern

7. CONCLUSION ……………………………………76

A. REFERENCES……………………………………a-i

B. LIST OF FIGURES………………………………b-i

C. ABBREVIATIONS…………………………………c-i

D. GLOSSARY…………………………………………d-i

E. PHOTOCREDITS…………………………………e-i

F. ACKNOWLEDGEMENTS…………………………f-i

PREFACE

The Santa Monica Bay Restoration Commission is a locally-based, independent state entity. It is charged with restoring and protecting Santa Monica Bay, a "nationally significant estuary" designated by Congress in 1988 under the United States Environmental Protection Agency's National Estuary Program. The Commission is a broad-based partnership that brings together local, state, and federal agencies, environmental groups, businesses, and members of the general public. The Commission's 35-member Governing Board oversees an ambitious restoration agenda, works to achieve broad consensus, and implements innovative policies and projects based on the best available science.

As a National Estuary Program, the Commission works through actions and partnerships outlined in a comprehensive Bay Restoration Plan, which was initially approved by the United States Environmental Protection Agency and the State of California in 1995. As the guiding document for the Commission, the Bay Restoration Plan provides a blueprint for how to recover the Bay from past environmental damage and move toward long-term, sustainable health.

Over arching Goals of the Bay Restoration Plan:

- Improve water quality
- Conserve and rehabilitate natural resources
- Protect the Bay's benefits and values

Besides facilitating and promoting implementation of restoration projects, the Commission periodically assesses and reports on the Bay's environmental conditions. These assessments provide the essential information needed to measure progress in restoring the Bay's natural habitats and resources as well as to identify remaining and emerging challenges.

Results of these periodic assessments are compiled and published in the State of the Bay Report with input from the Commission's Technical Advisory Committee. The first such report was published in 1993, following an extensive characterization study that described the Bay's physical, biological, and sociological setting; sources of contamination; and the effects of pollution on the Bay's resources and human health. The Commission updates the State of the Bay Report approximately every five years.

In the winter of 2007, the Technical Advisory Committee re-organized to strengthen its role and responsibilities and to elevate it from a forum for technical discussions, to a scientific panel that provides review and recommendations to the Governing Board. The Technical Advisory Committee consists of experts in coastal and watershed sciences, such as fisheries, physical oceanography, natural resource economics, ecotoxicology, and intertidal, plankton and wetland ecology.

The 2010 State of the Bay Report is the latest assessment of Santa Monica Bay's ecological health. The Technical Advisory Committee provided explicit guidelines and much of the writing for this Report. The involvement of the Technical Advisory Committee ensured that the most relevant and accurate information was used to describe the Bay's condition. The Technical Advisory Committee's leadership also made it possible for this Report to assess the Bay's condition in several new ways. The most notable example of this is the use of one scale to rate habitat condition, in Chapter Three.

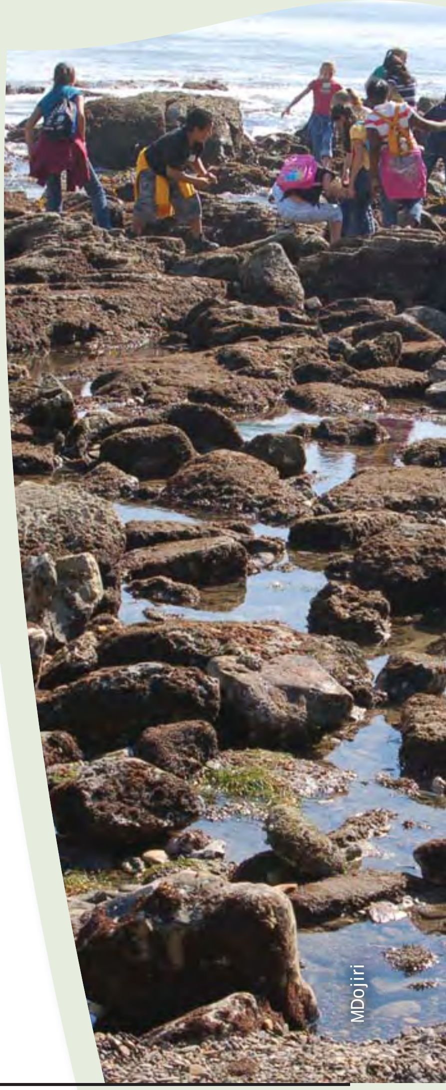
The 2010 State of the Bay Report is shaped by a newly updated Bay Restoration Plan, which was adopted by the Commission in 2008. The Bay Restoration Plan details protection and management strategies to achieve the restoration of the precious resources of the Bay and its watershed. A one page summary of this new Plan can be found on the inside cover of this Report. The Bay Restoration Plan and the 2010 State of the Bay Report are companion documents, and much of the information used to develop the Bay Restoration Plan is presented and explained in the 2010 State of the Bay Report. More importantly, the specific information in the 2010 Report on the health of the Bay's habitats and resources will provide a clear reference point from which the Commission can gauge progress towards the implementation of the of Bay Restoration Plan.

At a Glance

At a Glance

The 2010 State of the Bay Report provides a comprehensive and up-to-date analysis of the environmental conditions of Santa Monica Bay. It is the latest in a series of "State of the Bay" reports published by the Santa Monica Bay Restoration Commission (SMBRC). Under the guidance of SMBRC's Technical Advisory Committee, this newest Report provides several new ways of looking at the health of the Bay's natural habitats and resources, measures progress towards achieving the goals of the Bay Restoration Plan, and identifies challenges ahead.

The Bay Restoration Plan was initially approved by the United States Environmental Protection Agency and the State of California in 1995 to serve as a blueprint to guide recovery of the Bay from past environmental damage toward long-term, sustainable health. In 2008, SMBRC updated the Bay Restoration Plan to reflect the progress made, identify new priorities, and propose new initiatives to guide restoration efforts. Much of the information used to update the Bay Restoration Plan is presented and explained in this State of the Bay Report. More importantly, the information presented in this Report will provide a clear reference point from which to gauge progress in implementing the updated Bay Restoration Plan at this important juncture in the Bay's history.



Following the Introduction, the main discussion in the State of the Bay Report is presented in five chapters. The first of these, Chapter Two, looks backward and highlights several major achievements, some of which took forty years to come to fruition. In Chapter Three, the Report describes the ecological health of major aquatic habitats in the Bay and its watershed. Chapters Four and Five, the core and most extensive sections of the Report, describe in detail how various issues associated with water quality, water resource management, habitat restoration, and natural resource management are being addressed. These chapters also discuss areas of progress, current status, information gaps, and major obstacles. And, Chapter Six looks forward at looming issues that require attention and resources in order to continue restoring and protecting Santa Monica Bay. The Report ends with a Conclusion that focuses on next steps.

This section offers a glance at the key findings and messages presented in each chapter of the Report.

At a Glance
Accomplishments

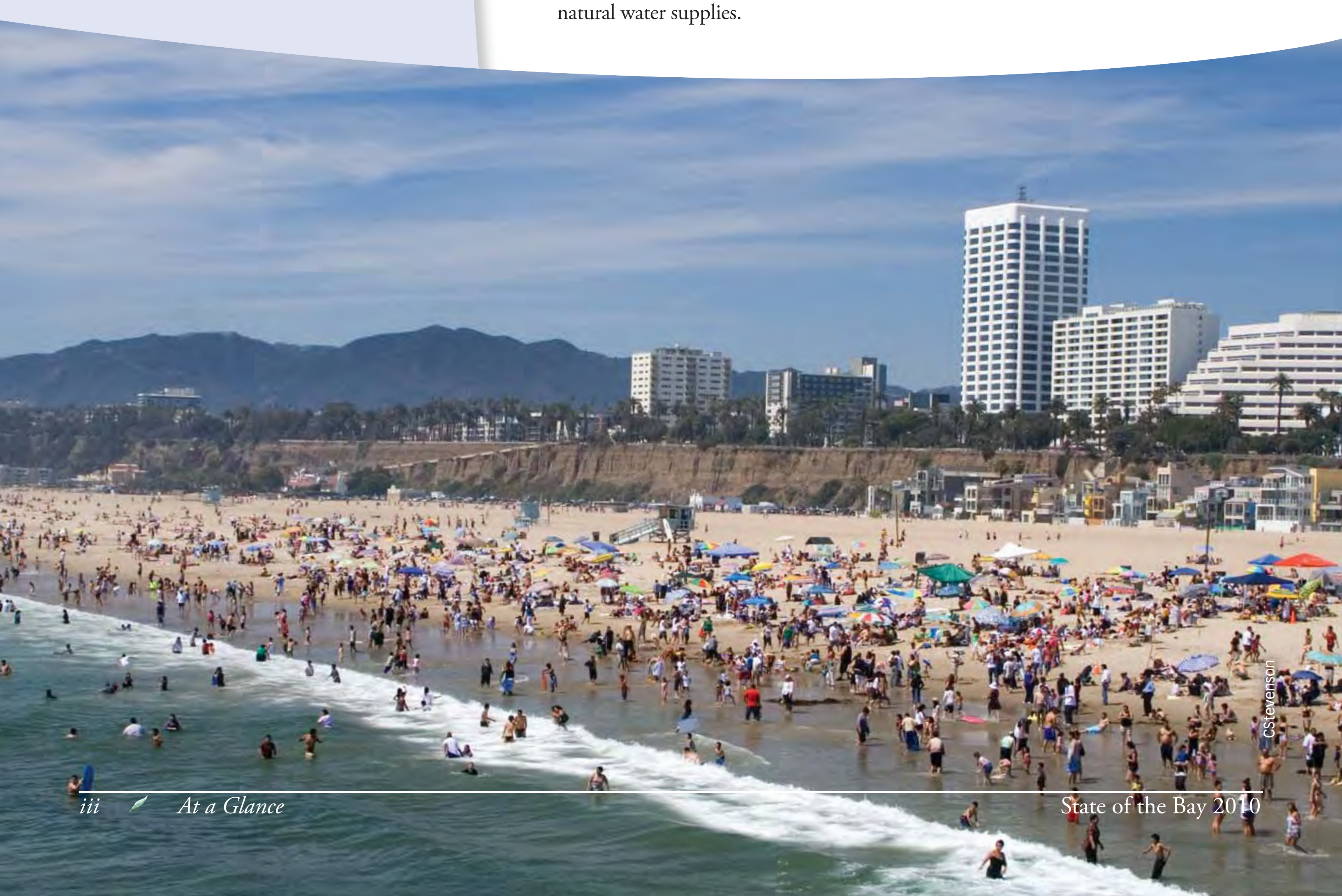
The Accomplishments Chapter of the 2010 State of the Bay Report begins by highlighting the biggest achievements in restoring the Bay as a result of addressing point-source pollution, beach water quality, and habitat restoration needs. This section also sets the stage for discussions about the next set of challenges facing the Bay.

Key Messages

Wastewater Treatment. Initial efforts to clean up the Bay focused on point source discharges. In the last several decades, pollutant loading from wastewater discharged to the Bay has decreased dramatically. This improvement has been achieved through rigorous source control programs and treatment upgrades at the two largest publicly owned treatment works in the Bay. As a result, the severely degraded ocean floor habitats surrounding the sewage outfalls have made a remarkable recovery.

Beach Water Quality. Santa Monica Bay beaches are safer for swimming than they were five years ago because of reduced pathogen indicator contamination during summer dry weather. This reduction has largely been achieved through the installation of low-flow diversions and on-site treatment facilities in many storm drains throughout the Bay watershed. Also, the City of Los Angeles, other cities in the Bay watershed, and the Sanitation Districts of Los Angeles County have taken significant steps to reduce sewage spills.

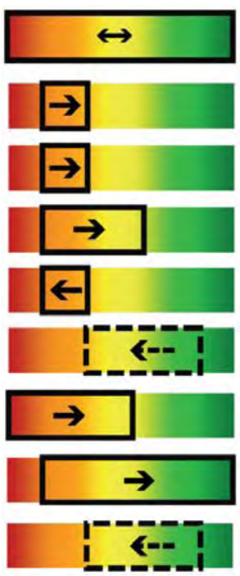
Habitat Protection. Since the late 1990s, SMBRC and its partners have acquired and preserved more than 8,000 acres of open space in the Bay watershed, including streams, wetlands and coastal sage scrub habitats. After acquiring habitats, the next step is often restoring them, which has been initiated or completed at many locations. Acquiring habitats and restoring them also increases public access to natural areas, provides critical habitat for wildlife, and protects the natural processes that help to clean and enhance natural water supplies.


CStevenson

At a Glance
Habitat Conditions

This chapter of the Report provides an assessment of the condition of the nine major habitat types found in the Bay and its watershed. This chapter introduces a new framework, which uses a standard scale to rate the condition of habitat types and characterize their overall status and trends (see below). In general, the assessment finds that habitat conditions vary with proximity to human development, with habitats further away from developed areas in better condition. Most habitats in most areas are degraded to some degree due to human disturbances. While the conditions of a few of these habitats are still in decline, the condition of several habitats remains stable, and others are improving in quality because of the increasing efforts to protect and restore them, such as the dune restoration occurring in the South Bay. Below is a summary of the "Status and Trends" assessments for each habitat type, shown roughly in the order in which water flows, from headwaters to ocean.

Key Messages



- Creeks and Streams: CRITICAL to EXCELLENT depending on location
- Coastal Wetlands and Lagoons: POOR with one GOOD exception
- Coastal Dunes and Bluffs: POOR with one GOOD exception
- Sandy Beaches: POOR to FAIR depending on location
- Rocky Intertidal: Mostly POOR with a few FAIR exceptions
- Seagrass Beds: FAIR to GOOD based on limited data
- Rocky Reefs: CRITICAL to FAIR depending on location
- Soft Bottom: POOR to EXCELLENT depending on location
- Open Ocean: FAIR to GOOD based on limited data

How to Read the Habitat Conditions Assessment

Status:	CRITICAL	POOR	FAIR	GOOD	EXCELLENT
Characteristics:	Defaunation and loss of key ecosystem functions	Significantly reduced biodiversity and some loss of ecosystem function	Reduced biodiversity and reduced level of ecosystem function	Biodiversity and ecosystem function are similar to pristine conditions	Biodiversity and ecosystem function are equivalent to pristine conditions

Status:

- The box outlines the full range of conditions of a given habitat type.

Trends:

- An arrow pointing to the right indicates a positive trend.
- A double headed arrow indicates that conditions are neither improving nor declining.
- An arrow pointing to the left indicates a negative trend.

In General:

- Dashed lines indicate that the assessment for that given habitat type is based on limited data.

At a Glance

Water Quality

The Water Quality chapter describes in more detail the progress and challenges of improving water quality—focusing on pathogen control and reducing trash loads associated with stormwater runoff and water resource management.

Key Messages

Pathogens and Indicator Bacteria. A lot of effort has gone into cleaning up dry weather flows and maintaining good beach water quality during summer months (April to October). Bay beaches generally meet public health guidelines during these months, except at a few notable "hot spots." However, water quality at Bay beaches remains poor during the wet season. Long-term solutions proposed in the Bay Restoration Plan focus on integrated water resources management and low impact development approaches to reduce the volume and contaminant loads of stormwater runoff. Reducing pathogens and nutrients from septic systems are critical priorities for SMBRC. Enhancing source tracking methods and improving the turnaround time and specificity of beach water quality testing—i.e. developing a "rapid indicator" for pathogens—are other high priorities for SMBRC and many of its partners.

Trash. Trash in the local creeks and streams, along the beaches, and in the Bay can pose a potential hazard to human health, harm aquatic life, and degrade the aesthetics of these natural areas. Trash entering the Bay from the watershed is also one source of marine debris. Measures to reduce trash have increased substantially over the last few years. The year 2009 marks the five-year milestone of 50% trash reduction required by the Ballona Creek Trash Total Maximum Daily Load. Monitoring the actual amount of trash captured by these devices and thus the amount of trash prevented from entering the Ballona Creek is difficult. Therefore, reductions are gauged based on the number of full trash capture devices installed in the watershed. Using this measure, the 50% milestone may have been achieved. Additional measures need to be implemented to control other sources of marine debris. Some controls have already been enacted, such as bans on polystyrene food packaging in Santa Monica, West Hollywood, and plastic bags and polystyrene food packaging in Malibu. However, opposition from the plastic manufacturing industry has impeded several other cities in the Bay watershed from taking proactive steps to reduce trash loading in the Santa Monica Bay.

Water Resources. Water quality, water supply, and flood control issues are interconnected and necessitate an integrated, regional approach. Efforts to improve outdoor water conservation are on-going, while water districts and wastewater treatment facilities have committed to tapping the potentially vast capacity of wastewater recycling. Further momentum for these efforts comes from the State Water Resources Control Board's 2009 policy, which supports irrigation uses of recycled wastewater. In addition, green infrastructure and low impact development practices are long-term solutions that address the region's water supply, flood control, and water quality problems cost-effectively and deserve more attention.

At a Glance

Natural Resources

This chapter of the Report details many of the on-going programs and projects that address habitat loss and degradation, including restoration, remediation, invasive species control, and marine protected areas.

Key Messages

Habitat Restoration. Restored habitat creates an oasis of nature for both wildlife and people within this highly urbanized region. While it may not be possible to reclaim all of the habitat in the Bay and its watershed that has been lost, it is vital to restore the habitat that remains. Funding made available by SMBRC and other state agencies has led to many successful restoration projects in several different habitats within the Bay and its watershed, including a Palos Verdes kelp forest, the Malibu Lagoon, Upper Las Virgenes Creek, Lower Topanga Creek, Stone Canyon Creek, and the beach bluffs in Redondo Beach.

Control of Invasive Species. Invasive plants and animals have increasingly become a major threat to the integrity of natural resources in the Bay and its watershed. Invasive species of concern include *Arundo donax*, ice plant, red swamp crayfish, and bullfrogs. The New Zealand mudsnail is the latest known invader, and it is rapidly spreading in the riparian habitat of the Santa Monica Mountains. In most cases, eradicating an invasive species is not possible, and preventing it from spreading can be painstaking and never-ending. However, perseverance can control their populations, as demonstrated in the Trancas Creek crayfish removal project.

Remediation of Contaminated Sediment on the Palos Verdes Shelf. From the late 1940s to the early 1970s, dichlorodiphenyltrichloroethane (DDT) and other highly toxic chemicals were discarded into the ocean through the wastewater treatment system. This event is a perfect example of how human actions can harm the environment and consequently, human health. After many years of investigation, the United States Environmental Protection Agency is moving forward with a multi-strategy remediation plan. One goal of the plan is to cap the most contaminated sediment area in order to reduce the amount of toxins entering into the food chain, thereby reducing the health risks associated with consuming contaminated seafood.

Species of Special Interest. Several species that reside in the Bay or its watershed deserve special consideration due to their dwindling populations and iconic nature. Efforts are being made to bring many of the rare, threatened, or endangered species back to a healthy population size. Successful progress is evident with some of these species, such as the El Segundo blue butterfly, California brown pelican, California least tern, and giant sea bass. Other species, such as the southern steelhead trout and Western snowy plover, still need more help, or a new approach to species management altogether.

Fish, Fishing, and Fishery Management. Available information indicates broad declines in many fish species, such as kelp bass (calico bass), that were once abundant in the Bay. However, population assessments are largely based on fishery-dependent data (catch and effort), which can be an unreliable indication of changes in a population. Fishery-independent data have been collected only by a few researchers for a handful of species. One of these species is the giant sea bass, and the data is just beginning to show signs of recovery as a result of protection measures implemented more than twenty-five years ago. More fishery-independent data for key resident species should be collected in order to better understand the health of these populations. These data could also be used as indicators of the health of the Bay's fisheries.

Marine Protected Areas. California is finally implementing the Marine Life Protection Act, passed in 1999. The groundbreaking community-based process used to develop a network of marine protected areas for all of California, region by region, began along the southern California coast in 2008. The proposed network is currently undergoing a California Environmental Quality Act review and may become law as early as the fall of 2010. At press time, the proposed State plan includes a reserve off of the southwest corner of the Palos Verdes Peninsula and a small reserve between Point Dume and Paradise Cove. A critical next step will be to implement a long-term monitoring program and periodic assessments of the effectiveness of these reserves.

At a Glance
Looking Ahead

The Report calls attention to four major challenges that will increasingly threaten the Bay and its watershed in the coming years—climate change, harmful algal blooms, atmospheric deposition, and contaminants of emerging concern.


DCaron

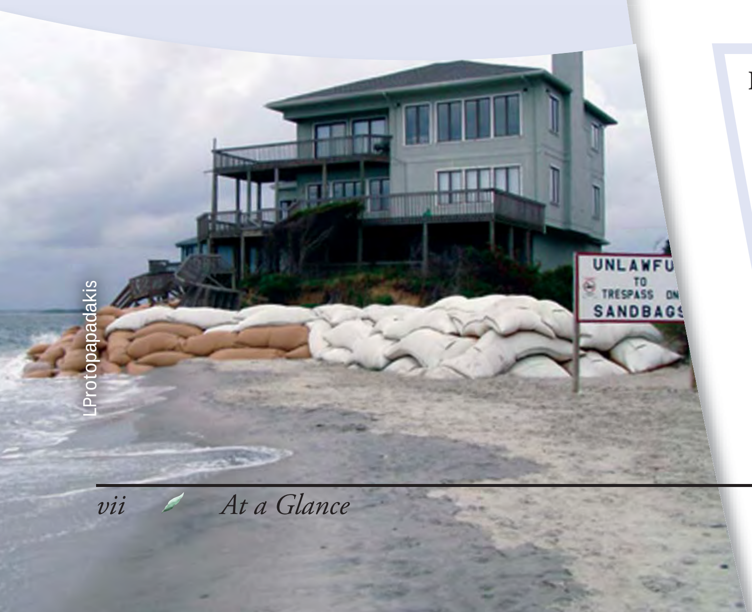
Key Messages

Climate Change. In addition to efforts to reduce greenhouse gas emissions globally, a plan for how to adapt to the changing climate needs to be addressed locally. By the end of this century, in Santa Monica Bay, a significant rise in sea level and an increasingly acidic ocean is expected, along with severely reduced annual rainfall and the host of problems that accompany these dramatic changes. A plan for adapting, based on site-specific scientific modeling and analysis of the impacts of climate change, needs to be developed.

Harmful Algal Blooms. Blooms of toxic and noxious marine microalgae are increasing in frequency and severity. Circumstantial evidence suggests that human activities are exacerbating these blooms. New research designed to separate the relative contributions of natural and anthropogenic causes of these blooms, establish a surveillance system, and evaluate the effectiveness of management approaches for controlling nutrient inputs is needed.

Atmospheric Deposition. Studies have shown that air pollution is a major source of several contaminants found in local waters. However, the air quality and water quality regulatory systems are completely disconnected from each other, which hinders agencies from addressing this problem. Air and water quality regulatory agencies need to take on the responsibility jointly and coordinate with each other to significantly reduce pollutant loading through atmospheric pathways.

Contaminants of Emerging Concern. Tens of thousands of chemicals used throughout the Bay watershed and surrounding areas make their way into local waters. Most of these chemicals are unmonitored, they are difficult to remove from wastewater and urban runoff, and their impacts on the environment are only just being discovered. Further investigations into the types, levels, and effects of these chemicals are necessary in order to adopt a more proactive approach for preventing their release into the environment. Efforts should focus on minimizing the manufacture and use of potentially harmful chemical compounds, and growing efforts to develop "green" chemistry will help.



LProtopapadakis

In conclusion, changes in approach and behavior have already resulted in admirable progress and achievements in the protecting Bay and its watershed. Ahead lay many challenges brought by both past legacies and new threats. The SMBRC and its partners are prepared to confront these challenges with new strategies and approaches, which are detailed in the updated Bay Restoration Plan. With broad partnerships and new actions to implement this Plan, the Santa Monica Bay community can make substantial further progress in restoring the health of the Bay.

1. Introduction

1. Introduction

The 2010 State of the Bay Report is a comprehensive assessment of the Bay's environmental conditions, covering all major habitats and a broad range of issues. To produce this Report, information was gathered from a variety of sources, including many years of monitoring data collected in the Bay, research findings published in scientific journals, and technical reports developed by agencies and other organizations. This information is not only used to indicate environmental health, but also to illustrate that past projects have had positive impacts and that many challenges remain.

This Report focuses primarily on what has occurred since the Santa Monica Bay Restoration Commission (SMBRC) released the 2004 State of the Bay Report. However, this Report also looks back further than prior reports to highlight some major achievements of the past fifteen years and the improvements now evident after years of monitoring. The Report goes on to assess the ecological health of many Bay and Bay watershed habitats, highlighting the most troubling issues for each ecosystem. With this assessment as a foundation, the Report focuses in more detail on the ongoing issues that affect the health of the different Bay and Bay watershed habitats. The Report describes specifically how various issues have been addressed, including areas of progress, current status, information gaps, major obstacles, causes of the remaining problems, and ways to ameliorate them. Finally, the Report looks ahead at emerging issues that will need to be addressed in the coming years.

Topics covered in this Report also closely follow the structure of the updated Bay Restoration Plan. Two of the Plan's priority issues, water quality and natural resources, comprise the main focus sections of this Report. The Plan's third priority issue, benefits and values to humans, is a cross-cutting theme discussed in different places throughout this Report and adds an additional layer of understanding to a given story. Some stories contain an element of all three priority issues. The sediment contamination on the Palos Verdes Shelf, for example, is a historical water quality problem, a habitat degradation problem, and a human health problem due to fish tissue contamination. To highlight the multiple aspects of this example, the remediation of the contaminated area is discussed in the Natural Resource section, with a side story that discusses the human health component of this issue.

The Santa Monica Bay is a unique place. The productive natural resources of the Bay and its watershed are enjoyed by millions of people. The surrounding Los Angeles metropolitan area is one of the largest urban expanses in the United States (see Figure 1-1). For this reason, the challenges for Santa Monica Bay are representative of most urban areas, and local accomplishments have far-reaching consequences. If water quality and natural resources can be improved and restored here in Santa Monica Bay, then these achievements are possible elsewhere. The 2010 State of the Bay Report lays out how the SMBRC and its partners are facing these challenges.

Figure 1-1. Santa Monica Bay and its watershed. Approximately 2.18 million people* live in the Santa Monica Bay watershed. Roughly half of the Bay watershed is urban with development concentrated in the southern part of the watershed. The Santa Monica Mountains, in the north part of the Bay, provide most of the parkland. This map does not show locally managed parkland in the Baldwin Hills, Palos Verdes Peninsula, or Ballona wetlands. Data Sources: United States Census Bureau and SMBRC. Cartography: Lorna Apper.

*Estimate based on population estimates as of July 1, 2008 for Los Angeles and Ventura County.

2. Accomplishments

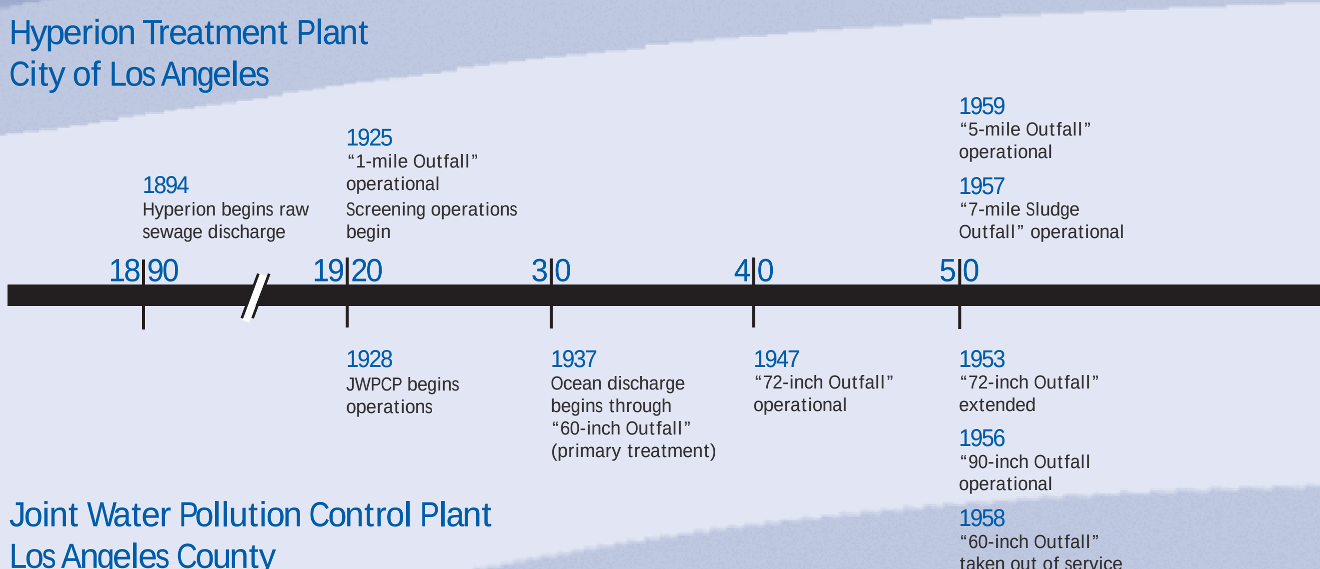
The results of some of the most significant efforts to address issues affecting the Bay and its watershed have only recently become evident, even though some of these efforts took place more than ten years ago. While State of the Bay reports typically focus on events that occurred in the approximately five preceding years, so as not to overlap with the previous report, a look back at the results of some of the most significant accomplishments toward protecting the Bay and its watershed demonstrates that the actions initiated many years ago laid the foundation for the resulting improvements in the environment observed and monitored today. These improvements show the strides made to advance the goal of protecting and restoring the health of Santa Monica Bay and its watershed. However, the monitoring results also show the steps ahead—a testament to the need for long-term commitments to restoring the ecosystem health of the Bay and its watershed.

2.1 Wastewater Treatment

The number of people living in Los Angeles County has steadily increased from one million in 1960 to nearly ten million in 2008 (United States Census Bureau, 2008). The majority of wastewater generated within Los Angeles County is treated by two treatment plants that discharge into Santa Monica Bay. The City of Los Angeles' Hyperion Treatment Plant (Hyperion) discharges treated wastewater from one outfall located five miles offshore of Dockweiler State Beach near the middle of the Bay, while the Sanitation Districts of Los Angeles County's (LACSD) Joint Water Pollution Control Plant (JWPCP) discharges from a network of outfalls located about two miles offshore of White Point on the south face of the Palos Verdes Peninsula.

These publicly owned treatment works (POTWs) began taking steps to improve the quality of their discharges in the late 1960s and have continued to make steady progress by implementing aggressive pre-treatment programs, increasing advanced treatment capacity, improving sludge handling, recycling some of the growing amounts of treated wastewater, and encouraging water conservation. Because of these efforts, the Bay receives less output of wastewater and solid material today, despite the fact that these POTWs receive more input due to continuous population growth in the service areas (see Figure 2-1 and Figure 2-2).

Figure 2-2. Timeline showing major milestones reached for water quality management in wastewater treatment by Hyperion (top) and JWPCP (bottom). Milestones are listed horizontally by decade and vertically by year. Data Sources: LACSD and CLA-EMD.



Accomplishments
Wastewater Treatment

(a) City of Los Angeles Hyperion Treatment Plant Flow and Suspended Solids 1950 - 2008

(b) JWPCP Wastewater Treatment Plant Flow and Suspended Solids 1950 - 2008

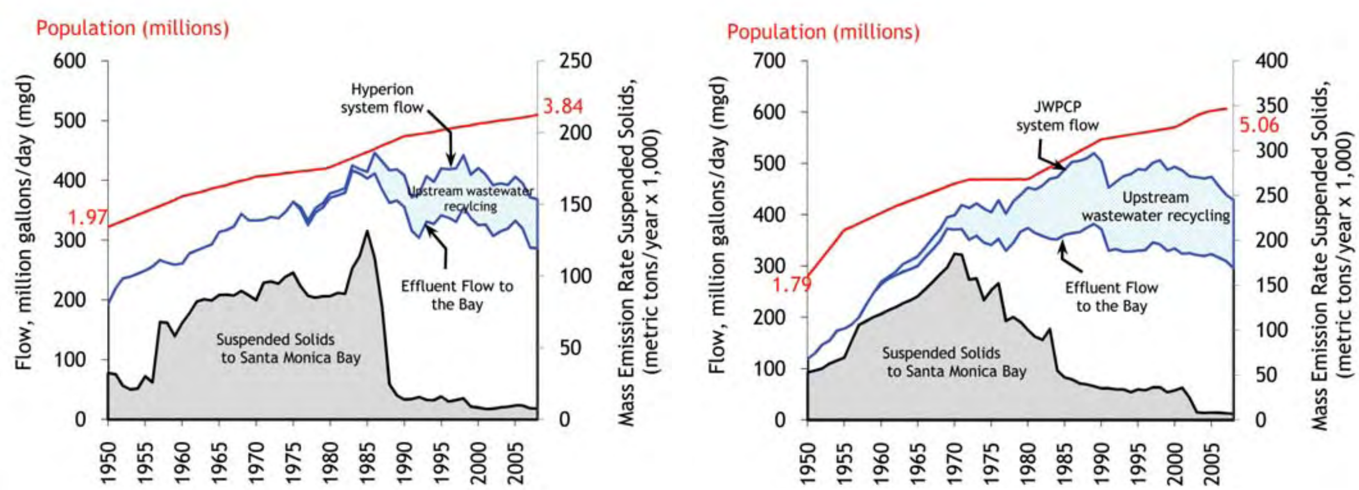


Figure 2-1. System flow, mass emissions of suspended solids (grey shading), and wastewater discharges for (a) Hyperion and (b) JWPCP increased as population grew in their respective service areas until they began recycling wastewater (blue shading) and treatment changed in 1989 (Hyperion) and 1970 (JWPCP). Afterwards, system flows and effluent flow leveled off, and mass emissions of suspended solids decreased despite still growing populations. Data Sources: LACSD and City of Los Angeles Environmental Monitoring Division (CLA-EMD).

60 | 70 | 80 | 90 | 2000 | 2010

1965
First LACSD ocean monitoring near outfalls

1966
"120-inch Outfall" operational

"72-inch Outfall" taken out of service

1970
Advanced primary treatment begins

1971
Routine ocean monitoring begins

1972
U.S. Congress passes Clean Water Act

1983
Partial secondary treatment begins

1987
"7-mile Outfall" taken out of service; now sludge transported to landfill

1989
"5-mile Outfall" meets all secondary standards except Biological Oxygen Demand (a measure of overall water quality)

1995
Ecosystem health around outfalls shows significant improvement (Fig. 2-3)

1998
Full secondary treatment begins

2002
Full secondary treatment begins

2007
Ecosystem health around outfalls shows significant improvement (Fig. 2-3)

2007
Ecosystem health continues to recover (Fig. 2-3)

2.1 Wastewater Treatment - *continued*

Both POTWs reached a key milestone when they achieved full secondary treatment for the large volumes of sewage they treat. Hyperion led the way in 1998 followed by the JWPCP in 2002. Full secondary treatment systems enabled both facilities to remove significantly more solids from the wastewater discharged into the Bay than the removal achieved with primary or partial secondary treatment. The 2004 State of the Bay Report documented these achievements, but with only a few years of monitoring, not enough data were available to demonstrate how the marine life and habitat around the outfalls have benefited.

Today, a clearer picture is emerging. Monitoring data show biodiversity has increased to near reference levels around both the Hyperion and JWPCP outfalls—a notable improvement over the years of partial secondary treatment (see Figure 2-3). The most important factor in this recovery is the more than 90% reduction of suspended solids discharged to the Bay. The decomposition of the organic material contained in these solids created low oxygen and high hydrogen sulfide levels in the sediments, reducing the community of benthic organisms living in the sediments (benthic infauna) to only the most pollution tolerant species. Suspended solids also included toxic contaminants such as metals and hydrocarbons. The pre-treatment programs and water conservation efforts of both POTWs have also contributed to significant declines in the levels of pollutant loading to the Bay (Section 4.3 discusses the multiple benefits of these activities).

Despite these significant improvements, the legacy contamination of sediments with high levels of dichlorodiphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCBs) around the JWPCP outfall on the Palos Verdes Shelf remains a challenge. These contaminated sediments continue to affect the health of the entire food web, including humans who consume fish from the area. Implementation of the remediation plan developed under the auspices of the United States Environmental Protection Agency's (USEPA) Superfund investigation is a viable approach to addressing this challenge (Section 5.3 discusses this further).

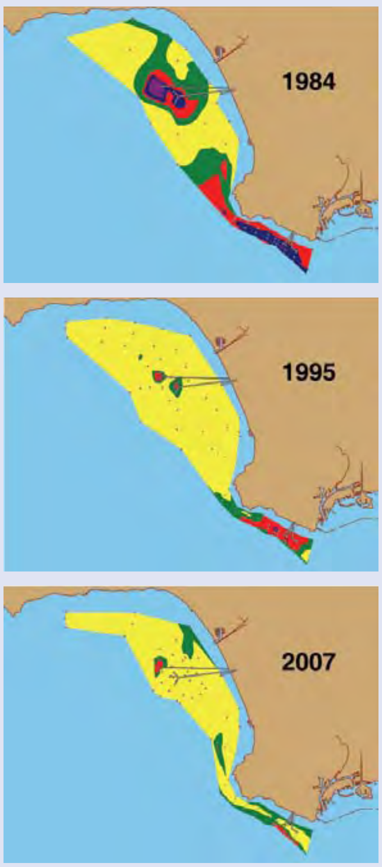


Figure 2-3. Benthic Response Index map of Santa Monica Bay. With mass emissions relatively high at the outfalls of Hyperion and JWPCP in 1984, benthic infauna diversity was very low and the biological community was degraded (red, blue, and purple areas on map). As treatment improved and mass emissions decreased, the areas around the outfalls became more biologically diverse by 1995. By 2007, after the POTWs achieved full secondary treatment, these areas became nearly indistinguishable from reference sites (yellow and green areas on map). While it may appear that conditions away from the outfalls are slightly degrading between 1995 and 2007 (green, instead of yellow), this may merely be caused by statistical anomalies as opposed to actual environmental degradation. Future monitoring will help to clarify these changes. Data Sources: LACSD and CLA-EMD.

Accomplishments

Beach Water Quality

2.2 Beach Water Quality

Santa Monica Bay is renowned for the beauty and recreational opportunities provided along its fifty-five mile shoreline, which includes twenty-two public beaches. Millions of people visit these beaches annually, making beach-going an important part of the coastal economy. However, prior to the 1980s, the Bay's beaches were closed frequently and the beach-going public warned not to swim due to sewage spills and high indicator bacteria levels in the surf zone.

Efforts to improve beach water quality began in the late 1980s. The City of Los Angeles began major sewer upgrades under court order and in response to public outcry about the frequent sewage overflows and spills that affected the Bay's beaches. The resulting improvements increased sewage storage and treatment capacity, retrofitted aged sewer lines, and included more frequent sewer line inspections and cleanings. Together, these actions have contributed to a decrease in the number of sewage spills by more than 400% over the last eight years (see Figure 2-4). The Cities of Santa Monica and Los Angeles also constructed the region's first low-flow diversion from the Pico-Kenter drain in response to results of studies that detected human pathogens in two storm drains, including Pico-Kenter (Santa Monica Bay Restoration Project (SMBRP), 1990; 1991; 1992). Low-flow diversions are placed in storm drains to reroute dry weather runoff to a treatment facility in order to prevent contaminated runoff from reaching the beach.

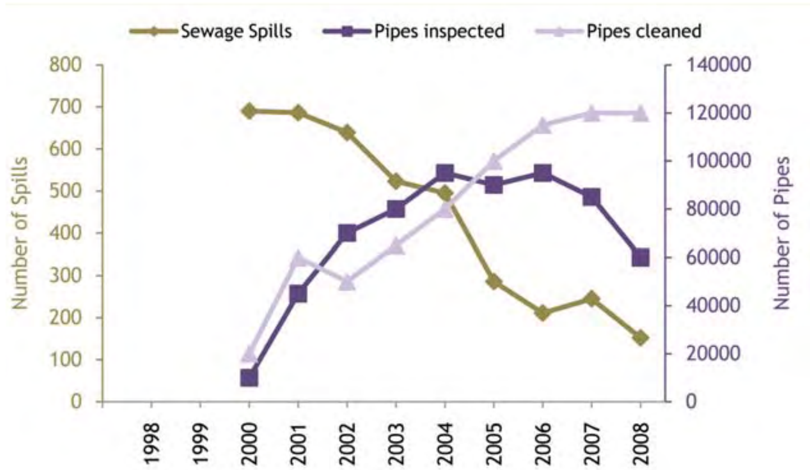
Since 1996, the pace of progress began to accelerate significantly after a land-mark epidemiological study linked, for the first time, the illnesses of swimmers and surfers in Santa Monica Bay with proximity to the storm drain outlets releasing contaminated runoff (SMBRP, 1996). In 1997, the state legislature passed Assembly Bill 411 (AB411), which establishes statewide beach water quality standards and mandates beach water quality monitoring and reporting from April to October. By 1998, the USEPA reached a court sanctioned agreement (Consent Decree) with the Natural Resources Defense Council, requiring development of Total Maximum Daily Load (TMDL) standards. A TMDL is the maximum amount of a pollutant that a receiving water body can absorb without adversely affecting its beneficial uses, and is mandated by the federal Clean Water Act to improve water quality, protect aquatic life, and restore impaired beneficial uses, including recreational water contact, within a fixed time frame (See Chapter Four, which discusses TMDL implementation in more depth).

Since 1999, various beach cities and Los Angeles County have installed many more low-flow diversions, removing a major pathway through which contaminants reach the Bay's beaches (see Figure 2-5). As a result, most Santa Monica Bay beaches continue to have low enough numbers of indicator bacteria to be considered safe for swimming and surfing during the dry weather months (April to October), according to the Beach Report Card issued by the local environmental group, Heal the Bay (see Figure 2-6). Beach water quality is likely to further improve in the coming years since a new treatment facility and eight year-round, dry weather runoff diversions are scheduled to begin operating in 2010.

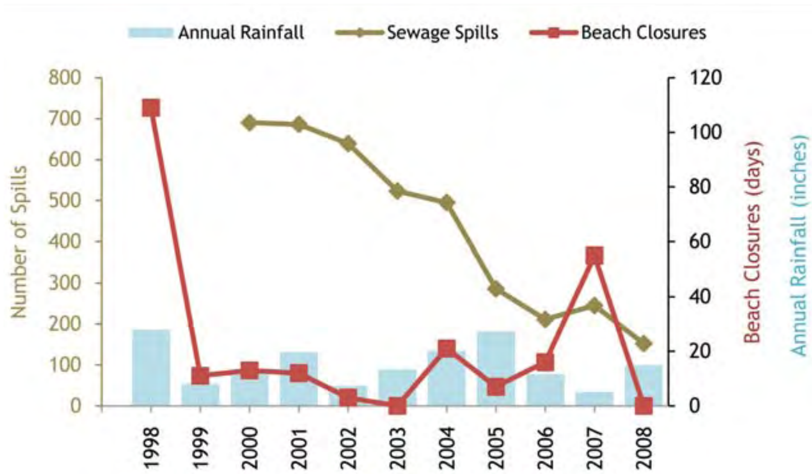
One remaining challenge is to reduce contamination at the few Bay beaches still considered *un*safe for swimming and surfing during dry weather. These beaches, such as Malibu's Surfrider Beach and the Santa Monica Pier, are consistent offenders. However, low-flow diversions are considered infeasible at most of these locations, so other approaches need to be explored in order to identify and eliminate the sources of contamination. Another, impending challenge will be to find and implement cost-effective solutions for reducing pathogen inputs from stormwater during wet weather (November to March) (see Section 4.1 for more details).

Figure 2-4. Correlation between (a) sewage system maintenance and number of sewage spills, and (b) sewage spills, beach closures, and annual rainfall. Beach closures have generally declined since the 1990s, partially in response to fewer sewage spills. The increase in beach closures in 2007 is, in part, due to a series of spills upstream from Long Beach, a part of Los Angeles County not in the Bay. Other factors, such as rainfall, also influence the number of beach closures. Data Sources: CLA-EMD, Los Angeles County Department of Health Services, and National Weather Service.

Correlation Between Sewage Spills, Pipe Inspection and Maintenance, and Beach Closures



(a)



(b)

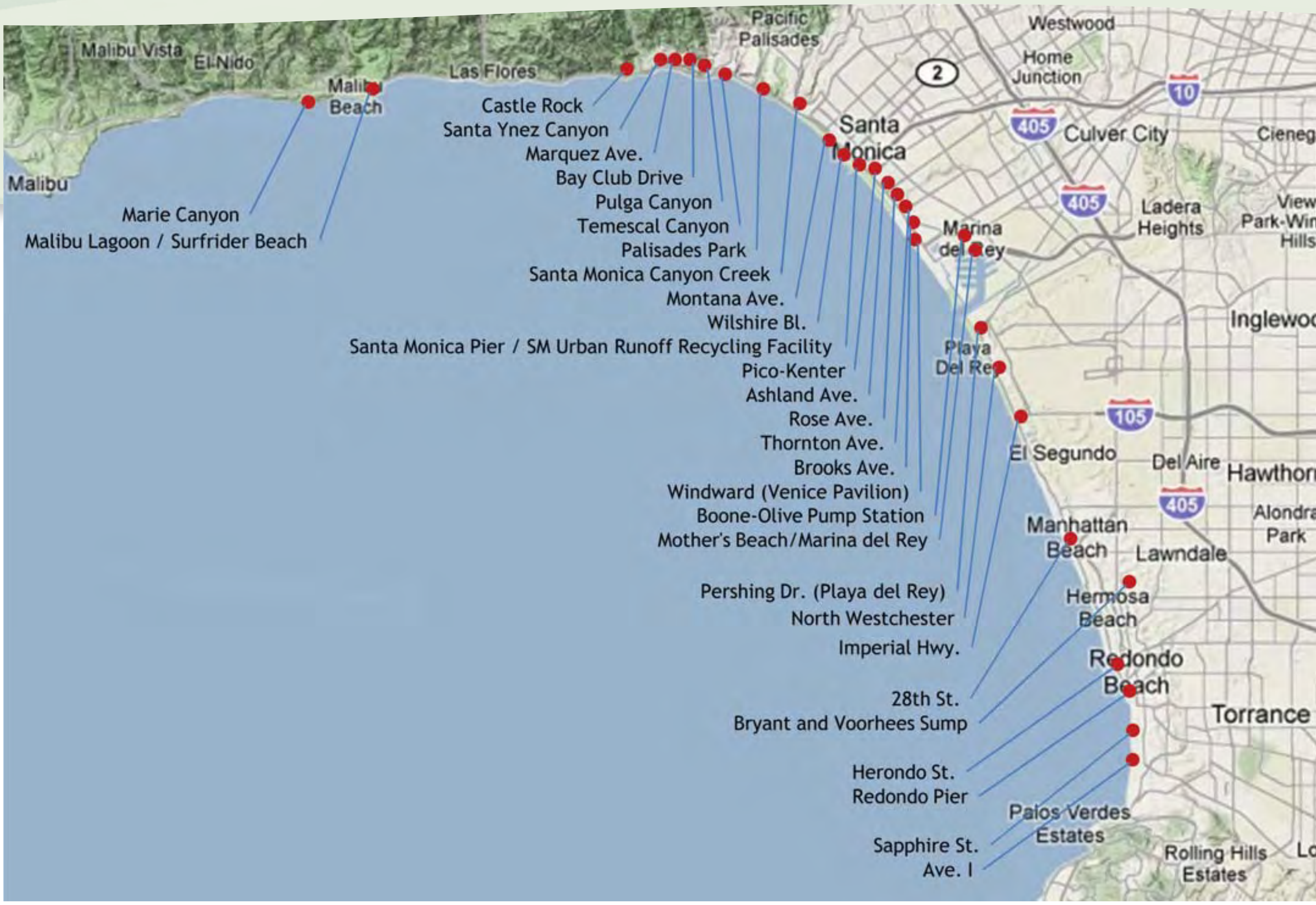


Figure 2-5. Map of low-flow diversions installed by Santa Monica Bay beach cities and Los Angeles County. Most of these projects divert dry weather flow to a POTW. A few projects include facilities to treat runoff on-site, such as Malibu Lagoon, Marie Canyon, and the Santa Monica Pier. Data Sources: SMBRC and Google. Cartography: Lorna Apper.

Percentage of Santa Monica Bay Beaches Receiving A or B Grades on Heal the Bay's Beach Report Card

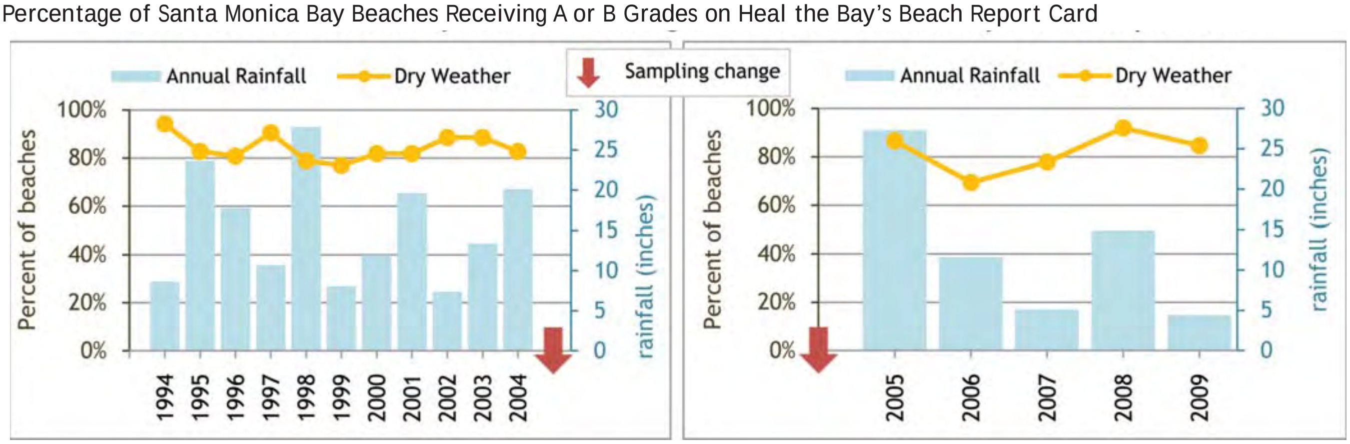


Figure 2-6. Percentage of Santa Monica Bay beaches receiving A or B grades on Heal the Bay's Annual Beach Report Card. Rainfall was measured in downtown Los Angeles. The graph is split between 2004 and 2005, marking the 2004 change in sampling protocols, which require samples to be collected directly in front of the storm drain (see Section 4.1). Data Sources: Heal the Bay and the National Weather Service.

2.3 Habitat Protection

The Santa Monica Bay watershed is located in one of the world's most sprawling and built-out metropolitan areas. This development has indelibly altered the landscape. Most natural creeks and streams have been confined in concrete channels, wetlands have been drained and filled, and the flood plains and hillsides have been covered by asphalt or concrete streets, parking lots, and buildings. The conversion of what were once open spaces to man-made structures and impervious surfaces has resulted in the severe or, in many cases, complete loss of vegetation, wildlife populations, and the natural functions of the original habitats. The loss of these open spaces results in fewer buffers or undisturbed areas that can trap and assimilate contaminants, increased volume and intensity of stormwater runoff, and decreased pervious areas that allow natural infiltration of stormwater and recharge of groundwater. All of these factors contribute to degradation in water quality.

Because it would be difficult or infeasible to reclaim most of the natural areas that have been lost to urbanization, the remaining open spaces are increasingly precious resources. Therefore, the preservation of open spaces should be a critical component of comprehensive strategies for preservation and restoration of habitats in any given watershed. One of the most important and effective mechanisms for protecting open spaces is to establish public ownership through acquisition. The federal government and State of California established the Santa Monica Mountains National Recreational Area and the Santa Monica Mountains Conservancy (SMMC) in the late 1970s and early 1980s. Together, these organizations helped to protect more than 150,000 acres of unspoiled coastal open areas. Many of these areas were preserved permanently under public ownership through acquisition. In the early 2000s, the Baldwin Hills Conservancy was established to preserve two square-miles in the Baldwin Hills area, which contain recreational areas, open spaces, and wildlife habitats. However, the tension between conservation and development continues to intensify as open spaces—or developable lands, depending on the perspective—become increasingly scarce.

The last decade marked a period of significant progress in open space preservation, thanks largely to voter-approved state bond funding and strong community support. Since 2000, the State was able to acquire 8,055 acres of open space. The most remarkable preservations occurred in 2003 with the acquisitions of 483 acres of Ballona Wetlands and another 2,959 acres at Ahmanson Ranch, containing the headwaters of Malibu Creek. Both properties were considered the last remaining habitats of their kind and were at one time slated for large-scale development. Since 2003, another 2,742 acres of open spaces have been purchased for preservation in the Santa Monica Bay watershed, including King Gillette Ranch and Corral Canyon (see Figure 2-7). Many of the later acquisitions include largely undeveloped, mountainous areas in the northern part of the Bay watershed, including the streams and creeks that flow into the ocean along the Malibu coast, which is designated an Area of Special Biological Significance by the State of California. Land has also been acquired in the South Bay, where much less open space remains today. The Palos Verdes Peninsula Land Conservancy (PVPLC) and the City of Rancho Palos Verdes added two new properties in the Palos Verdes Peninsula to the total lands currently under their care. These properties are especially important for the restoration of the endangered Palos Verdes blue butterfly.

In most cases, acquiring open spaces makes it possible for habitat restoration to begin. Due to years of neglect or historical conversion to other land uses, habitats on acquired lands are often severely degraded. Restoration of degraded habitats has been initiated or completed at several locations in recent years (see Section 5.1). Moving forward, open space preservation will continue to play an important role in achieving the goals of the Bay Restoration Plan, such as the goals of protecting and restoring the Bay's habitats and improving water quality through integrated water resource management (see Section 4.3).

Improving public access often coincides with acquiring open space. The ability to visit, enjoy, and appreciate natural areas is a major benefit for both the residents and visitors of this region. Access to the beaches, wetlands, and mountainous areas of the Bay and its watershed has improved within the past five years. Some highlights are below:

2005: A new public viewpoint was constructed to provide access to ocean views at Big Rock in Malibu. The viewpoint site is located near an existing public access stairway to the beach.

The Centinela Avenue access to the Ballona Creek Trail and Bike Path, adjacent to the Ballona Wetlands, was improved with new gateway parks and educational signs, converting these under-utilized public spaces into safe and accessible parklands.

2007: Carbon Beach East access way opened at 22132 Pacific Coast Highway in Malibu after a 2002 lawsuit was settled, allowing "vertical" access to the beach.

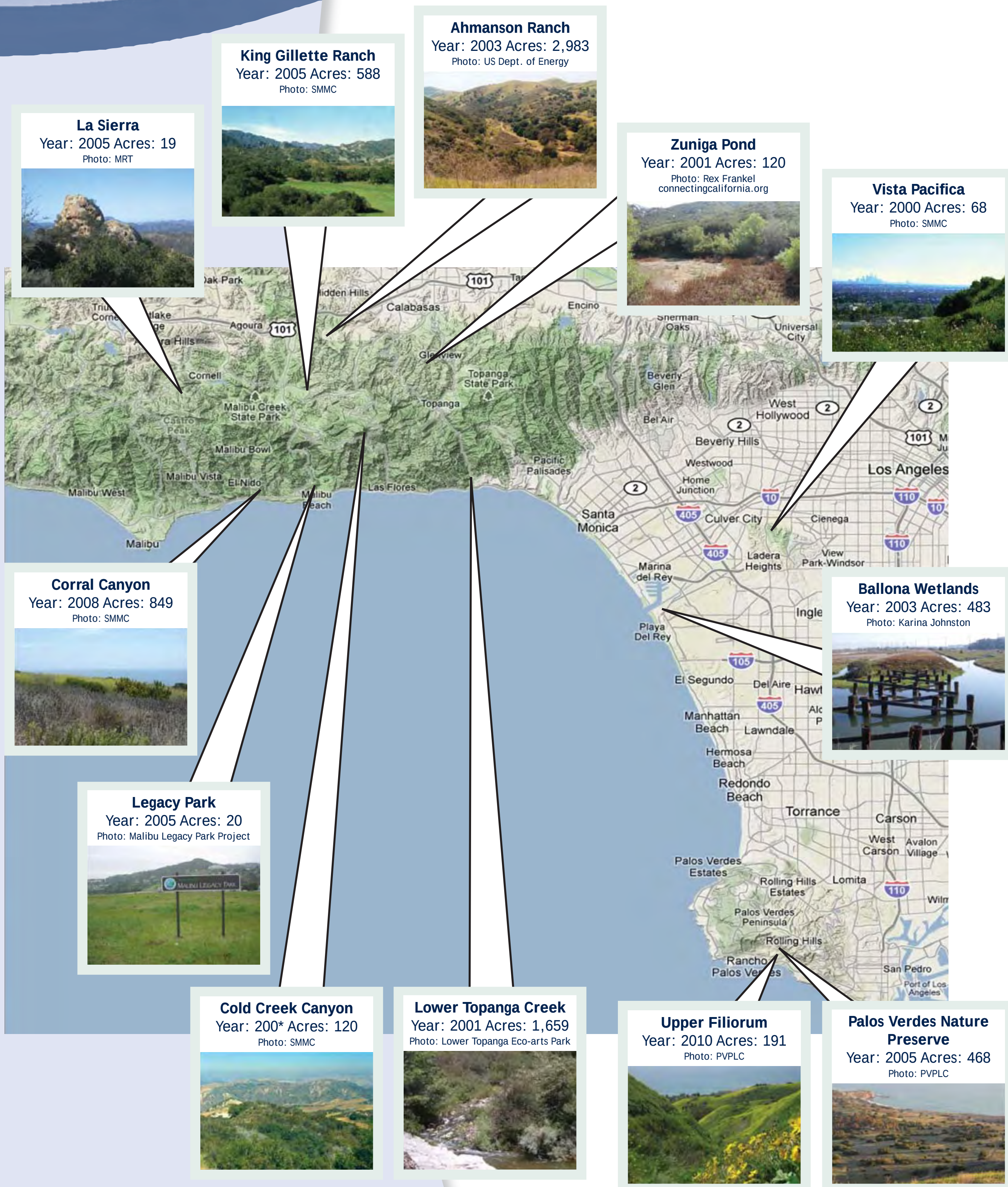
2008: An easement on the beach property connected the Carbon Beach East access way to existing beachfront easements, creating 280 linear feet of new public beach.

2009: Terranea Resort opened in Palos Verdes Peninsula, re-opening public beach access at the old Marineland site.

Three new gateway parks were added to improve existing access points to the Ballona Creek Trail at intersections with Sepulveda Boulevard, Inglewood Avenue, and McConnell Avenue.

At press time, two projects are in the process of improving public access to the Ballona Wetlands. Access points to enter the wetlands from Marina del Rey and Playa Vista are under development. Perimeter trails and signage programs are planned and could be implemented in the next twelve months by the State Coastal Conservancy, the California Department of Fish and Game, the State Lands Commission, and other partner organizations.

Figure 2-7. Map of Santa Monica Bay Watershed Showing the Location of Major Natural Areas Acquired to Preserve Open Space in the Last Decade
Data Sources: SMBRC, Mountains Restoration Trust (MRT) and Google.



3. Habitat Conditions

3. Habitat Conditions

The Santa Monica Bay and its watershed encompass many types of habitats (see Figure 3-1). These habitats support essential ecosystem functions such as nutrient cycling, water purification, and flood control as well as providing life's basic necessities for the species that inhabit them.

It is important to periodically assess the health of these habitats so that resource managers can track changes over time, attribute causes to these changes, and ultimately provide policy makers with the information they need to evaluate the effectiveness of current resource protection policies and plan for the future. Recognizing the need for periodic assessments, SMBRC worked with its Technical Advisory Committee to develop a common metric for describing habitat conditions for this State of the Bay Report (see Figure 3-2).

Location of Major Habitat Types
within the Santa Monica Bay and its Watershed

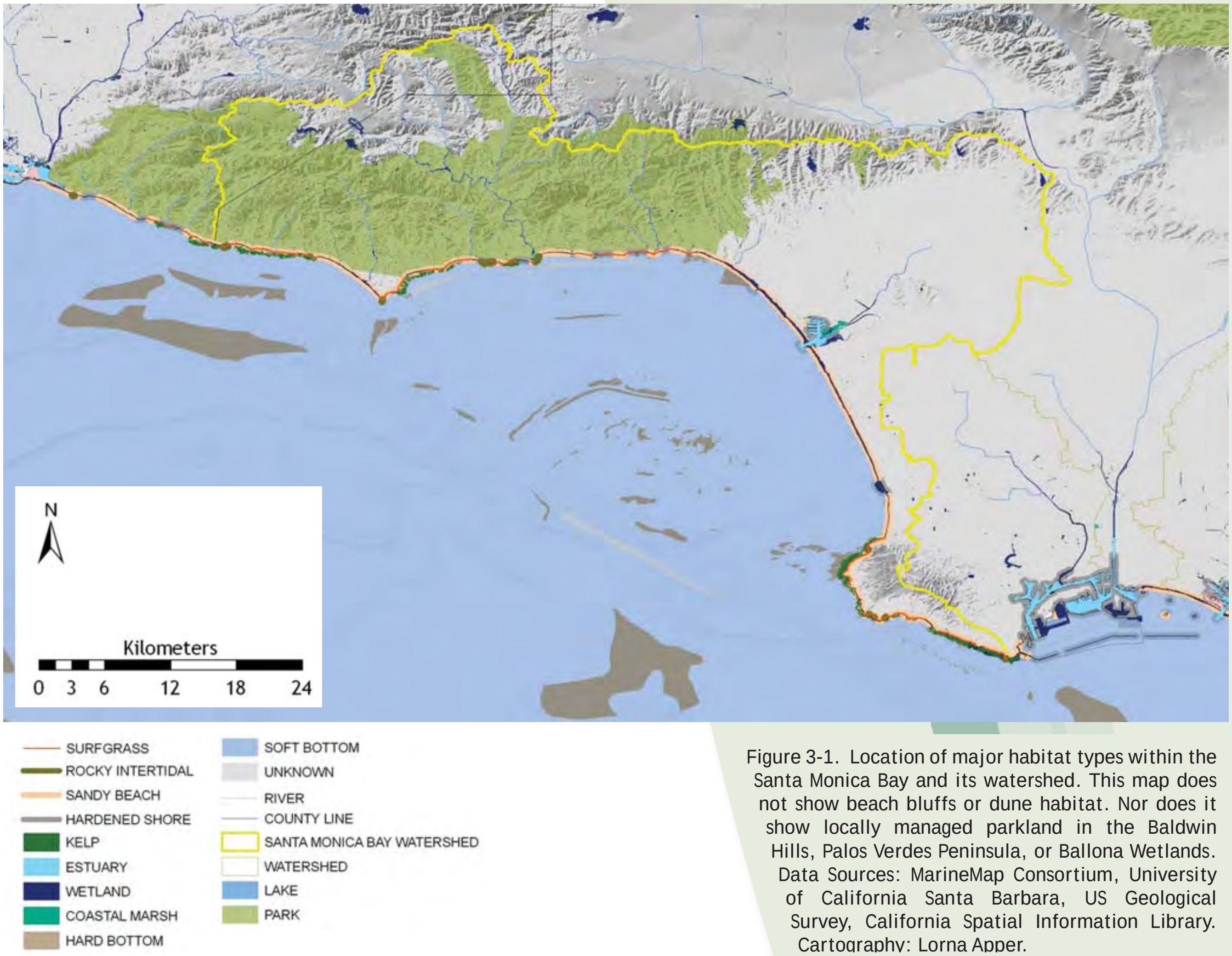


Figure 3-1. Location of major habitat types within the Santa Monica Bay and its watershed. This map does not show beach bluffs or dune habitat. Nor does it show locally managed parkland in the Baldwin Hills, Palos Verdes Peninsula, or Ballona Wetlands. Data Sources: MarineMap Consortium, University of California Santa Barbara, US Geological Survey, California Spatial Information Library. Cartography: Lorna Apper.

Habitat Conditions

The assessments that follow are SMBRC's first efforts to assess the health of the nine major habitats in Santa Monica Bay, using this metric. The assessments contain two types of information: the "Habitat Description", which describes the key features of each habitat, and the "Status and Trends", which provides an assessment of the overall condition of the habitat, major stresses, and the prospects for future change. These assessments are based on the non-human components of the ecosystem only. The effects of the current condition of the habitats in the Bay and its watershed on human health and enjoyment of these resources are discussed in other sections of the Report.

The assessments are based on a variety of quantitative and qualitative information and data. Decades of monitoring has provided a detailed picture of the condition of some of these habitats, such as subtidal soft bottom sediments and kelp canopies. However, for many other habitats in the Bay and its watershed, determining the status and trend is difficult because the data collected have been insufficient in detail or longevity.

To improve information gathering for future assessments, the SMBRC developed a Comprehensive Monitoring Program (SMBRC, 2007). The Program identifies indicators of habitat health for each habitat in the Bay and its watershed and how to collect the data needed to fill information gaps. As this monitoring program is implemented, future State of the Bay Reports will be able to provide a more quantitative and comprehensive assessment of each habitat.

Figure 3-2. Habitat Condition Characterization for the Santa Monica Bay and its Watershed

Status:	CRITICAL	POOR	FAIR	GOOD	EXCELLENT
Characteristics:	Habitat has lost nearly all characteristic species and does not support key ecosystem functions.	Biodiversity is significantly reduced, many characteristic species are absent or major communities are impaired, such that some ecosystem function is lost	Biodiversity is clearly reduced, including loss of some characteristic species. All major ecosystem functions are present, but may be at reduced level.	Slight changes in biodiversity. Conditions may not be equivalent to pristine habitat, but significance of ecological differences is uncertain. Changes may be due to natural variations.	Ecosystem function is equivalent to the best expected for the region.

How to Read the Habitat Conditions Assessment

Status:

- The box outlines the full range of conditions of a given habitat type.

Trends:

- An arrow pointing to the right indicates a positive trend.
- A double headed arrow indicates that conditions are neither improving nor declining.
- An arrow pointing to the left indicates a negative trend.

In General:

- Dashed lines indicate that the assessment for that given habitat type is based on limited data.

How are status and trend determined?

The assessments in this section reflect the best professional judgment of the researchers familiar with the habitats in the Bay and its watershed. The assessments reflect the researchers' interpretations based on a combination of available data, some of which is qualitative. In the few cases where quantitative indices exist for one or more aspects of the habitat, the index is incorporated into the assessment and is noted as such.

The "Status and Trends" discussions are an integral part of the habitat condition assessment, as they provide the context, reasoning, and qualitative descriptions for the assessments.

LProtopapadakis

Habitat Conditions

Creeks and Streams

Habitat Description

At one time, the Santa Monica Bay watershed was covered with a web of creeks and streams that were fed by seasonal rains and natural springs. Many of the natural streams in the watershed were intermittent, with greatest flows occurring in the wet season during winter. However, the large volumes of imported water now used outdoors and year-round to water landscaped areas (City of Los Angeles Department of Water and Power, 2008; West Basin, 2008) cause many historically intermittent streams to flow year-round today.

There are twenty-eight distinct drainage basins in the Santa Monica Bay watershed, with more located in the north part of the Bay watershed than the south. Malibu Creek is the largest un-channelized creek in the Bay watershed. Many of the other creeks and streams in the eastern Santa Monica Mountains are confined to concrete channels for at least parts of their lengths.

The Ballona Creek drainage basin dominates the coastal plain. At 130 square miles, it is the largest sub-watershed draining to the Santa Monica Bay. Ballona Creek drains portions of west central Los Angeles and several other cities, and 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.

The riparian zone is the interface between land and stream. Riparian corridors in the Bay watershed are important habitats for many plants, invertebrates, fish, amphibians, reptiles, and birds. Streams in the Santa Monica Mountains provide critical habitat for endangered species, such as the southern steelhead trout, California red-legged frog, and the southwestern pond turtle. In addition, the riparian zone is a biofilter, protecting creeks and streams from the harmful effects of urban runoff.

Status and Trends

↔ CRITICAL to EXCELLENT depending on location

Little riparian habitat remains in the coastal plain of the Santa Monica Bay watershed, due to the channelization of Ballona Creek and most of its tributaries. Therefore, conditions of most of the streams in this area are considered CRITICAL to POOR due to the complete or nearly complete loss of their ecological functions. In the Santa Monica Mountains, a few streams such as Arroyo Sequit, Cold Creek, and Solstice Creek remain in relatively natural states, and their conditions are considered GOOD or EXCELLENT. In the rest of the Santa Monica Bay watershed, many streams can only be considered FAIR or POOR, due to water quality degradation from pollution, invasions of non-native species, and disruptions to natural stream flows.

Historically, the streams flowing out of the hills and onto the coastal plain would meander or braid before gradually making their way to the ocean through the once expansive Ballona Wetlands. Now, concrete channels have replaced these diverse habitats, and rainwater is prevented from soaking into the ground. Polluted runoff from surrounding development further damages the wildlife that still lives in these streams. Man-made barriers, such as dams or roads, often block access to upstream habitat for the southern steelhead trout and other species. More than 80% of southern steelhead trout spawning habitat and 60% of their rearing habitat is inaccessible in Malibu Creek as a result of these barriers (California Trout, 2006) (see Section 5.4 for more discussion of southern steelhead trout).

A positive trend is that efforts to protect or restore streams in the watershed have gained momentum and achieved some success in recent years. Several projects to remove small barriers blocking fish passage and to control invasive species have been completed successfully, and further improvements are expected from similar, upcoming projects. However, the municipal codes of most local watershed cities currently do not sufficiently protect streams. Instead they allow encroachment and further urbanization. Conditions of streams in urbanized areas could start to improve if measures such as stream protection ordinances and stream restoration projects, similar to those completed in Las Virgenes Creek, are done at more locations (see Section 5.1 for more about these projects).

While physical alterations of the riparian areas in the watershed, such as channelization and culverting, will ultimately need to be corrected, improving water quality will also be critical for the restoration of these areas to GOOD or EXCELLENT conditions. The development and implementation of trash, metals, and nutrient TMDLs can help to reduce the adverse impacts of pollution on wildlife and habitat quality (see Section 4.1 for more discussion).

Habitat Conditions

Coastal Wetlands & Lagoons

Habitat Description

Coastal wetlands and lagoons are estuaries formed at the mouths of rivers and streams where fresh water and salt water meet. In general, wetlands are permanently or semi-permanently open to the ocean while lagoons are seasonally separated from the ocean by sand bars. The largest coastal wetland in the Santa Monica Bay watershed is the Ballona Wetland Complex, which includes Ballona Creek and Lagoon, Del Rey Lagoon, and other salt marsh, mudflat, dune, and bluff habitats. Other major estuaries in the Bay watershed include Malibu Lagoon, Lower Zuma Creek and Lagoon, Topanga Lagoon, and Trancas Lagoon.

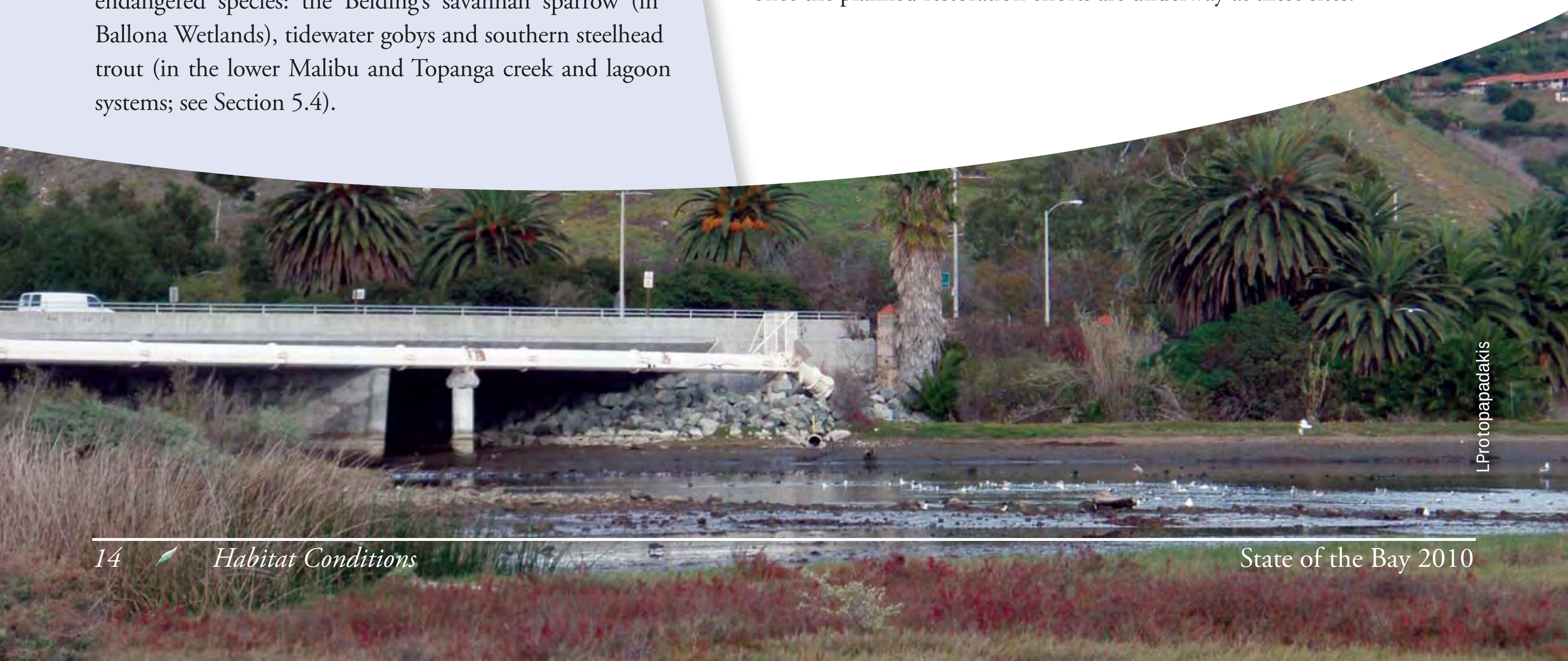
Wetlands and lagoons are among the most productive ecosystems in nature, providing essential habitat for a variety of species, including birds, fish, reptiles, invertebrates, mammals, and vegetation. Many are uniquely adapted to periods of inundation and saturation. In addition to the species common to most wetlands and lagoons in the southern California Bight (the offshore waters of Southern California from Point Conception to the Mexican border and including the Channel Islands), the Bay's wetlands are home to at least three federally endangered species: the Belding's savannah sparrow (in Ballona Wetlands), tidewater gobys and southern steelhead trout (in the lower Malibu and Topanga creek and lagoon systems; see Section 5.4).

Status and Trends

POOR with one GOOD exception

Urban sprawl, oil and gas exploration, the development of Marina del Rey, channelization, dredging, filling, and other human activities have reduced wetland acreage to less than 10% of its historic dimensions in the Bay watershed. The conditions of most of the remaining wetlands are considered POOR because they are also severely degraded due to poor tidal exchange, polluted runoff, and the presence of invasive plants and animals. One exception is Zuma Lagoon, where a restoration project completed by the National Park Service and the SMBRC in 2001 helped to improve habitat and restore some of the lagoon's ecological functions. The Zuma Lagoon is considered to be in GOOD condition (Tiszler, 2001). However, modifications to the upstream hydrology and recent efforts to control mosquitoes, including vegetation removal and pesticide applications, continue to threaten the lagoon's restored ecology (see Section 5.1 for more detail).

The existing areal extent of the wetlands and lagoons is expected to remain the same or increase slightly. This is because almost all remaining wetland and lagoon habitats are under public ownership, mainly due to recent acquisitions by the State. Some progress has been made toward restoring hydrological and ecological functions at the remaining wetlands and lagoons, although these efforts are still in their planning stages, such as Ballona Wetlands, or in the early implementation stage, such as Malibu Lagoon and Topanga Lagoon (see Section 5.1 for more detail). Conditions are expected to improve once the planned restoration efforts are underway at these sites.



Habitat Conditions

Coastal Dunes & Bluffs

Habitat Description

Beach bluffs and coastal dunes are consolidated sandy soils formed from old coastal dune systems. Historically, the coastal dune system extended as a series of ridges and troughs along much of the Santa Monica Bay coastline. Today, however, they exist as isolated patches surrounded by urbanized coastline, or within relatively small restoration areas.

Remnant bluff habitats are located along the Malibu Coast, particularly around Point Dume and Westward Beach, along the Pacific Palisades and Santa Monica coastlines, and on the Palos Verdes Peninsula. Traces of the historical El Segundo dune system (the long stretch of bluffs and dunes from the mouth of Ballona Creek to the Palos Verdes Peninsula) still exist along the South Bay coast as a beach-facing, narrow strip restricted between the bicycle path and urban development. Due to various preservation and restoration efforts, beach bluffs and coastal dunes also exist near Los Angeles International Airport (LAX), in the Ballona Wetlands, on the property of Hyperion, at the recreational Sand Dune Park in Manhattan Beach, and along a narrow strip in Redondo Beach.

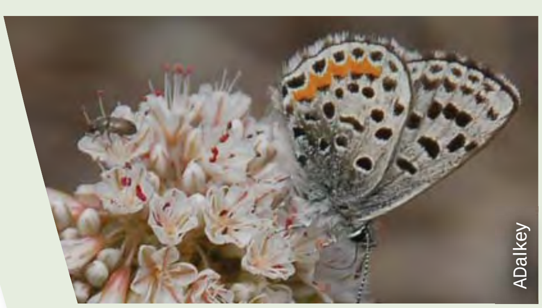
Historically, beach bluffs and coastal dunes supported rich and diverse flora and fauna, depending on the distance of the habitat from the ocean and the degree of soil consolidation. The sand bluffs and dunes supported coastal strand, dune scrub, or bluff scrub coastal vegetation communities and the now rarely seen silvery legless lizard, Pacific pocket mouse, bobcat, and California condor. Bluffs and dunes along the Bay's coastline are important habitats to many endemic species, such as the El Segundo blue butterfly, which are adapted to their unique environment. Because of the biogeographic isolation of the El Segundo dune system, the flora and fauna are locally unique communities and highly vulnerable to extinction due to their relatively small population size (see Section 5.4 for more detail).

Status and Trends

POOR with one GOOD exception

Construction at LAX, oil refining, sand mining, and urban development have all claimed large portions of the Bay watershed's historical dune habitat. Nearly all of the remaining coastal dune and bluff habitats along the Santa Monica Bay coast and on the Palos Verdes Peninsula are considered in POOR condition due to severe degradation, primarily from invasive plants, coastal development, and erosion. The largest remaining contiguous dune habitat, located near LAX, is considered in GOOD condition. This is largely because the site is currently closed to most human disturbances and contains a thriving population of the El Segundo blue butterfly, which depends exclusively on the native vegetation still present at the site.

Progress has been made to prevent further damage to the remaining dune and bluff areas and to restore degraded habitats, primarily through invasive plant removal and planting of native vegetation. The El Segundo blue butterfly recently re-colonized the newly restored beach bluff sites in Redondo Beach. However, considerably larger areas of bluff habitat restoration may be needed to ensure the recovery of this butterfly (Longcore, T. (Ed.), 2005) (see Section 5.1 and 5.6 for more discussion of dune restoration and the El Segundo blue butterfly, respectively).



Habitat Conditions
Sandy Beaches

Habitat Description

Sandy beaches are the most prominent and dominant habitat along the Santa Monica Bay shoreline, extending over fifty miles. Typically, sand is eroded from beaches in winter and deposited in summer, which sometimes results in dramatic seasonal changes in beach slope and width.

Sandy beaches are highly prized for their social and economic uses, but they are also unique and biologically diverse ecosystems. Ecologically speaking, sandy beaches in southern California can be productive habitats for marine life, with up to twenty-five species of macro invertebrates, including sand crabs and Pismo clams. Sandy beaches also support surf fish, such as California corbina, barred surfperch, and shovelnose guitarfish, which are caught by sport fishermen in the surf zone or on piers. Sandy beaches along the Bay provide foraging and roosting habitat for dozens of species of shorebirds as well as nesting grounds for the endangered California least tern. Many sandy beaches along the Bay are important spawning grounds for California grunion, and the annual grunion runs are considered among the most spectacular natural wonders in California (see Section 5.4 for more on these species).

Status and Trends

POOR to FAIR depending on location

Overall, the ecological conditions of the sandy beaches along the Bay range from POOR to FAIR depending on the location and level of manipulation, such as beach grooming, beachfront development, beach infrastructure, and inputs from storm drains. The sandy beaches along the Bay are heavily used as a cultural and recreational resource by millions of people, including residents and visitors from around the world. The Bay's beaches are primarily managed for recreation and human safety, rather than for their value as habitat for coastal and marine species.

In many areas, the sand substrate has been frequently altered by additions of imported or dredged sand, mechanized maintenance, and coastal armoring of the shoreline. Over the years, beach nourishment projects have also added about 23 million cubic meters of sand to the shores along the Bay, resulting in beaches that are wider than they were historically. Coastal armoring, such as rock revetment, jetties, and seawalls, constructed to protect roads and residential housing, are present along many of the Bay's beaches. Coastal armoring alters the natural sedimentation-erosion patterns of the shoreline and may cause increased erosion and loss of habitat.

Between 1933 and 1995, Los Angeles County surveyed beach profiles along approximately twenty-two miles of coast in the Santa Monica Bay. These surveys revealed that the shoreline of Santa Monica Bay advanced seaward from 1935 to 1990 due to coastal armoring (Maalouf et al, 2001). Although the long-term environmental impacts of these human actions on the beach ecosystem are still being studied, many of the sandy beaches along the Bay have lost at least some of their ecological functions, especially those functions associated with burrowing invertebrates and bird species richness.

In recent years, progress has been made to improve habitat value and lessen the impacts of intense human use on certain species. One example is the expansion and improvements at the least tern colony at Venice Beach, and the western snowy plover nests found at Zuma, Surfrider, and Santa Monica beaches (see Section 5.4). Another example is the implementation during grunion spawning season of a beach grooming protocol that protects the incubating grunion eggs that are buried in the sand. These measures seem to be working, as indicated by increased least tern breeding success and healthier grunion runs. However, a more comprehensive management plan is needed in order to further improve our sandy beach protection and restoration efforts.

Habitat Conditions
Rocky Intertidal

Status and Trends

Mostly POOR with a few FAIR exceptions

The conditions of the rocky intertidal habitats along the Bay are considered to be mostly POOR with the exception of a few locations still considered FAIR, mainly due to lower levels of human use, such as Inspiration Point on the Palos Verdes Peninsula. The POOR condition determination arises from a dramatic decline in the population of rocky intertidal organisms and evidence of decreased biodiversity, percentage of plant cover, organism size, and density of rare, large, conspicuous species such as octopi and sea hares.

Historical overharvesting of species, such as black abalone, has helped create the POOR condition of rocky intertidal habitat. Unfortunately, POOR conditions persist, possibly worsening in some places, even where legal harvesting prohibitions are in place, such as the two small protected areas on the Palos Verdes Peninsula. The most likely causes include ongoing overharvest of intertidal species, such as keyhole limpets, for commercial uses and by shore fishermen looking for bait, as well as disturbances by shell collectors and contamination from storm drain runoff in some areas. A 2004 study conducted by the SMBRC demonstrated that Santa Monica Bay rocky intertidal sites receive a plethora of visitors. Visitor activities, such as rock turning, collecting, and inadvertent trampling, have damaged many intertidal species and the biological community as a whole (Ambrose & Smith, 2004).

Sadly, many harmful activities continue despite prohibitions against them, such as poaching mollusks from existing protected areas. Other harmful activities, such as trampling, are not yet prohibited, even in the existing marine protected areas, and a few harmful activities have actually been encouraged by marine educators, such as moving lower intertidal species to the upper intertidal (where they will not survive). Without more restrictions, the prospect for rocky intertidal habitat improvement along the Bay is dubious. However, implementing new restrictions must also be accompanied by resources for enforcing them, in order to successfully improve these habitats.

Habitat Description

Rocky intertidal areas along with mixed rocky and sandy shoreline cover approximately 30% or twenty miles of the Santa Monica Bay's coastline. In the northern part of the Bay, rocky intertidal habitat is found intermittently between the Ventura County line and Will Rogers State Beach in Pacific Palisades. The Malibu coastline is a mixture of rocky reefs and sandy beaches. Most of the rocky intertidal habitats in this area are comprised of boulders, with some bedrock benches. These habitats are also heavily influenced by sand, with pronounced sand scouring and the seasonal coverage of intertidal rocks by sand.

In the southern part of the Bay, rocky intertidal habitats are found from Malaga Cove to Point Fermin on the Palos Verdes Peninsula. The Palos Verdes shoreline consists largely of rocky habitat, both bedrock benches and boulder beaches, at the bases of steep cliffs, and is much less influenced by sand than in Malibu. The very different geomorphologies between the north and south influence the rocky intertidal communities, with some species that are adapted for different features and generally occur in either the north or the south portion of the Bay.

The rocky intertidal areas are an important interface between the sea and the land, providing habitat for numerous and diverse species. Wave-cut rocky platform is the most common rocky shore type found along the Bay, and it supports rich tidepool and intertidal communities, including many species of barnacles, limpets, rockweed, mussels, turfweed, and surfgrass. The splash zone is characterized by periwinkles, barnacles, limpets, and rock lice. Diversity increases in the upper intertidal zone, with additional species of snails, attached bivalves, chitons, and hermit crabs. The lower intertidal zone transitions to the subtidal habitats with many species of sponges, mollusks, crustaceans, sea stars, and octopi all present in large numbers.

Habitat Conditions
Seagrass Beds

Habitat Description

Seagrass refers to both surfgrass and eelgrass. Surfgrass occurs on rocky substrates in the high-energy habitats of the low intertidal and shallow subtidal reef. Surfgrass is more prevalent in the Bay than eelgrass, so surfgrass' distribution, abundance, and status and trends are better understood.

The composition of biological communities in Santa Monica Bay's surfgrass beds is typical of low rocky intertidal habitats, except for some specialized species. California spiny lobster and rock crabs take refuge underneath the surfgrass canopy, and many nearshore subtidal fish seek food and shelter above these beds. Surfgrass beds are common within the northern part of the Bay off Malibu and particularly abundant north of Lechuza Point. Abundant surfgrass beds also exist off the north-west side of the Palos Verdes Peninsula (Egstrom, 1974).

Eelgrass beds important habitats in shallow bays and estuaries. In the Santa Monica Bay, eelgrass beds provide refuge for resident species and also serve as nursery areas for many commercially and recreationally important finfish and shellfish. Currently, eelgrass distribution is not well mapped in the Bay. However, divers have reported seeing patchy eelgrass beds in deeper water (twenty to fifty feet) off Malibu, north and south of Point Dume. Others have reported eelgrass in Basin D in Marina del Rey. However there is no record of eelgrass off the Palos Verdes Peninsula (Alstatt & Engle, 2009).

DPondella

Status and Trends

FAIR to GOOD based on limited data

Conditions of seagrass beds in the Bay are considered FAIR to GOOD because of the abundance and extent of surfgrass beds off Malibu and Palos Verdes. Additionally, the patchy eelgrass beds off Malibu do not appear to be substantially different from historical reports. However, this assessment is based on limited data and may change as more information is collected.

Surfgrass abundance changes seasonally and from year to year, based on past reports, the long-term trend has been decline. Additional substrates suitable for surfgrass exist in the Bay along several segments of the Malibu coast and most of the Palos Verdes Peninsula, but surfgrass does not currently grow on these substrates. While eelgrass is known to occur along the Malibu coast, reports indicate that this growth has never formed solid beds, and uncertainty remains about its current abundance and condition. Further assessments need to be conducted for both of these species in order to better manage the existing habitat and possibly restore historical habitats in the future.

DPondella

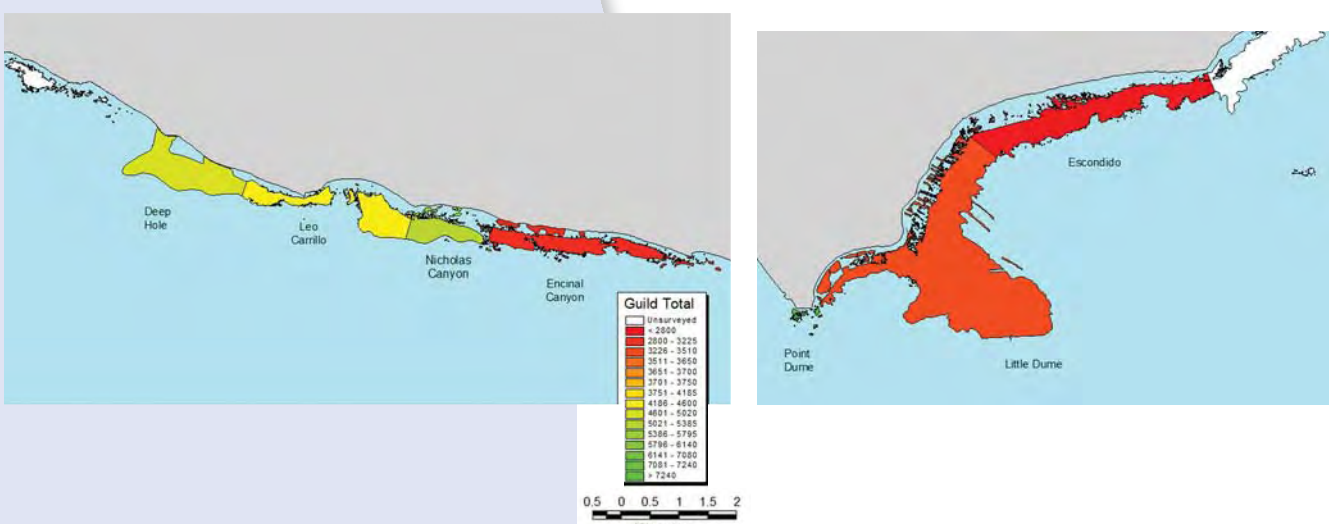
Habitat Conditions
Rocky Reefs

Habitat Description

In Santa Monica Bay, hard bottom rocky reefs and outcrops are primarily located in the shallow subtidal zone off Malibu and Palos Verdes. These rocky reefs are primarily composed of sedimentary strata, marked by shale boulders and shelves separated by reaches of sand and cobble.

Although the rocky reefs are 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 that cover some rocky reefs. The kelp beds provide protection and habitat for more than eight hundred species of fishes and invertebrates, some of which are uniquely adapted for life in the kelp. Because of the diverse and abundant assemblage of organisms, rocky reefs in the Bay are important sites for recreational diving and fishing. The key commercial and recreational species in this habitat are lobsters, kelp bass, and white seabass. The protected giant sea bass is another key species, and its population is now recovering due to protections against overfishing.

Current Condition of Rocky Reef Habitat in the Santa Monica Bay



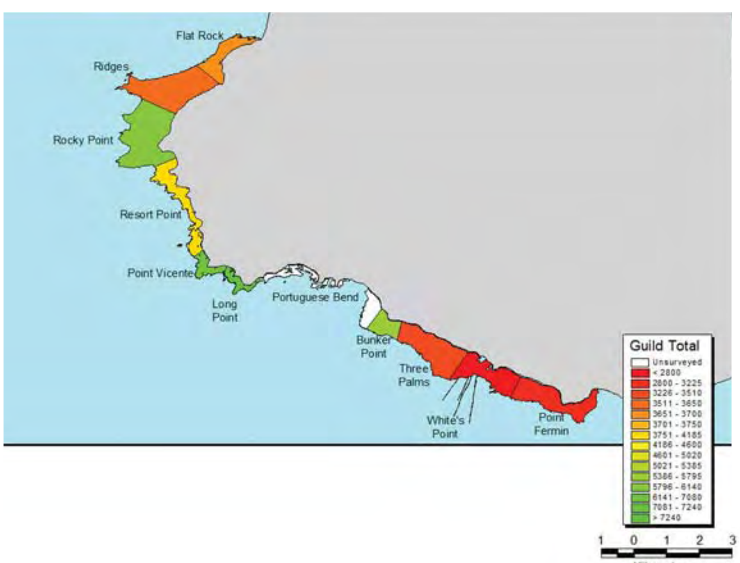
Status and Trends

CRITICAL to FAIR depending on location

The condition of the Bay's nearshore rocky reefs varies greatly from location to location, ranging from CRITICAL to FAIR, with some signs of improvement. Kelp canopy, probably the most important indicator of health for rocky reef habitats, now covers many of the rocky reefs off both the Malibu coast and Palos Verdes Peninsula. The recovery is especially noticeable off Palos Verdes and is largely linked to the drastic reduction in the discharge of suspended solids from JWPCP and the relocation of its ocean outfall further offshore, as well as efforts to restore this habitat (see Section 5.1 for more on kelp restoration). However, the current extent of kelp canopy is still less than 25% of the highs recorded one hundred years ago.

The rocky reefs considered in CRITICAL condition, such as the habitats off the southeast end of Malibu and near the Portuguese Bend landslide on Palos Verdes, have been buried by excessive sediment deposits, which cover up the rocky substrate needed to support kelp growth. Other reefs have suitable substrate but continue to be bare, such as the areas off the southwest face of Palos Verdes from Rocky Point to Bunker Point. Several factors may contribute to this situation, including the overharvesting of key sea urchin predators, such as the sea otter, California spiny lobster, and California sheephead. Without these important predators, herbivorous sea urchins dominate the reef and displace hundreds of other species. These denuded rocky reefs are also more prone to invasion by non-native species.

Figure 3-3. Current condition of rocky reef habitat in the Santa Monica Bay. This habitat value model uses trophic levels (feeding guilds), a diversity factor (# of guilds), population density, fish size, and species fidelity. Surveys were conducted by divers in 2007 and 2008. Conditions are scaled from red (critical) to green (good). White areas have not been surveyed (Pondella, 2009).



A 2007-2008 survey of twenty-nine natural reefs from Point Conception to San Diego found that of all the reefs surveyed, eight of the ten in the best condition, based on fish guilds, were in Santa Monica Bay (Pondella, 2009) (see Figure 3-3). The closure of much of the Bay to commercial fishing in the 1950s partially explains why reefs in Santa Monica Bay are in better condition than elsewhere. However, even reefs in *relatively* good condition are under significant stress from recreational fishing and are only considered to be in FAIR health (see section 5.5).

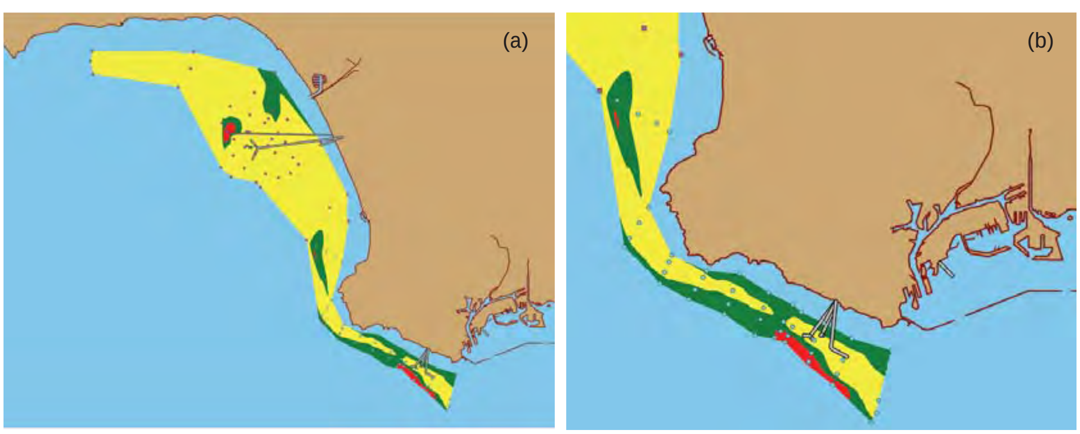
It appears that the conditions of the nearshore rocky reef habitats will continue their upward trends of the last twenty years. Sea urchin removal, kelp transplanting, and sediment scouring will help to create more suitable substrate and restore degraded kelp habitats. Additionally, the establishment of Marine Protected Areas will prevent over exploitation of key predators that are critical in maintaining the habitat's function (see Section 5.6). However, increases in ocean temperature as a result of global climate change may create conditions that are less favorable for giant kelp growth, which would make this ecosystem even more vulnerable to further degradation.

Habitat Conditions
Soft Bottom

Habitat Description

Soft sediments, composed of sand, silt, and clay, make up the majority of the bottom habitat in the Bay. Soft sediments provide both a home and food source 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 flatfishes, rockfishes, sculpins, combfishes, and eelpouts. Some of these fish, such as California halibut, California scorpionfish, barred sand bass, and white croaker, also account for a significant percentage of recreational fish catch from piers and boats. Unfortunately, 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.

Color-coded Map of Soft Bottom Quality



- Defaunation
- Loss of community function
- Loss of biodiversity
- Marginal deviation from reference
- Reference conditions

Figure 3-4. Color-coded Map of Soft Bottom Quality in (a) the Bay and (b) the Palos Verdes Shelf, based on the benthic surveys conducted by the POTWs. Results are derived from the benthic response index, which measures the health of the benthic infaunal community. Data Sources: LACSD and CLA-EMD.

Status and Trends

POOR to EXCELLENT depending on location

The present day condition of the Bay's soft bottom habitat shows substantial improvement over the severely degraded conditions that existed for most of the last seventy years. This is largely a result of improved treatment of sewage and control of historical pollution sources (see Section 2.1). *Most* of the habitat can now be considered in FAIR to EXCELLENT condition because it supports healthy benthic infaunal communities that are similar to those present within unpolluted reference areas (see Figure 3-4a). Benthic infauna, probably the best indicator of health for soft bottom habitats, are animals, such as worms, that live within the upper layers of marine sediments.

However, one concern that has not been resolved by improved wastewater treatment is the legacy contamination of sediments around the JWPCP outfall on the Palos Verdes Shelf. These sediments are contaminated with high levels of DDT and PCBs and are a primary source of contamination of fish, marine mammals, and birds feeding in the area. The overall condition of the habitat on the Palos Verdes Shelf is still considered POOR because the sediment contamination continues to put the health of the entire food-web at risk, despite the much improved health of the benthic infaunal community as indicated by the Benthic Response Index (see Figure 3-4b) (see Section 5.4 for a more detailed discussion of this issue and remediation plans).

In the foreseeable future, the condition of the Bay's soft bottom habitat is expected to improve further. Since pollutant loads from point source discharges continue to decline and should remain low, natural processes will decompose and bury the historical sediment contamination. Additionally, the rate of recovery of contaminated sediment around JWPCP's outfall on the Palos Verdes Shelf may increase with remediation, as the USEPA moves forward with its plan to cap the most contaminated area with clean sediments (USEPA, 2009). However, the soft bottom habitat does face other stresses, and future trends and impacts are unclear. These stresses include contaminant loads from stormwater runoff, recreational fishing, and discharges of new and unregulated chemicals whose effects are poorly known (see sections 4.1, 5.5, and 6.4, respectively).

Habitat Conditions
Open Ocean

Habitat Description

The open ocean, or pelagic, habitat is the most extensive habitat in the Bay, ranging from the surface to depths of 1,600 feet and having a total water volume of about 6.8 trillion gallons. The currents of the Bay are characterized by a clockwise circulation pattern. Two eddies, one near Malibu Point and one near the southern end of the Palos Verdes Peninsula, create water upwelling zones that make abundant nutrients available for marine organisms. The pelagic environment in the Bay supports a wide range of organisms of all trophic levels, from the producers (e.g., microalgae and kelp) to the top predators (e.g., sharks, giant sea bass, dolphins, and eagles).

Because of its central location within the larger Southern California Bight, the Bay's pelagic habitats are an important transition region between the different biogeographies to the north and south. The Bay's pelagic assemblages combine both cold water species from the northern part of the Bight and warm water species from the southern part. The abundance of these diverse species fluctuates as ocean current and temperature regimes undergo cyclic changes. During periods El Niño periods, warm water species (including popular migratory sport fish) increase in abundance, while cold water species either disappear or recruit poorly.

In the Bay, three species of dolphins (bottlenose, short beaked common, and long beaked common dolphins) are present year-round and are known to congregate and feed offshore along the Santa Monica and Redondo submarine canyons, where food is plentiful (see Section 5.4 for more). Baleen whales also are routinely observed feeding in the Bay. Populations of several important commercial fishery species in the Bay has fluctuated greatly during the last century, following the same trends observed in the rest of the Bight.

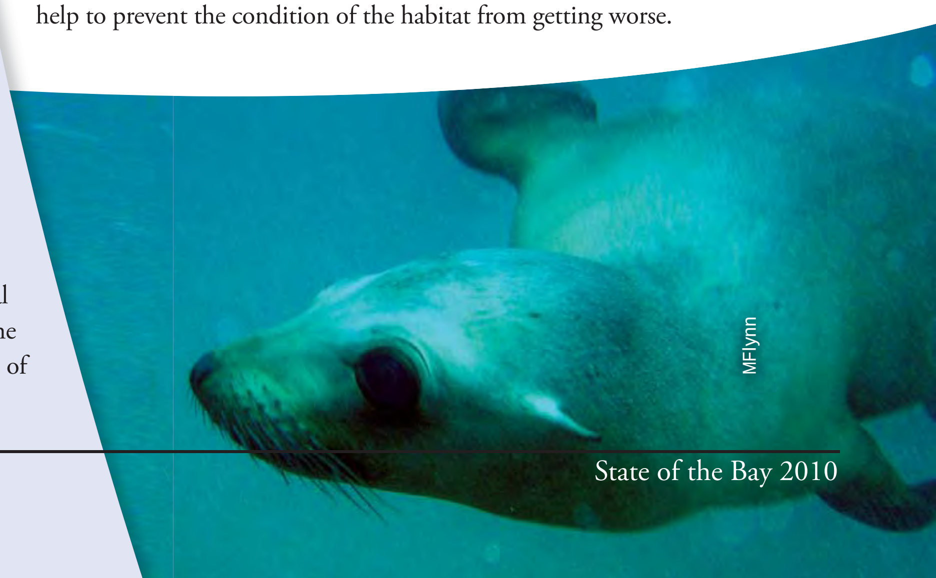
Status and Trends

FAIR to GOOD based on limited data

Condition of the Bay's open ocean habitat is considered FAIR to GOOD based on limited data from specific studies of algal blooms, phytoplankton and zooplankton, fish and mammal assemblage and population, contaminant burdens, and commercial and sportfish catch efforts. Offshore areas appear to fare better than nearshore areas due to fewer and less severe impacts from the myriad of human activities.

Highly migratory and pelagic marine species are in decline Pacific-wide (Meyers & Worm, 2003). This decline in the abundance of apex predators is having as-yet-unmeasured repercussion throughout the food-web. Many marine fishes, mammals, and seabirds forage on coastal pelagic species, which are also the targets of the largest commercial fishery in California. The allowed take for this fishery has been increasing over the past few years, possibly in response to overfishing of many of their predators (Worm, et al., 2009) (see Section 5.5 for further discussion on local fisheries and fishery management).

However, the condition of the open ocean habitat may worsen due to the cumulative effects of several known and potential impacts. Fish and marine mammals continue to show elevated contaminant burdens originating from historical deposits in the Bay. There is evidence that these fish and mammals are also accumulating additional contaminants of emerging concern (see Section 6.4 for further discussion). Overfishing, in conjunction with the high mortality of larval and juvenile marine life due to the water intake pipes of coastal power plants, could result in declining fish stocks and other marine species (see Section 4.3 for further discussion). Harmful algal blooms appear to be getting more severe, due to climate change effects and increased nutrient inputs, and could devastate the health of open ocean habitat (see Section 6.2 for further discussion). Furthermore, ocean acidification, also spurred by climate change, will also have devastating impacts on the many microscopic organisms that have calcium carbonate skeletons or shells, and these organisms are critical primary producers in the ocean (Orr, et al., 2005). On the other hand, new control measures for pollutant loading, marine protected areas, and other fishery management measures, if enacted, may help to prevent the condition of the habitat from getting worse.



4. Focus on Water Quality

Poor water quality has been a major problem in the Santa Monica Bay for many years. The Bay's adjacent highly urbanized coastal plain—one of the most populous areas in the nation—generates large quantities of hundreds of different kinds of pollutants, many of which end up in the Bay. The pollutants of greatest concern, due to their adverse or potentially adverse impacts on the Bay's beneficial uses, are pathogens, trash, metals, DDT, PCBs, and nutrients. Known impacts of these pollutants include health hazards for humans due to pathogens in the surf zone, aesthetic impacts of trash along the Bay's beaches and streams, and chemical contamination of local fish, to name a few.

At one time, ocean outfalls operated by the region's two largest wastewater treatment facilities were the primary pathways for many pollutants of concern entering the Bay. The amount of pollutants discharged through these outfalls has been greatly reduced in the last few decades (see Section 2.1). Today, thousands of miles of storm drains throughout Los Angeles County are the primary conduits for pollutant loading. In particular, trash, pathogens, metals, and nutrients wash off the urban landscape, into storm drains, and out to the Bay. In addition, historical deposits of toxins in Bay sediments, such as DDT and PCBs, continue to be released into the environment through biological processes and resuspension, thus contaminating local marine life. Atmospheric deposition (see Section 6.3), boating activities, and septic systems are also known to contribute to contaminants to the Bay.

Pollutant Loading: The concept of "loading" is used to quantify how much pollution is entering the Bay. Pollutant loads are estimates of the total amount of pollutants entering a water body from various sources. Loading is usually expressed in weight per unit time or area (i.e. tons/year or tons/acre).

Efforts to control pollutant loading through the storm drain system and other pathways have increased. The 1998 Consent Decree required the USEPA to develop TMDLs for all major pollutants of concern for the Bay by 2014. Since then, the Los Angeles Regional Water Quality Control Board (Los Angeles Regional Water Board), a state agency, has taken the lead in developing the TMDLs scheduled for Santa Monica Bay. As of June 2009, the Los Angeles Regional Water Board had adopted nine separate TMDLs, which regulate the amount of trash, bacteria, and metals in the Bay and the three major water bodies in the Bay watershed: Marina del Rey, Ballona Creek and its estuary, and Malibu Creek. The TMDLs are being implemented mostly through new control measures incorporated into existing National Pollution Discharge Elimination System (NPDES) permits. At least seven more TMDLs will be developed or adopted in the next five years (see Table 4-1). The development of TMDLs not only played a key role in moving water quality improvement efforts forward; it is also a useful tool in assessing progress toward achieving a numeric target for pollutant loading.

Total Maximum Daily Load (TMDL) is the maximum amount of a single pollutant that a receiving water body can absorb without adversely affecting its beneficial uses. Each TMDL sets a numeric target, which is the desired pollutant load for that water body. The numeric target is the sum of the individual allocations for pollutant loading from all point and nonpoint sources, plus an allotment for natural background loading, and a margin of safety. Under the federal Clean Water Act, water quality agencies must develop and adopt TMDLs for all impaired water bodies in their jurisdictions and ensure implementation of TMDLs through permits or other regulatory means. The NPDES permit program controls water pollution by regulating point sources, including storm drain outfalls, that discharge pollutants into waterways and is the key mechanism used to implement TMDLs.

This chapter examines progress made after the adoption of indicator bacteria and trash TMDLs as well as the adoption of a newer, integrated water resource management approach. Bacteria and trash severely impair the beneficial uses of the Bay and were the earliest pollutants to be regulated in the TMDL process. As a result, some information has been collected on these pollutants in the Bay; however, data are still insufficient to establish long-term trends. Until more monitoring data become available, assessing progress in TMDL implementation must rely primarily on programmatic indicators, such as the status and enforcement levels of local stormwater ordinances or permits, and the number of infrastructure retrofits or other best management practices installed.

In recent years, an integrated water resource management approach has become increasingly recognized as a sustainable solution to water quality problems and a potential tool to achieve compliance with TMDLs. The last part of this chapter examines the current status of this integrated approach and its vast potential for solving multiple water resource issues.

Table 4-1. Status of TMDL Development for Impaired Water Bodies in the Santa Monica Bay Watershed
Data Source: SMBRC

Pollutant	Water Body	Date of TMDL Adoption
Bacteria	Santa Monica Bay dry weather	2003
	Santa Monica Bay wet weather	2003
	Marina del Rey Harbor, Mother's Beach, and Back Basin	2004
	Malibu Creek	2006
	Ballona Creek, Estuary, Sepulveda Channel	2007
Trash	Ballona Creek and Wetland	2002
	Malibu Creek	2008
Marine Debris	Santa Monica Bay	Planned
Metals and Toxics	Ballona Creek, Ballona Creek Estuary	2006
	Marina del Rey	2006
	Malibu Creek	Planned
	Malibu Creek	Planned
Nutrients	Malibu Creek	Planned
Historical Pesticides, Chlordane	Santa Monica Bay	Planned
Habitat Alteration, Hydromodification, Exotic Vegetation	Ballona Wetlands	Planned
Benthic Community Effect	Malibu Lagoon	Planned


LProtopapadakis

Pathogens and Indicator Bacteria

Indicator Bacteria

The concentration of indicator bacteria has been used for decades to measure beach water quality. Indicator organisms, such as fecal coliform, Enterococcus spp., and E. coli, do not necessarily cause disease, but are found abundantly in human fecal waste, the main source of human pathogens. They are therefore used to indicate the presence of pathogens (disease-causing organisms such as viruses), for which detection methods are either difficult, time consuming, costly, or unavailable. Protective levels for bacteria indicators are defined in federal and state recreational water standards. These levels are based on correlations between indicator bacteria concentrations and the incidence of illness in swimmers, which was established by epidemiological studies such as the one conducted in Santa Monica Bay in 1995 (SMBRP, 1996).

4.1 Pathogens and Indicator Bacteria

In 1997, in response to AB411, the State developed and issued new standards and protocols for monitoring beach water quality during dry weather (April to October) and for notifying the public of potential health risks associated with contacting contaminated water in the surf zone. This was an important trigger for the construction of many low-flow diversions built in storm drains emptying to the Bay (see Section 2.2). Six years later, success has been mixed. Water quality is good at most beach locations, meaning it meets the beach water quality standards prescribed by the dry weather bacteria TMDL most of the time. Yet, throughout the year, hundreds of samples still exceed the TMDL standards (Figure 4-2). A closer look at the pattern of exceedances reveals that during the summer dry season, most occur at a few locations, including Surfrider Beach, Santa Monica Canyon, and Santa Monica Pier. Among the sixty-seven sites monitored in the Santa Monica Bay, the eight most persistently problematic sites account for 50-70% of all dry season exceedances in the Bay (Figure 4-3a).

Up to now, low-flow diversion with treatment has been the primary, and most heavily invested-in, tool used by local agencies and municipalities to reduce exceedances of indicator bacteria thresholds at beaches. They have been credited for improving beach water quality during the summer dry season and may still be useful in addressing water quality at some of the persistently problematic sites. For example, the number of TMDL exceedances at the Marie Canyon storm drain outlet in Malibu has declined after a multistage disinfection system became fully operational in October 2007. A project designed to increase the capacity of the existing low-flow diversion project at Santa Monica Canyon (on the northern border of Santa Monica) began construction in October 2009. When coupled with a new sewer line expected to be completed mid-2011, this project will divert dry weather runoff *year-round* and should help to reduce levels of indicator bacteria at one of the most problematic beaches in the Bay (Figure 4-3b).

Number of Samples Exhibiting Bacterial TMDL Exceedances at Santa Monica Bay Beaches

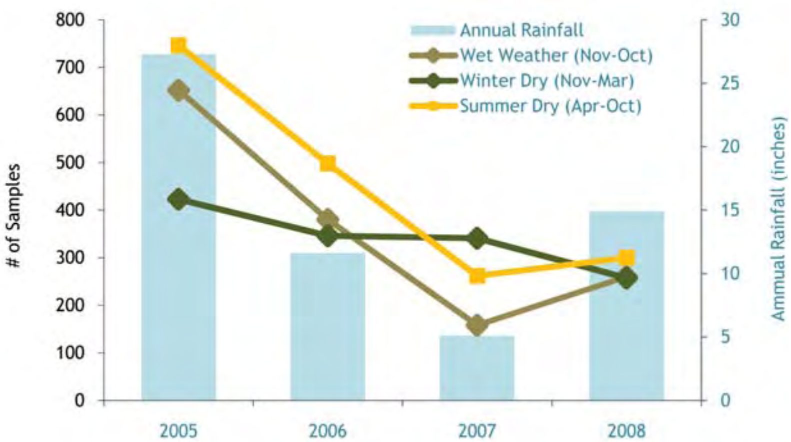


Figure 4-2. Number of samples exhibiting bacteria TMDL exceedances at Santa Monica Bay beaches during wet and dry periods compared with annual rainfall. Note that while the number of wet weather exceedances is similar to those during summer months, the data are not directly comparable because there are significantly fewer sampling days during wet weather. Data Sources: CLA-EMD and Los Angeles County Department of Health Services.

Water Quality
Pathogens and Indicator Bacteria

Although diversion and treatment are proven technologies, they do not solve the pathogen contamination problem at all locations. Other measures are needed to address storm drains with dry weather large flows, such as Ballona and Malibu Creeks, and to address contamination caused by nonpoint sources, such as improperly sited or malfunctioning septic systems. Another drawback of low-flow diversion projects is that they are incapable of handling the large volumes of stormwater generated during rain events and are therefore not a viable option for reducing year-round, all-weather pathogen contamination. This is one of the main reasons why the quality of runoff reaching the Bay is far worse in wet weather than dry weather. Furthermore, poor water quality in wet weather is a chronic problem even at some beaches where water quality is good or excellent during dry weather (Figure 4-4). However, a new phase in water quality management began in 2003, when the Los Angeles Regional Water Board adopted dry and wet weather TMDL limits. These new standards have intensified efforts to address wet weather contamination and are encouraging novel approaches, such as low impact development (see Section 4.3).

In addition to implementing pollution abatement and prevention measures, the success or failure in reducing health risks also depends on the ability to warn the public of the risk accurately and quickly. What is measured, where it is measured, and how long it takes to get results, are all important components in a successful beach monitoring program. For example, indicator bacteria are also commonly found in soils and the fecal waste of many different animals, and from these sources, the bacteria do not necessarily indicate the presence of human pathogens. Methods specific to human pathogens are being developed and tested in order to improve the accuracy of the health warnings.

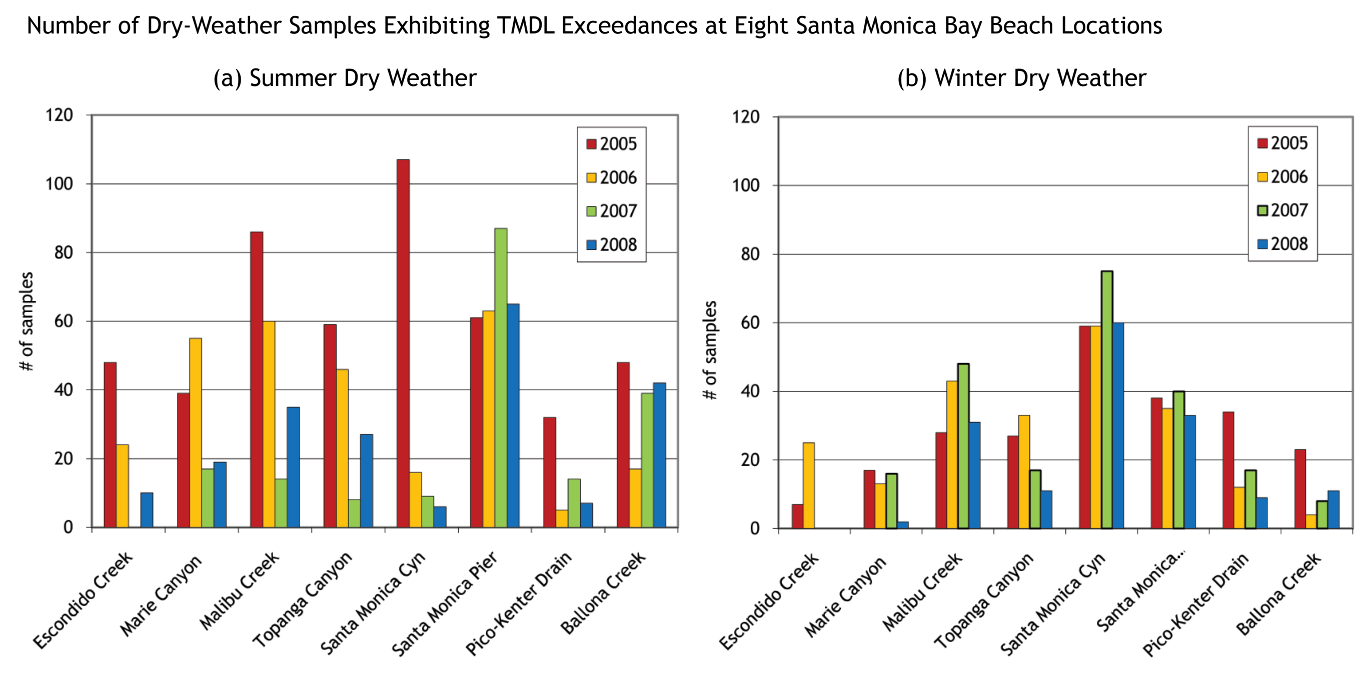


Figure 4-3. Number of (a) summer and (b) winter dry weather samples exceeding TMDL standards at eight Santa Monica Bay beach locations. Note that the Santa Monica Canyon consistently exceeds standards more often during winter dry weather than any other site. Data Sources: CLA-EMD, Los Angeles County Department of Health Services, and Heal the Bay.

In 2004, Los Angeles area stakeholders (i.e., municipalities, Los Angeles County, environmental groups, and regulators) designed and implemented a new beach water quality monitoring program. The Santa Monica Bay Beaches Bacterial TMDL Coordinated Monitoring Program was a significant improvement over the preceding program. This comprehensive monitoring program includes sampling at additional beach sites and at "point zero", where storm drain flows contact and mix with ocean water in the surf zone. The prior sampling points were fifty yards away from this mixing zone, resulting in widely varying results, due to unpredictable mixing and transport. The new protocols provide a more conservative assessment of risk to swimmers. However, measurements taken at point zero result in concentrations that are many times higher than those from samples collected fifty yards away. Therefore, samples collected after November 2004 appear more contaminated than those collected before the change, and Los Angeles County beaches appear more "contaminated" than beaches in other California counties.

Sources of Surf zone Contamination

Pathogenic bacteria and viruses are known to contaminate the surf zone and pose risks to human health when they occur above certain concentrations (SMBRP, 1996). These contaminants can be traced back to a variety of sources, including urban run-off, sewage spills, septic systems, and boating discharges. Preventing dry weather runoff, reducing wet weather runoff, maintaining or switching from septic systems to sewer systems, maintaining sewer lines and beach bathroom facilities, educating boaters, and improving source tracking methods are all steps SMBRC and its partners are taking to improve year-round beach water quality (see Sections 2.2 and 4.3 for discussions about the first two).

The method currently used to quantify bacteria indicator abundance in a sample requires eighteen to ninety-six hours of incubation to determine if TMDL limits have been exceeded. Since bacterial contamination on beaches often lasts less than twenty-four hours, beaches may remain open during the period that they are contaminated, and be closed after the contamination is no longer present. Several new methods that can be completed in only a few hours are in the late stages of development. The Southern California Coastal Water Research Project (SCCWRP) is testing several new methods in an epidemiological study that compares health risk relationships between new and traditional bacteriological monitoring methods at several southern California beaches, including Surfrider Beach in Malibu.

Percentage of All C,D, and F Beach Grades Received During Wet and Dry Weather

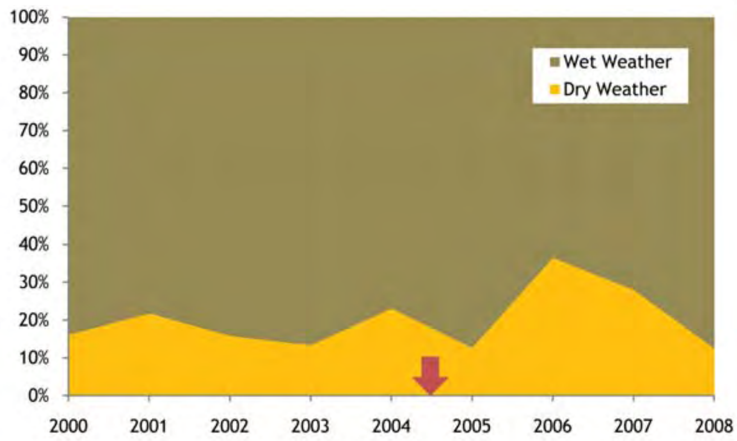


Figure 4-4. Ratio of wet weather to the dry weather grades for beaches in Santa Monica Bay that receive C, D, and F's on Heal the Bay's annual Beach Report Card. The red arrow marks the 2004 change in beach water quality monitoring protocols. Overall, beaches perform worse in the wet season than in the dry season. Data Source: Heal the Bay.

4.2 Trash

Discarded polystyrene food containers, cigarette butts, and plastic bottles and bags are some of the common trash items seen on city sidewalks, parking lots, and streets. The Los Angeles County Department of Public Works estimates that cigarette butts alone account for over 900,000 pieces of trash found on the streets each month. These items flow through the storm drain system into the Bay and harm marine life in the Bay and thousands of miles beyond. Some of the trash washes up on beaches, degrading the aesthetics of the Bay's much visited coastline and posing potential health hazards to wildlife.

The Los Angeles Regional Water Board adopted the first trash TMDL in the Santa Monica Bay watershed for Ballona Creek and Wetlands in August 2002. The implementation schedule for this TMDL requires a 10% progressive reduction from the baseline waste load allocation each year in order to achieve a 50% reduction by 2009, and the numeric target of zero trash, no later than 2015.

To meet the trash reduction targets under this new regulatory requirement, cities in the Ballona Creek sub-watershed and Los Angeles County have developed and implemented multi-faceted strategies. Baseline monitoring to identify high trash-generating areas was carried out in an effort to strategically locate trash reduction devices, such as catch basin inserts, that prevent trash from entering storm drains. A study conducted by the City of Los Angeles, the largest city in the Ballona Creek sub-watershed, discovered that approximately 20% of the City's area generated about 60% of the trash found on the street (City of Los Angeles Department of Public Works, 2002) (see Figure 4-5). Research and pilot tests have led the Los Angeles Regional Water Board to certify full-trash-capture systems as 100% compliant with the trash TMDL, creating an incentive for municipalities to install them.

Full-capture systems are any single or series of devices that trap all particles greater than five millimeters in diameter and also have a design capacity capable of capturing all the trash in a flow resulting from a one-year, one-hour storm.

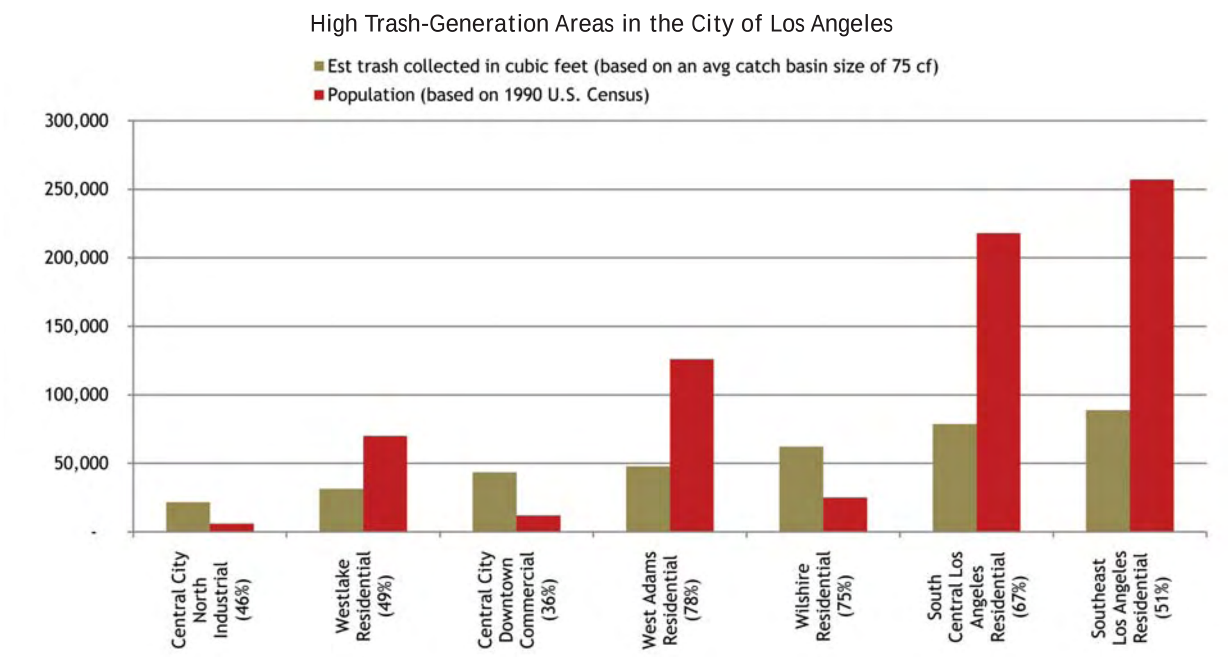


Figure 4-5. Areas in the city of Los Angeles generating large volumes of litter, organized in order of increasing volume. Population size and litter are not directly correlated. However, densely populated or highly visited areas often generate more trash than other areas (modified from a table in: City of Los Angeles Department of Public Works, 2002).

KJohnston

In the past five years, efforts to achieve compliance with the Ballona Creek trash TMDL have primarily involved installing certified full-capture devices and in-channel trash capture devices. Full-capture devices, such as catch basin covers and inserts, keep trash out of storm drains, and in-channel trash capture devices, such as continuous deflective separation (CDS) units and trash nets, collect trash within the channel before it reaches the Bay. In the Ballona sub-watershed alone, more than 10,000 catch basins have been retrofitted with trash capture devices. The City of Los Angeles has also committed to retrofitting all 11,000 of their remaining catch basins by 2011.

The SMBRC has partnered with the County of Los Angeles, City of Los Angeles and other cities to carry out many of these retrofit projects, by awarding and administering state bond money to fund them. To date, this money has funded the installation of over seven hundred catch basin inserts and nine in-channel devices, such as CDS units, throughout the Ballona Creek sub-watershed.

The strategies to reduce the amount of trash entering the storm drain system do not rely solely on structural devices. Strategies also involve targeting high trash-generation areas with institutional controls. Some such controls are enforcing anti-littering laws, changing street sweeping schedules or protocols, cleaning catch basins, picking up abandoned trash, providing trash receptacles, conducting anti-litter education and outreach, and implementing community clean-up programs.

According to annual progress reports on TMDL implementation submitted by both the City of Los Angeles and the County of Los Angeles, trash loading from the Ballona Creek sub-watershed already may have been reduced, or is very close to being reduced, by 50%, one year ahead of the schedule (based primarily on the number of full-capture devices installed) (City of Los Angeles Stormwater Program, 2008; Los Angeles County Department of Public Works, 2009). A second trash TMDL was adopted in the Santa Monica Bay watershed in 2008 for Malibu Creek. This TMDL took effect in 2009 and gives the Malibu sub-watershed municipalities eight years to reduce trash to zero. However, the land use characteristics of this sub-watershed may create a significant challenge for devising strategies to control the sources of trash coming from within State and National parklands.

Ultimately, the success or failure of all these efforts will be judged by measurable reductions of trash in the receiving water body—the Bay and its beaches. Each year, hundreds of tons of trash still reach the Bay. A large portion of this trash washes back to shore to be picked up by maintenance crews and volunteers (Figure 4-6). A Santa Monica Bay Marine Debris TMDL is being developed and will be an important step in addressing trash loading at the Bay's beaches from the smaller drainage basins in the Santa Monica Bay watershed that do not have trash TMDLs as well as non-land based sources of trash.

Figure 4-6. (a) Trash tonnage at Los Angeles County beaches. The quantity of litter and trash in containers removed from beaches managed by Los Angeles County Department of Beaches and Harbors has decreased from 2005 to 2008. (b) Rainfall and beach visitation influences the amount of trash found on beaches. Data Source: Los Angeles County Department of Beaches and Harbors.

Measuring Progress

It is difficult to directly measure the percentage of trash volume or tonnage actually. The trash TMDL allows municipalities to demonstrate compliance with trash reduction requirements based on percentage of drainage areas with full-capture devices installed. Adopting this methodology, for example, the City of Los Angeles estimated that the more than 10,000 retrofitted catch basins should prevent trash loading from approximately 31,300 out of 62,400 acres, thus approximately 50% of the land area within the Ballona Creek watershed. Similarly, the Los Angeles Department of Public Works estimates that it achieved nearly 89% reduction within its jurisdiction by early 2009, since can block all trash from three out of four separate unincorporated County sub-areas within the Ballona Creek watershed by installing 247 full-capture devices.

The most common type of trash that is transported via stormwater runoff to Santa Monica Bay and the world ocean is plastic (Figure 4-7). The main sources of plastic found in stormwater runoff includes litter (mostly plastic bags, packaging, and other single-use disposable products), trash lost in garbage transportation, construction debris, and debris from commercial establishments and public venues. The most effective measure to prevent disposal of plastics into the ocean is to phase out and eventually stop using these plastic products. Several cities in the watershed, including Malibu, Manhattan Beach, Santa Monica, Los Angeles, West Hollywood, and Calabasas, have passed ordinances banning or limiting the use of plastic bags or polystyrene containers. However, these bans are now facing legal challenges initiated by the plastics manufacturing industry. Los Angeles County and most watershed cities are currently awaiting the outcomes of these legal challenges before taking action or adopting similar bans. A statewide ban on these problematic plastic products is also stalled due to opposition from the plastic manufacturing industry.

Trash Collected in California on the 2007 Coastal Cleanup Day

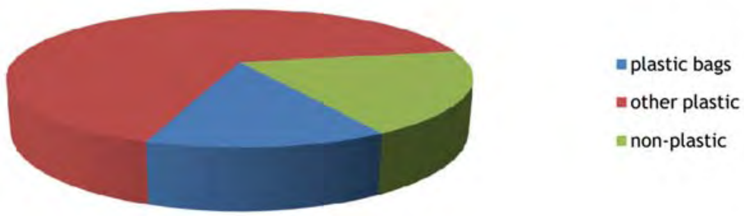


Figure 4-7. Trash associated with shoreline and recreational activities collected in California on the 2007 Coastal Cleanup Day (based on data in: Ocean Conservancy, 2007).

4.3 Water Resources

Water quality, water supply, flood protection, and open space are interconnected. As more and more open space in the Los Angeles basin is converted into urban areas with paved surfaces, less and less water soaks through the ground to recharge local aquifers. Instead, water runs off the pavement, picks up pollutants, and carries them into our streams and coastal waters. During rain, this process increases the risk of flooding. In addition, traditional engineering approaches to flood control further restrict the water-absorbing ability of natural waterways by confining creeks into concrete channels, including Ballona Creek (Gumprecht, 1999). Even during dry weather, excessive outdoor water use throughout the watershed creates unnecessary runoff and increases the demand on the local water supply.

Local institutions for managing water resources were traditionally structured to deal with each of the different aspects, mentioned above, in an isolated fashion. However, managers traditionally responsible for a single "silo" recently began to recognize the value of addressing water quality, water supply, flooding, habitat protection, and recreational amenities simultaneously through integrated water resources management. Such integration is already being reflected in some water resources management plans for fulfilling future water demand, such as those developed by water supply agencies in the Santa Monica Bay area. The City of Los Angeles' Water Supply Action Plan calls for meeting approximately 30% of the current water demand with local water sources by 2030 (City of Los Angeles Department of Water and Power, 2008). To do this, the city devised a multi-faceted approach, involving water conservation, wastewater recycling, stormwater capture, and groundwater basin cleanup. West Basin Municipal Water District (West Basin), already a local leader in wastewater recycling for irrigation, is taking a similar approach, with the addition of a seawater desalination component (West Basin, 2008) (Figure 4-8).

Current and Projected Increase to Water Supply from Local Sources for the City of Los Angeles and West Basin

(a) City of Los Angeles Water Supply Sources

(b) West Basin Water Supply Sources

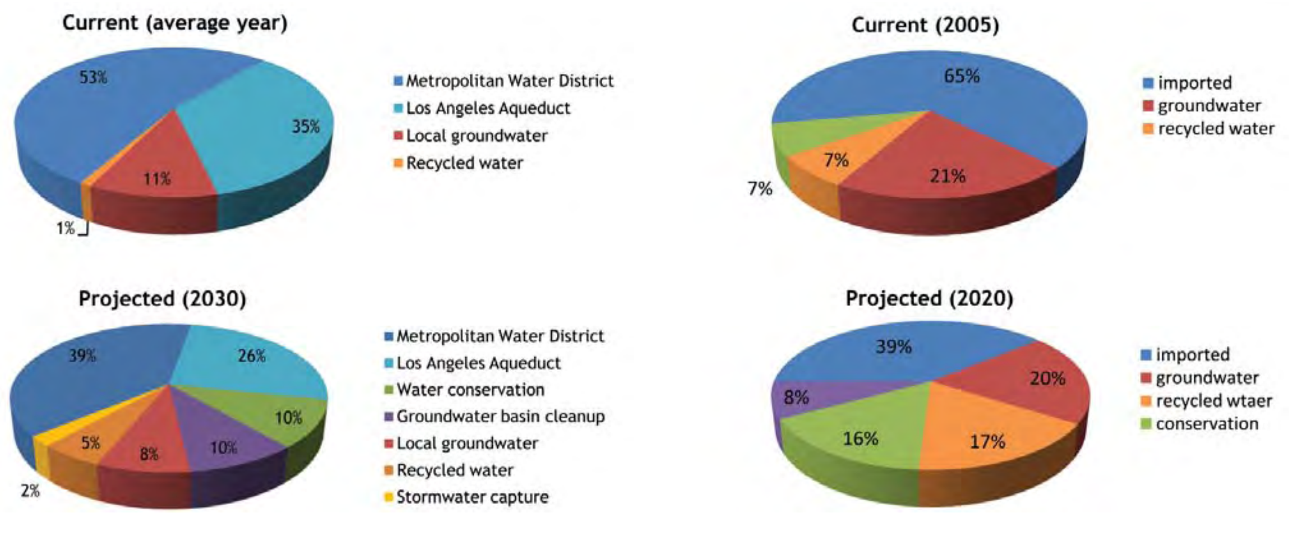


Figure 4-8. Current and projected increase to water supply from local sources for (a) the City of Los Angeles and (b) West Basin. Combined, integrated water resource management projects will account for 27% (including groundwater basin cleanup) and 33% of water supply, respectively (modified from City of Los Angeles Department of Water and Power, 2008; and West Basin, 2008).

Water Conservation

The link between the region's increasing population and demand for water seems to have finally been broken in recent years. In the service area of the City of Los Angeles Department of Water and Power, for example, water use has remained steady despite the continued increase in population, largely due to water conservation measures being implemented since the late 1980s (Figure 4-9). These measures include a combination of conservation incentives and enforcement of "prohibited uses." For instance, it is estimated that the low-flow toilet program (a conservation incentive) continues to save Los Angeles more than fourteen billion gallons of water each year—enough to fill the Rose Bowl about fifty-six times.

However, this trend may not continue unless additional actions are taken. As more and more conservation measures are enacted, the remaining conservation options also become more limited. This is now believed to be the case for indoor water conservation opportunities. As a result, focus is shifting to measures and technologies that reduce outdoor water use, where big water savings can still be found. For example, approximately 30% of water use in Los Angeles is outdoors, for activities such as watering lawns. Finding new ways to reduce outdoor watering is critical not only for reducing urban runoff and improving water quality, but also for conserving the precious local, potable water supply.

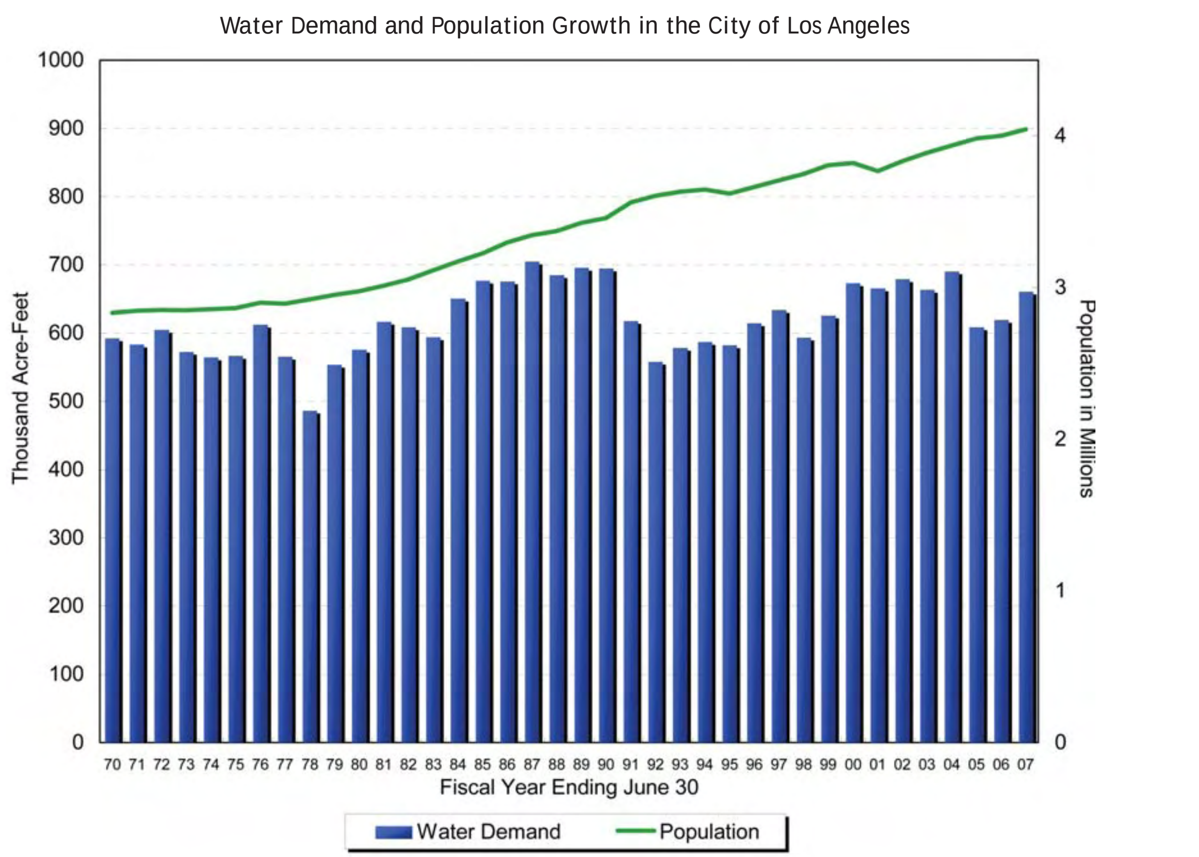
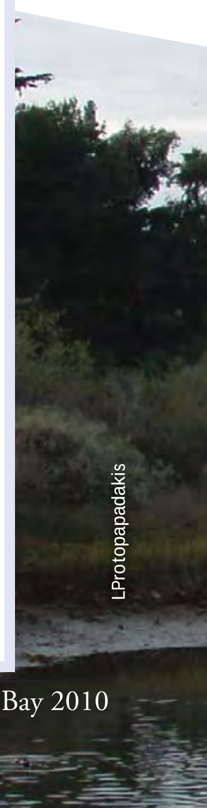


Figure 4-9: Water demand in the City of Los Angeles stayed level even as the population increased (taken from City of Los Angeles Department of Water and Power, 2008).



LProtopapadakis

Water Recycling

Another area of great potential is to increase local water supply through wastewater recycling. The volume of wastewater available for recycling is huge—the City of Los Angeles produces enough treated wastewater to meet more than 70% of the City's current potable water demand (City of Los Angeles Department of Water and Power, 2008). And now, after the upgrades to full-secondary treatment (see Section 2.1), recycling wastewater has become more feasible and cost-effective. West Basin has notably increased the amount of wastewater they recycle, and other agencies, including LACSD, have taken strides to find more uses for recycled water (Figure 4-10). However, recycled wastewater currently fulfills less than 10% of water demand in the region. To go from meeting 10% of water demand to more than 80%, several issues will need to be resolved. One is the lack of existing infrastructure to distribute treated wastewater to irrigation systems that can use it directly or to spreading grounds where it can be used to recharge drinking water aquifers (indirect potable reuse). Another issue is the lack of funding to build new infrastructure. Concerns about public acceptance of recharging drinking water aquifers in the City of Los Angeles, along with the energy costs and the disposal of the concentrated waste by-products, also need to be addressed.

Current regulations restricting recycled water to non-potable purposes or indirect potable reuse (through groundwater recharge) is another factor that will prevent full use of this resource, but safety concerns make agencies and the public reluctant to modify these restrictions. In early 2009, the State Water Resources Control Board (State Water Board) adopted a recycled water policy aimed at streamlining the regulatory process in order to increase public acceptance and promote broader uses of recycled water. Even with current restrictions in place, recycled wastewater can still be used in a variety of ways. At this time, it is used for recharging groundwater, injecting into seawater barriers, outdoor irrigation, supplying industrial processes, filling artificial lakes or ponds, and re-establishing water-related habitats.

Three significant wastewater treatment facilities in the Santa Monica Bay watershed are on the path to achieving substantial wastewater recycling. The Tapia Wastewater Reclamation Facility in the Malibu Creek sub-watershed has achieved 100% recycling—meaning zero effluent discharge—of its effluent during nine months of the year. The treated wastewater is primarily used to irrigate public parks, schools, and road medians. The two largest wastewater treatment plants discharging into the Bay also have ambitious water recycling programs. The JWPCP, operated by LACSD, has set a goal to recycle 230,000 acre-feet per year by 2020—that is enough wastewater to replace current imported water supply in their service area. Hyperion, operated by the City of Los Angeles, plans to increase the volume of recycled wastewater used to recharge groundwater by supplying West Basin with up to 67,000 acre-feet per year by 2020—that is triple the current amount (SMBRC, 2008).

Increases in Recycling of Wastewater and it's Uses

(a) Wastewater Recycled by West Basin For Use Inside and Outside Their Service Area.

(b) LACSD Nonpotable Reuse vs. Groundwater Recharge (Fiscal Year 1980/81 to 2007/08)

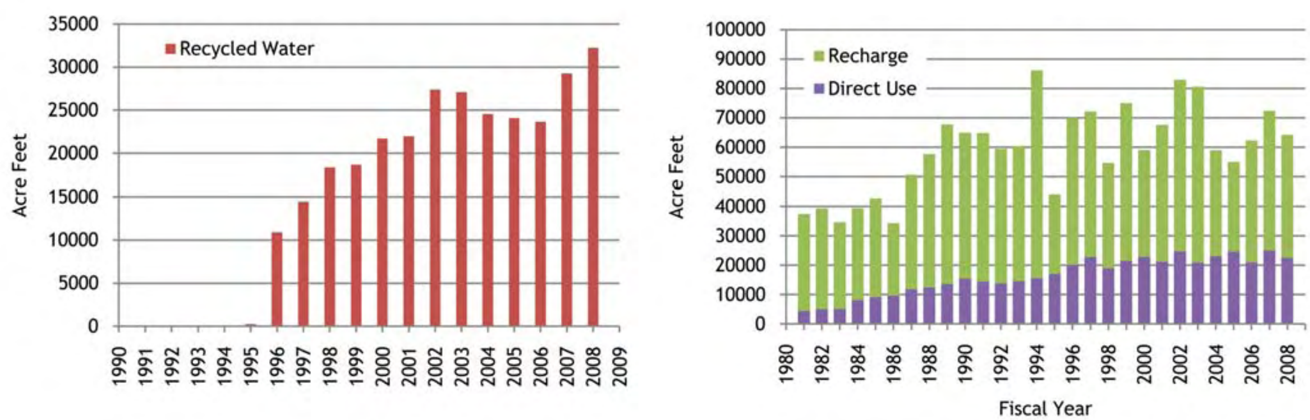


Figure 4-10
(a) Increasing volumes of wastewater are recycled by West Basin. Some of this water is sold to other agencies.
(b) Increasing use of recycled wastewater by LACSD. Data Sources: West Basin and LACSD.

Unintended consequences: Ocean Water Intakes

Many desalination project proposals seek to co-locate desalination facilities with coastal power plants in order to use the existing ocean intake pipes. However, these intakes are a threat to marine life because the mortality rate of the billions of larvae and other marine organisms pulled through the cooling water intake system is nearly 100% (South Coast Science Advisory Team, 2009). The State Water Board is developing a policy on power plant intakes in order to address the tremendous loss of marine life. The development of new ocean intakes, or new uses for existing intakes, is in direct conflict with the current direction of the State Water Board policy. Furthermore, the high energy costs of desalination might interfere with the State's goal of reducing carbon emissions to 1990 levels by 2020.

Brine Disposal

The following questions remain largely unanswered:

- How and where should the concentrated brine that results from desalination and wastewater recycling processes be disposed?
- How would ocean disposal of the dense waste by-product from desalination disperse, and what impact would this ultra saline water have on marine life?
- How hazardous will the waste from wastewater recycling be, and where should it be dumped, given that the source water—that is, treated wastewater—already contains many contaminants of emerging concern? (see Section 6.4)

As both desalination and wastewater recycling activities increase, these concerns will need to be resolved.

Desalination

Desalination is the process of converting seawater into drinking water. The desalination process is similar to wastewater recycling, as are the energy costs and disposal concerns. However, desalination also requires an ocean intake system, which adds additional environmental concerns (see sidebar) and regulatory hurdles. While desalination is an option for securing a plentiful supply of water from local sources, it is not part of an integrated water resource management system. In fact, it may undermine integrated water resource management by removing the biggest incentive to conserve water, capture and infiltrate stormwater, and recharge groundwater—that is, the dwindling of other available water supplies. Furthermore, without using alternative sources of energy, the highly energy-intensive desalination approach to increasing water supply is in direct conflict with California's ground-breaking carbon emission reduction policies, as outlined in Assembly Bill 32.

Nonetheless, eighteen desalination projects have been proposed throughout the state, with two in Santa Monica Bay. Both local proposals, submitted by West Basin and the City of Los Angeles Department of Water and Power, are pilot studies that involve co-locating desalination facilities with an existing coastal power plant to take advantage of existing ocean water intake pipes and the ready supply of power.

West Basin's proposal has been approved and is in operation. The project is the second of three steps toward full scale desalination that would comprise 8% of West Basin's planned future water supply. The first step was a pilot project co-located with the El Segundo Generating Station, which took in 40 gallons-per-minute of ocean water. This second step is a demonstration project, which requires 792 million gallons-per-minute to produce 360 million gallons-per-minute of drinking water. A full scale version of this project, capable of meeting 8% of future demand, would require 57,600 million gallons-per-minute of seawater, half of which would become brine waste product (West Basin, 2008a).

Stormwater Capture and Infiltration

Capturing stormwater and allowing it to infiltrate into the ground has seized local interest as water supply agencies, water quality regulators, and regulated communities recognize its multiple benefits. A study conducted by the Natural Resources Defense Council estimated that widespread use of stormwater infiltration, capture and reuse in Los Angeles County would result in a savings of 74,600–152,500 acre feet of imported water per year by 2030, which is enough to meet the water consumption needs of 456,300 to 929,700 people (Natural Resources Defense Council, 2008). As for the water quality benefit of stormwater infiltration, the Green Solutions study commissioned by SMBRC in 2008 found that nearly 40% of the polluted runoff clean-up needs in Los Angeles County could be met by creating infiltration and treatment areas on existing public lands, which account for approximately 1.7% of the total number of parcels and 13% of the area in the County (Community Conservancy International, 2008).

Green Infrastructure and Low Impact Development (LID)

Green infrastructure and LID are tools and practices used to increase stormwater capture and infiltration. Green infrastructure and LID may include rain gardens, bioretention areas, treatment wetlands, swales, porous pavements, disconnected downspouts, and French drains, to name a few. Conventional flood control practices are designed to move water off site and into the storm drains as quickly as possible, while green infrastructure and LID seek to do just the opposite—facilitate the on-site absorption and infiltration of as much water as possible, while harvesting runoff for irrigation uses during the dry season.

The trend toward infiltrating stormwater on-site, instead of diverting and treating it off-site, is evident in a variety of trends. State and local capital improvement grant programs, including the state bond funding administered by SMBRC, increasingly give priority to green infrastructure projects that can increase pervious surface area and stormwater infiltration. A good example is the Oros Green Street Project in the Los Angeles River watershed, completed by the City of Los Angeles and Northeast Trees in 2007. This project intercepts runoff with trench drains that cut across private driveways and are connected to rain gardens (vegetated infiltration areas) by buried piping. The project not only captures and infiltrates stormwater; it also beautified the street, created native habitat, and reduced outdoor water use for irrigation. Similar projects funded by the SMBRC include the Bicknell Green Street Project in Santa Monica and the Downspout Disconnection Project in Los Angeles.

The State, County, and City of Los Angeles have adopted a number of stormwater regulations, local ordinances, and green infrastructure programs requiring or encouraging the use of green infrastructure and low impact development methods that increase land permeability and on-site infiltration in new construction and re-development projects. The County of Los Angeles and the City of Santa Monica were among the first in the region to adopt ordinances that include these measures. And since 2004, the Los Angeles Regional Water Board has incorporated a Standard Urban Stormwater Mitigation Plan (SUSMP) under stormwater NPDES permits. The SUSMP applies to new and re-development projects above a certain size. It requires these projects to incorporate best management practices capable of infiltrating, capturing, and reusing or treating all of the site's runoff from a typical rainstorm (defined as ¾ inches of rain in twenty-four hours).

According to one estimate by the City of Los Angeles, each quarter-acre of hardscape has the potential to generate 100,000 gallons of stormwater runoff annually, and a five hundred-foot long residential street in Los Angeles could generate 140,000 gallons of stormwater runoff annually (City of Los Angeles Department of Water and Power, 2008). Capturing and infiltrating all or a large portion of this water on-site could translate to a significant increase in the water supply, reduction in runoff, *and* the risk of flooding. The Green Solutions study estimates that 5,866 acres of land would need to be converted or retrofitted if stormwater infiltration is the sole method used to comply with the bacterial TMDLs (Community Conservancy International, 2008). This is achievable if low impact development measures can be widely applied on both public and private parcels. Infiltration clearly has the potential to reduce polluted stormwater runoff enough to meet the TMDL goals, but completing a sufficient number of projects by the full compliance target date of 2021 will be challenging.

Water Quality

Water Resources

Bicknell Green Street Project

Completed in May 2009, this project in the city of Santa Monica transformed one block of Bicknell Avenue into a showcase for how green infrastructure practices can be applied to increase infiltration and reduce stormwater runoff pollution. The width of the street was reduced, and the pavement of the parking lanes on the street was replaced with permeable concrete, allowing water to pass through the six-inch concrete layer and infiltrate into the soil below (a). Newly installed sub-surface infiltration basins under the parking lanes provide temporary storage for runoff (b). The stored runoff is collected by catch basins with filters in the gutters and eventually percolates into the surrounding soil. In addition, climate-appropriate plants, supported by drip irrigation under the mulch, are located in depressed bioswales (c), which are integrated as part of the parkways.

(a)

(b)

(c)

Partially funded by the SMBRC's Proposition 50 Grant Program, this block of the Bicknell Avenue is celebrated as the first "green" street in the City of Santa Monica, and offers a model for similar streets throughout southern California. Photos: Neal Shapiro, City of Santa Monica.

Downspout Disconnection Project

Spearheaded by SMBRC and partially funded by SMBRC's Proposition 12 grant program, this pilot program will provide home and property owners, neighborhood associations, and roofing contractors a chance to work as partners with the City of Los Angeles to reroute roof runoff from stormwater collection systems to on-site pervious areas, infiltration planters, and/or rain barrels (photo below). The initial phase of the program seeks to partner with 600 of the estimated 1,600 property owners in the Jefferson neighborhood of the Ballona Creek sub-watershed. The project should prevent more than one million cubic feet of runoff from entering Ballona Creek every year. In addition, the project will reduce potable water needs by installing rain barrels that will use rainwater for irrigation on-site. Finally, the pilot project will also serve as a template for developing citywide standards for stormwater diversion on private property in the city of Los Angeles in the future. Photo: City of Los Angeles Bureau of Sanitation.

JCoffin

5. *Focus on* Natural Resources

5. Focus on Natural Resources

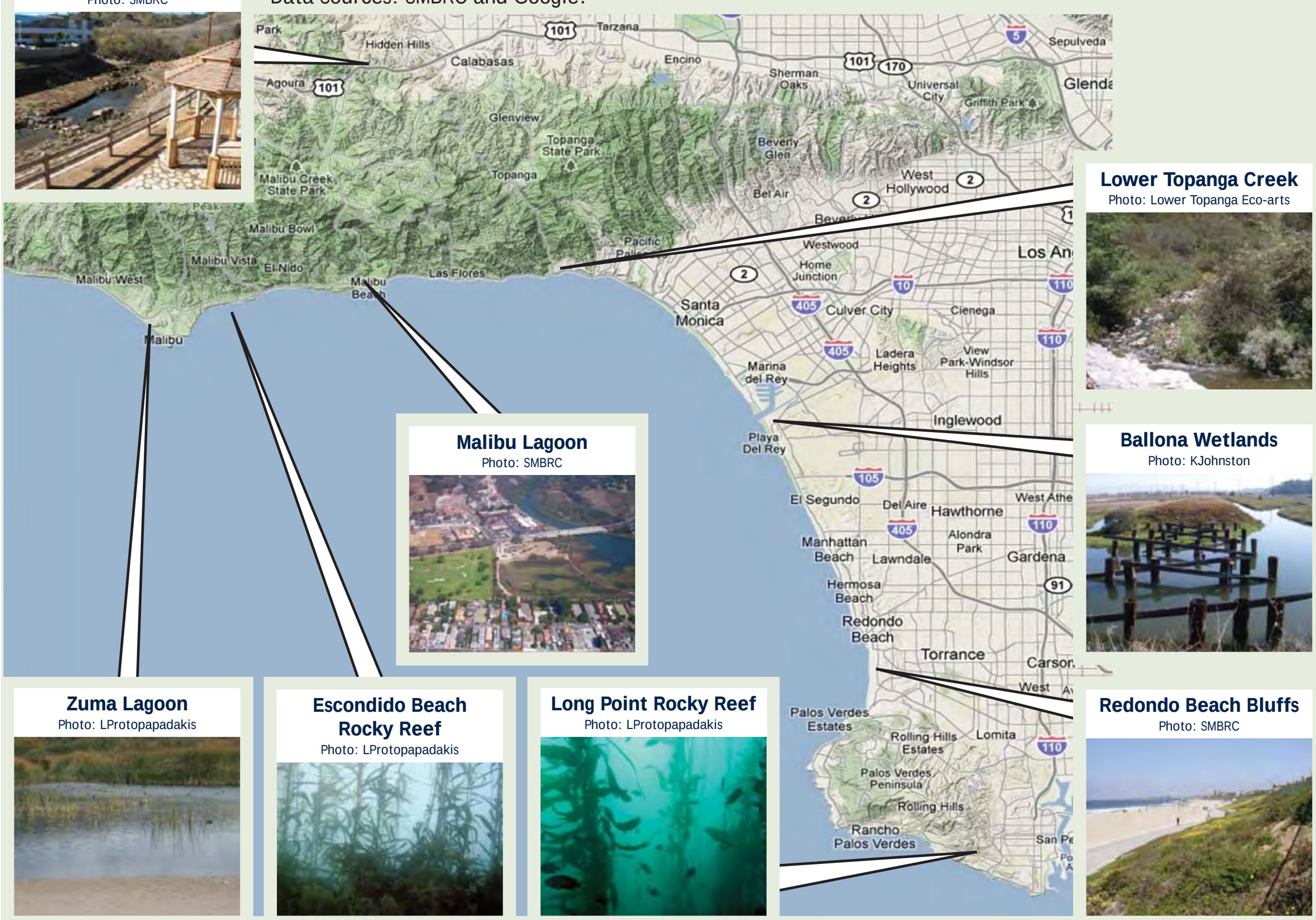
All major habitat types in the Bay have lost some ecological functions or are functioning at reduced levels (see Chapter Three). Major causes of habitat loss or degradation include urbanization, overharvesting of living resources, introduction of invasive species, and poor water quality, all of which have led to declines in biodiversity and ecosystem function and resilience. This chapter showcases the progress made to bring some of these habitats, and the natural communities they support, back to a healthier state. Major restoration efforts initiated or completed over the last five years are emphasized. This chapter also discusses the challenges and progress made to control invasive species, remediate contaminated sediments on the Palos Verdes Shelf, reintroduce and protect individual species of special interest, and better manage fisheries. The success or failure of these activities will provide a good indication of future conditions of the Bay's habitats.

5.1 Habitat Restoration

Section 2.3 highlighted the remarkable amount of land acquired in recent decades. These purchases guarantee the preservation of at least some habitats, many of which have been profoundly reduced from their historical extent. Unfortunately, many open spaces were degraded and in need of restoration at the time they were purchased. Restoration at some of these acquired parcels has already been initiated or completed. Ongoing maintenance of restored areas and new restoration projects are still needed.

Between 2006 and 2008, SMBRC and other organizations and agencies have restored approximately 170 acres of habitat in the Bay and its watersheds. A variety of habitat types have been restored, including streams, lagoons, wetlands, bluffs, and rocky reefs. Some of these projects are highlighted below and provide examples of ongoing efforts throughout the watershed (Figure 5-1).

Figure 5-1. Map of the Bay and its watershed showing locations of restoration projects discussed in this section. Data Sources: SMBRC and Google.



Habitat Restoration

Riparian Areas

In the last five years, successful stream restoration projects have restored and enhanced streams in the Bay watershed. Stream and riparian zone restoration requires a variety of different restoration techniques, depending on the site characteristics and the cause and extent of the degradation. While restoring natural stream channels in urbanized areas must be balanced with the need to protect human lives and property, a well-designed project in the right location can improve water quality and stormwater management, enhance habitat, and create new recreational opportunities and more beautiful surroundings, all without compromising flood protection. Techniques include removing concrete channels and barriers to fish migration, mimicking natural stream contours, and controlling invasive plants and animals. To prevent further loss and degradation, remnant natural streams and riparian corridors need to be identified and protected, and the causes of degradation must be identified and addressed.

Las Virgenes Creek:
Restoring Natural Hydrology, Wildlife Corridors, and Building Greenways

Las Virgenes Creek is a perennial stream and a major tributary of Malibu Creek. It drains a 12.5 square mile sub-watershed in the west-central part of the Santa Monica Mountains. While much of the drainage area is sparsely populated, it does include part of the urbanized Highway 101 corridor. In the mid-1970s, a 440-foot long section of Las Virgenes Creek between Highway 101 and Agoura Road was lined with concrete to protect underground utilities, nearby businesses, and residents from possible flooding damage. However, this action eliminated riparian vegetation, caused upstream and downstream channel scouring and erosion, disrupted a critical wildlife corridor between the undeveloped Upper Las Virgenes Canyon (formerly Ahmanson Ranch) and Malibu Creek State Park, and left an ugly concrete channel choked with algae and invasive plants in the middle of a popular business district.

Recognizing the need to restore the beauty and ecological functioning of the creek, the City of Calabasas partnered with SMBRC and others to restore the concrete channel to a more natural state. The straight channel was reconfigured to a more natural form by removing the concrete, changing the slopes of the stream banks, adding step pools, removing invasive vegetation, and planting native plants. The project also included a footpath that encourages pedestrian use, and educational signs that promote environmental awareness and continued protection. Although the restored creek section is relatively short, it has re-established direct connectivity between existing riparian communities, improved habitat and water quality, and enhanced the aesthetics of the creek. The highly visible project also demonstrates the feasibility of restoring urban creeks while maintaining public safety.

Before

After

Photos: Alex Farassati.


CStevenson

Topanga Creek:
Restoring Fish Passage and Natural Hydrology

Topanga Creek, in the Santa Monica Mountains, drains the third largest sub-watershed of the Bay watershed. The lower portion of the creek is a narrow perennial stream, flowing through a steep canyon covered with near-pristine chaparral habitat. Vegetation typically found in willow riparian habitats, such as cottonwoods, sycamores, and oaks, also thrive along the creek. The creek is one of only two remaining in the Santa Monica Bay that support a reproducing population of the endangered southern steelhead trout. However, a 1.8-acre berm in lower Topanga Creek altered the natural flood plain and restricted habitat critical for the southern steelhead trout, especially during periods of low stream flow. The berm, created from fill material from road-building projects over the last four decades, was originally built to protect homes in the floodplain. The homes were removed after lower Topanga Creek became part of the State Parks system in 2001 and restoration finally became feasible.

With grant funding from the SMBRC and other state agencies, the California State Department of Parks and Recreation in collaboration with the Resource Conservation District of the Santa Monica Mountains completed the removal of the berm in 2008. The project involved removal and disposal of approximately 58,000 cubic yards of the fill material (roughly 26,000 tons), including 17,000 tons of material that qualified as hazardous waste. The project restored over twelve acres of the natural floodplain and creek channel, and improved natural sediment transport in the lower creek. Additionally, the restoration permits endangered southern steelhead trout, no longer inhibited by the berm, to access an additional 3.3 miles of stream habitat.


Before

During


After

Photos: Rosi Dagit.

Natural Resources
Habitat Restoration

Wetlands and Lagoons

Urbanization has claimed most of the wetlands and lagoons that existed in the Bay watershed (see Chapter 3 for more details). The few remaining wetlands and lagoons are heavily impacted by human activities. Considering all that has been lost, it is important to protect and restore these remaining habitats. Several restoration activities in the Bay watershed are underway or have been completed since the last State of the Bay Report, including Phase I restoration at Malibu Lagoon and restoration planning at the Ballona Wetlands.

Malibu Lagoon Restoration Phase 1

Before

During

After

Malibu Lagoon

Malibu Lagoon is a 31-acre brackish lagoon and salt marsh at the mouth of the 110-square mile Malibu Creek sub-watershed. Malibu Creek drains roughly 122 square miles of land in the Santa Monica Mountains, and it carries freshwater, sediment, nutrients, and urban runoff into the lagoon. The lagoon then empties into the Bay at the renowned Surfrider Beach in the city of Malibu. Malibu Lagoon is the largest functioning lagoon in the Bay watershed still in a mostly natural condition. Yet, it is a small remnant of what was once a much larger system of wetlands and lagoons, which have been filled for commercial and residential development in the city of Malibu and construction of the Pacific Coast Highway.

Multiple vegetation communities and habitats are present at the lagoon, including coastal scrub and sage scrub, coastal salt marsh, coastal and valley freshwater marsh, brackish marsh, riparian woodland, coastal dunes, mud flats, sandy beach/sand bar, and open water, as well as non-native grassland and developed land. The creek and lagoon complex support many terrestrial and aquatic species, including the endangered tidewater goby and southern steelhead trout. The area is also home to several threatened or endangered birds, including the peregrine falcon, California least tern, and willow flycatcher, and the area is a vital stopover for migratory birds along the Pacific Flyway.

The habitat and water quality of the lagoon have been impacted by anthropogenic activities in the Malibu Creek sub-watershed, resulting in the loss of ecological function. Issues include excessive freshwater inputs from urban runoff, sedimentation, contaminated runoff, habitat loss, invasive species, and high nutrient, pathogen, and bacteria levels. Several technical studies conducted over the last ten years have characterized the sources and impacts of these impairments, and these studies have been used to develop a comprehensive Malibu Lagoon Habitat Enhancement Plan (Moffatt & Nichol, 2005). The plan was completed in 2005 and recommends lagoon restoration be conducted in two phases. Phase I, completed in 2008, involved removing a polluting asphalt parking lot that was adjacent to the lagoon and constructing a permeable parking lot further from the lagoon. The permeable parking lot incorporates runoff control measures, including a biological stormwater treatment system, to infiltrate and treat runoff before it enters the lagoon. The permeable parking lot also includes a public use area that enhances existing educational and recreational uses of the site, and the parking lot relocation created approximately two additional acres for wetland restoration in Phase II.

Ballona Wetlands

Restoration of the Ballona Wetlands has been highly anticipated since the remaining undeveloped acres were purchased by the State in 2004. The Ballona Wetlands once spanned 2,120 acres and covered the areas that are now Venice, Marina del Rey, Play Vista, and Playa del Rey (California Coastal Conservancy 2006). All that remains of the historic acreage is the six hundred acre parcel south of Marina del Rey. This area includes a mixture of estuary, lagoons, salt marsh, freshwater marsh, and dune habitats, remnants of the once much larger wetlands complex. Although the site has been altered over time, it continues to provide habitat for some threatened and endangered species. Significant cultural resources exist on the site, and it continues to provide open space for people and wildlife in the heart of urban Los Angeles.

The property is now owned by two state agencies: the California Department of Fish and Game (CDFG) and the State Lands Commission. Soon after the acquisition, the California Coastal Conservancy and SMBRC began planning the property's restoration. SMBRC has worked closely with the California Coastal Conservancy and facilitated local stakeholder participation, coordinated technical studies and scientific review, and undertaken a comprehensive field survey and baseline conditions assessment program.

By the end of 2008, the agencies and stakeholders had established restoration goals, developed an Interim Stewardship and Access Management Plan, completed a restoration feasibility report, and refined several restoration alternatives. The process was temporarily put on hold due to the State budget crisis in late 2008. However, partial funding has been restored, and the baseline assessment continues, in preparation for the California Environmental Quality Act (CEQA) process that will begin in 2010.

Restoration of the Ballona Wetlands is the best and largest remaining opportunity to restore coastal wetland habitat in the Santa Monica Bay watershed, and it remains a top priority for SMBRC and the other involved agencies. Future challenges include identifying potential funding for implementation of the restoration plan and ongoing operation and management of the public space.

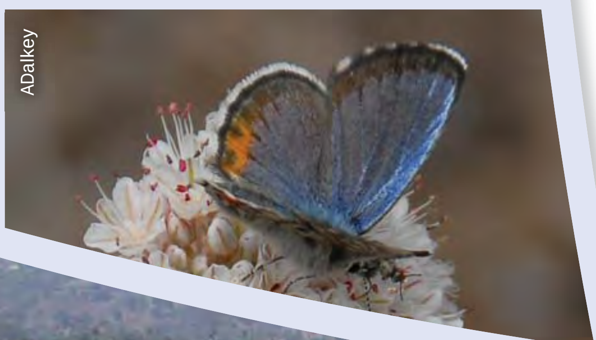
Ballona Wetlands Restoration Goals

- Restore and enhance salt water-influenced wetland habitats to benefit endangered and threatened species, migratory shorebirds, waterfowl, seabirds, and coastal fish and aquatic species.
- Restoration of seasonal ponds, riparian and freshwater wetlands, and upland habitats will be considered, where beneficial to other project goals or biological and habitat diversity.
- Provide for wildlife-dependent public access and recreation opportunities compatible with the habitat, fish, and wildlife conservation.
- Identify and implement a cost-effective, ecologically beneficial, and sustainable (low maintenance) habitat restoration alternative.

Natural Resources
Habitat Restoration

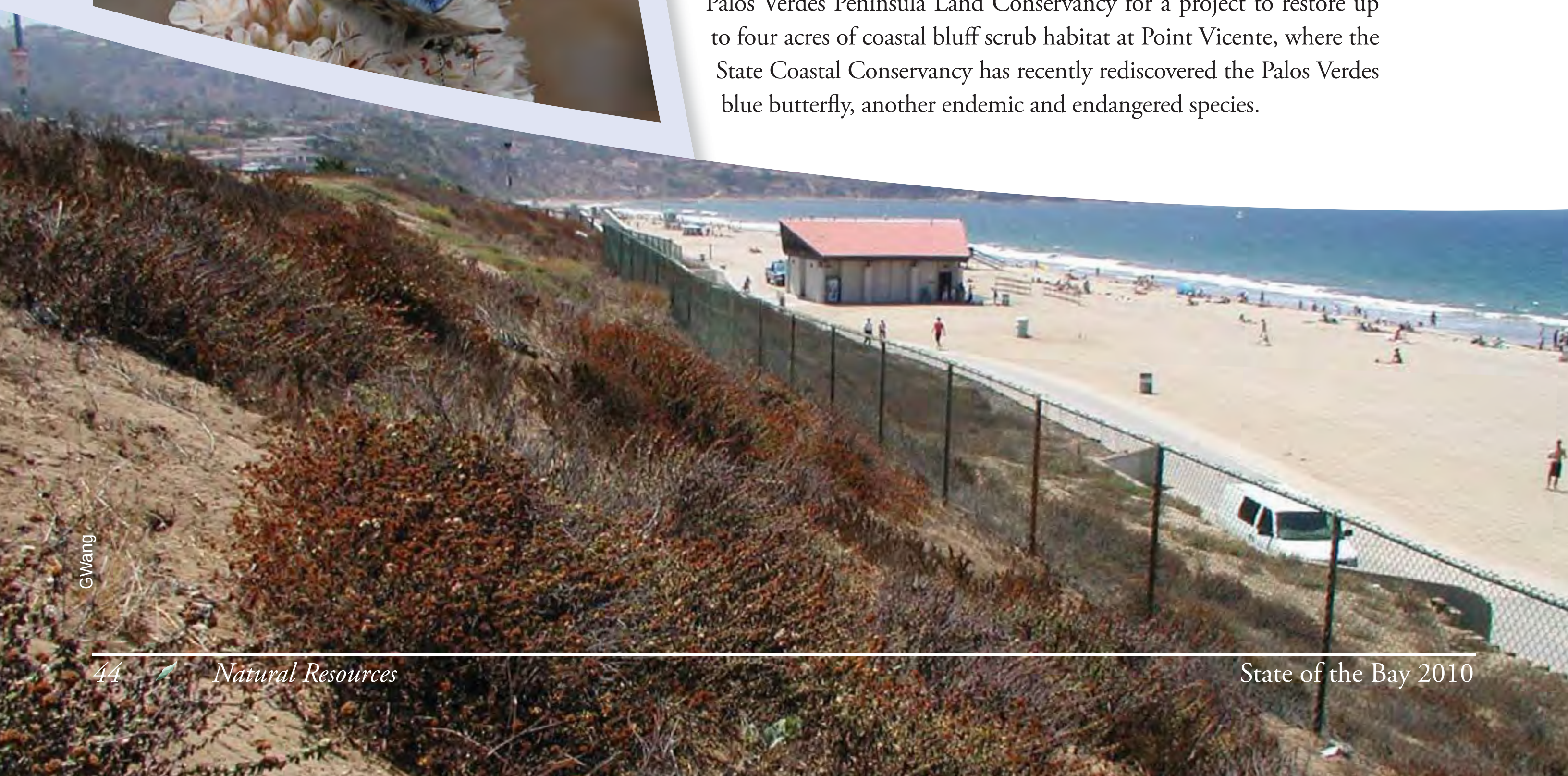
Dunes and Bluffs

Existing beach bluff habitats are greatly reduced from their historical extent, and those remaining have become critically important in sustaining many endemic plants and animals that are adapted to their unique environment. The El Segundo blue butterfly, a federally-listed endangered species, depends upon the remaining dune and bluff habitat. But even in the remaining dunes and bluffs, most of the native bluff scrub vegetation, which the butterfly depends on for survival, has been replaced by non-native vegetation, such as ice plant. Ice plant was originally introduced to reduce sand drift, but now, it exacerbates that very problem while also crowding out native plant species.



Between 2004 and 2006, the Los Angeles Conservation Corps's S.E.A. Lab used Proposition 12 funding awarded by SMBRC to work cooperatively with Los Angeles County Department of Beaches and Harbors and the City of Redondo Beach to rehabilitate beach bluff habitats in the South Bay. This project restored a 3.5-acre area by hand-pulling non-native species (primarily ice plant) from the bluffs and planting native vegetation, including dune buckwheat, California sunflower, deer weed, lupines, and ambrosia, which were cultivated at a newly established plant nursery located at S.E.A. Lab.

One year after completion of the restoration project, the El Segundo blue butterfly made an unexpected comeback in the newly-restored sites, where it had not been seen in decades. Even veteran biologists were surprised by the rapid re-colonization. Still, scientists warn that the species remains imperiled unless native vegetation planting programs can be expanded. Recognizing this need, SMBRC has also funded a Beach Bluffs Restoration Master Plan, which identified a total of thirty-eight acres of potential sites in the South Bay region for future restoration (Longcore, T. (Ed.), 2005). Partner agencies in the South Bay are now working to restore five major sites at Dockweiler Beach, Redondo Beach, and Torrance Beach as identified by the Master Plan. SMBRC has also expanded its efforts southward by providing Proposition 12 grant funding to the Palos Verdes Peninsula Land Conservancy for a project to restore up to four acres of coastal bluff scrub habitat at Point Vicente, where the State Coastal Conservancy has recently rediscovered the Palos Verdes blue butterfly, another endemic and endangered species.



Kelp Beds

Although the extent of kelp beds in the Bay has increased since the historic lows of the 1970s, many of the rocky reefs suitable for kelp are bare (see Figure 5-2 and Chapter 3 for details). Many once-healthy kelp beds in the Bay now do not receive adequate sunlight and are scoured and/or buried by excess sediments coming from urban runoff and other sources. They are also subject to predation by sea urchins, whose populations have increased significantly with the decline of their natural predators due to overharvesting (such as the California spiny lobster and California sheephead). In 1996, Santa Monica Baykeeper partnered with SMBRC to establish the Kelp Restoration and Monitoring Project, a community-based effort to restore kelp to areas denuded by intensive sea urchin grazing. The project is designed to monitor kelp growth before and after restoration and to compare different restoration techniques.

Santa Monica Baykeeper staff identified two project sites with urchin-caused barrens, where kelp was historically present. One is located offshore from Escondido Beach in Malibu, and the other is off of Long Point on the Palos Verdes Peninsula. Work began off Escondido Beach in 1997 and finished in 2006. Ongoing monitoring will asses the sustainability of the restoration efforts. Off Long Point, restoration work began in 2005 and finished in 2009. Restoration activities at the nearby Point Vicente reef are planned for 2010. Each project site consists of three sets of experimental restoration areas, plus a reference site and a control site. Volunteer scuba divers log hundreds of hours of dive time to collect sea urchins from the restoration areas and relocate the urchins offshore. Healthy juvenile kelp fronds are then transplanted to the experimental sites and monitored annually for new growth. Four to six years after initial transplanting, all completed restoration sites have achieved the project's primary goal of reaching and maintaining a kelp density of at least one healthy stipe per square meter (Santa Monica Baykeeper, 2006; 2007; 2008).

Marine habitats restoration is challenging because of dynamic sea conditions, and the work can be labor intensive. However, due to the reduced populations of predators, such as sea otters, California sheephead, and California spiny lobsters, sea urchin removal and other restoration activities will likely be needed into the foreseeable future. New restoration techniques are also being tested in order to reduce the amount of effort required to restore small areas. While kelp restoration projects off Palos Verdes and Malibu have significantly enhanced the abundance of kelp and associated fishes and invertebrates at the restoration sites, these gains are small in the context of the entire Bay's kelp habitats. Ultimately, ecosystem management measures, such as establishment of marine reserves, are necessary to help control the number of sea urchins by rebuilding the predator populations, which will allow the habitat to maintain its natural balance in the long term (see Section 5.6). Finally, challenges in addressing the potential impacts of sedimentation and turbidity to kelp communities also remain.

The Long Point Restoration Site

Photos: Santa Monica Baykeeper

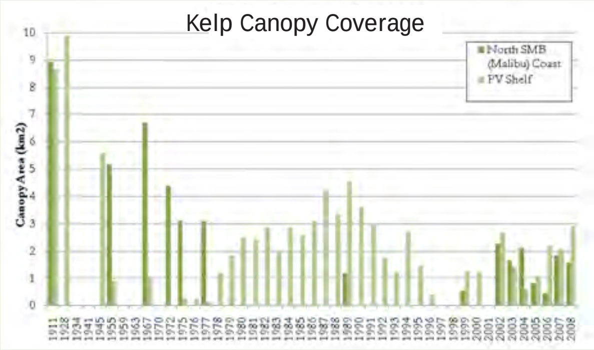


Figure 5-2. Kelp canopy coverage off Malibu and Palos Verdes from 1911-2008. Kelp coverage is currently much lower than at the beginning of the 20th century off the north Malibu coast and the Palos Verdes Shelf. The historical data serve as a reminder of the potential kelp canopy coverage possible. Years with no bars, represent years where no data were collected, not a lack of kelp. Data Source: Central Region Kelp Survey Consortium.

DPondella

Natural Resources
Invasive Species

5.2 Control of Invasive Species

Invasive species can cause tremendous environmental impacts, such as degradation of habitat and water quality and loss of diversity and abundance of native plants and animals. Although this section focuses on the environmental consequences of invasions, invasive species also provoke significant economic impacts. Billions of dollars are spent every year to control invasive species throughout the United States and globally. Additionally, invasive species can threaten public health by spreading parasites and diseases, such as the West Nile Virus, and invasive species can jeopardize public safety by destabilizing stream banks and levees, which may lead to erosion and flooding concerns.

Once established, invasive species adversely affect habitats and disrupt ecosystems. Without natural predators, invasive species can overrun natural systems, proliferate rapidly, and dominate a habitat, to the detriment and sometimes the exclusion of native species. Invasive species often compete directly with native species for nutrients, sunlight, and space, and indirectly by altering the food web or physical environment. Invasive species may also prey upon or hybridize with natives. Native species with limited population sizes or ecological ranges are particularly susceptible to displacement.

Invasive species of concern in the Bay watershed include plants and animals, such as giant reed, pampas grass, and ice plant as well as red swamp crayfish, bullfrog, and New Zealand mudsnail. Many invasive species propagate rapidly, are extremely difficult to control, and most are impossible to eradicate once established. All invasive species on list of "Notorious Invaders" (Table 5-3) fit one or more of these criteria and are prime targets of invasive control programs.

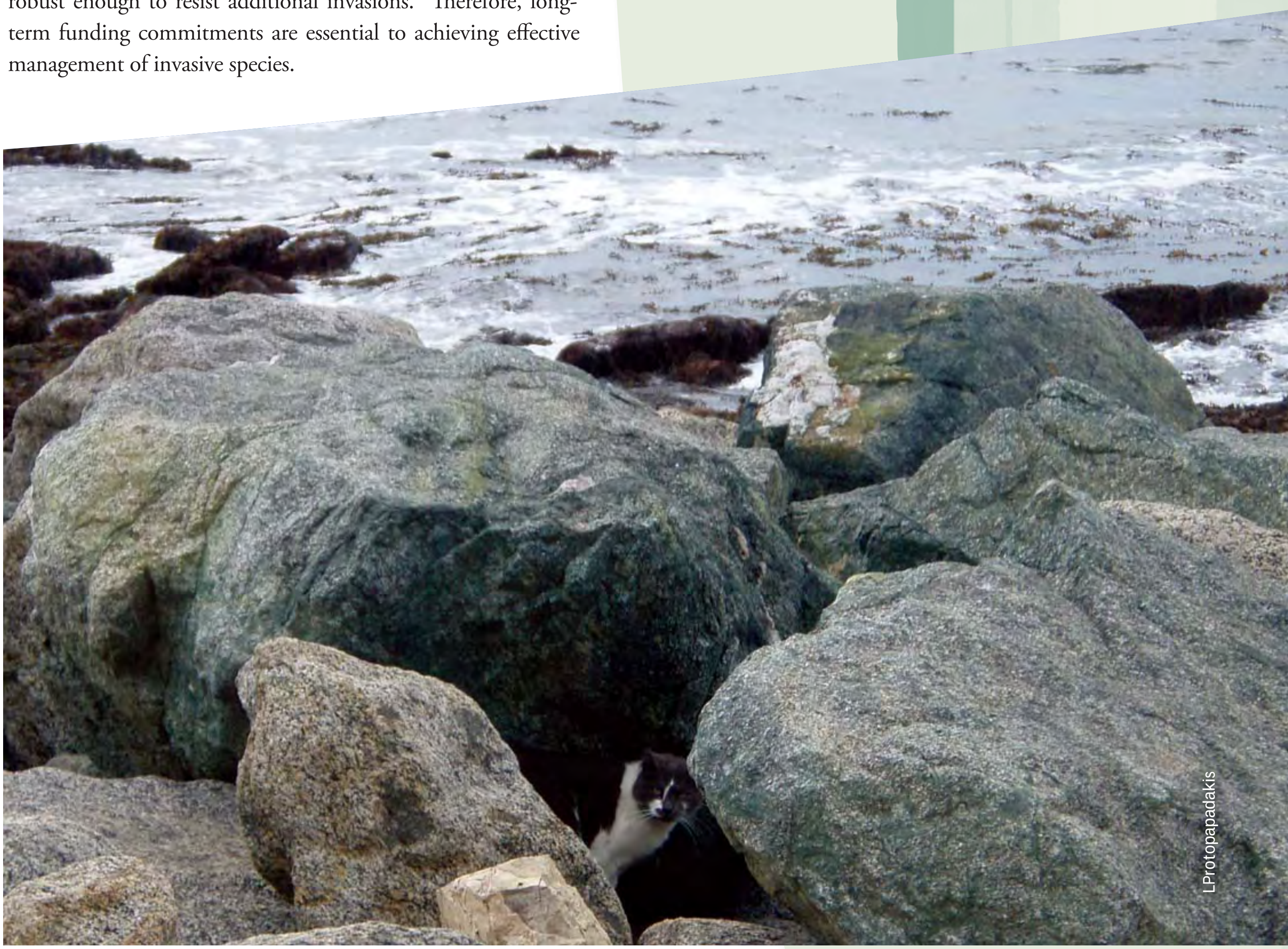
Notorious Invaders: problematic invaders in terrestrial, aquatic, and marine ecosystems

Terrestrial	Aquatic	Marine
<u>Plants</u>	<u>Plants</u>	<u>Seaweeds</u>
English & Algerian ivy *(Hedera helix & H. caneriensis)*	Giant reed *(Arundo donax)*	Japanese Wireweed *(Sargassum muticum)*
Tree of Heaven *(Ailanthus altissima)*	<u>Animals</u>	Brown Alga *(Sargassum filicinum)*
Fennel *(Foeniculum vulgare)*	Red swamp crayfish *(Procambrus clarkii)*	"Wakame" *(Undaria pinnatifolia)*
Castorbean *(Ricinus communis)*	New Zealand mudsnail *(Potamopyrgus antipodarum)*	<u>Invertebrates</u>
Periwinkle *(Vinca major)*	Bullfrog *(Rana catesbeiana)*	Blue Mussel *(Mytilus galloprovinciali)*
Spanish broom *(Spartium junceum)*	Carp *(Cyprinus carpio)*	Asian Clam *(Corbula amurensis)*
Pampas grass *(Cortadeira selloana & C. jubata)*	Large-mouth bass *(Micropterus salmoides)*	Bryozoan *(Watersipora subtorquata)*
Tree tobacco *(Nicotiana glauca)*		Green Crab *(Carcinas maenas)*
Fountain grass *(Pennisetum setaceum)*		Star Sea Squirt *(Botryllus schlosseri)*
Ice plant *(Carpobrotus edulis)*		Chain Sea Squirt *(Botryllus violaceus)*
Peruvian pepper *(Schinus molle)*		Sea Squirt *(Ciona intestinalis)*

Table 5-3. Notorious invaders. Species on this list are not listed in any particular order and are placed here because they are aggressive, difficult to control, or impossible to eradicate. Data Sources: Jack Topel (terrestrial and aquatic invaders), Kathy Ann Miller and Erin Maloney (marine invaders).

In recent years, several projects have been implemented to manage invasive plants and animals, including the giant reed *(Arundo donax)* and the red swamp crayfish *(Procambrus clarkii)*. Various physical and chemical methods have been employed to control non-natives in infested areas, including hand-pulling of giant reed and mechanical trapping of red swamp crayfish, as well as the application of herbicides and pesticides. Different species respond differently to each method, but in every case, control measures must be applied repeatedly, sometimes over many years, and in conjunction with the reintroduction of native species, until native communities are reestablished and robust enough to resist additional invasions. Therefore, long-term funding commitments are essential to achieving effective management of invasive species.

Eradication is rarely successful, and attempts to achieve eradication are expensive. The most cost-effective and successful strategy against invasive species is to prevent them from being introduced and established. A successful prevention strategy relies on a diverse set of tools and methods, including regulations and policies banning the import, use, and disposal of invasive species as well as public outreach that increases awareness in order to reduce the chance that invasive species will be unintentionally introduced or spread.



Natural Resources
Invasive Species

Case Study: New Zealand Mudsnail:

The mudsnail *(Potamopyrgus antipodarum)*, an aquatic snail native to New Zealand, is less than six millimeters in length. Over the last 150 years, it has spread to rivers, lakes, reservoirs, and estuaries in Australia, Europe, and North America. Most of the mudsnail populations in the western United States consist mostly of females that are self-cloning. That means a single snail can start a new population, and, under optimal conditions, is capable of producing a colony of forty million progeny in the course of a single year. Like most invasive species, they have no known natural predators outside of their native range, allowing them to reproduce until they virtually carpet a streambed. While densities vary depending on site conditions, studies have documented New Zealand mudsnail densities in some streams at more than 500,000 organisms per square meter. These massive colonies disrupt the entire food web by displacing native aquatic invertebrates, which native fish and amphibians rely on for food.

New Zealand mudsnails easily attach to boots, clothing and other personal belongings as well as recreational boating equipment, pets, and livestock. In this way, New Zealand mudsnails can hitchhike, undetected, from one location to the next. Since their initial discovery in Idaho during the mid-1980s, the New Zealand mudsnail has been found in almost every state in the western United States.

New Zealand mudsnails were first detected in the Santa Monica Bay watershed during routine benthic macroinvertebrate sampling in the Malibu Creek sub-watershed in May 2005. Unfortunately, the Malibu samples containing mudsnails were not analyzed until May 2006, so the problem was not discovered for a full year after the samples were collected.

Following the discovery of mudsnails, SMBRC hosted a mudsnail "summit" meeting in order to coordinate agency responses. The meeting resulted in a three-pronged strategy for managing the invasion:

- All water quality monitoring in the Santa Monica Mountains was suspended until presence/absence surveys could be completed to determine the extent of the problem.
- All agencies were asked to develop decontamination protocols to ensure mudsnails are not being transported from stream to stream.
- An aggressive public outreach campaign, using Public Service Announcements, websites, videos, and signs, was created to educate the public on how to identify the noxious invaders and prevent their spread to adjacent sub-watersheds. SMBRC also hosted a one-day workshop on preventing the spread of invasive species.

Since their discovery in 2006, SMBRC and its partners Heal the Bay and Santa Monica Baykeeper, have conducted yearly presence-absence surveys for the snails. The surveys indicate that New Zealand mudsnails have continued to spread. Mudsnails are well established within the Malibu Creek sub-watershed, and they have spread to previously uninfested streams within and outside of the Malibu Creek sub-watershed. In 2006, mudsnails were detected in only four of the sixteen streams surveyed and only

Preventing the spread of New Zealand Mudsnails

Recreational users: Avoid transferring anything wet (especially waders, boots, and gear) from stream to stream. Remove all mud and debris. Visually inspect and completely dry personal belongings in a clothes dryer, if possible. If a dryer is not available, drying belongings in the direct sun at temperatures of at least 85°F for several days will also reduce the risk of contamination. For more information, visit www.mudsnails.com

Resource management professionals: This includes scientists, monitoring crews, restoration groups, etc. Develop and implement Hazard Analysis and Critical Control Point plans to perform a comprehensive review of planned actions (monitoring, channel maintenance, restoration, construction activities, etc.) and to identify control points where specific actions should be implemented (dedicated equipment, decontamination protocols, etc.) in order to prevent the introduction or spread of invasive species. For more information on Hazard Analysis and Critical Control Point plans, visit www.seagrant.umn.edu/ais/haccp

in the Malibu Creek sub-watershed. As of October 2009, the mudsnail infestation has spread to eleven streams out of twenty-one surveyed, and mudsnails were found in four separate sub-watersheds: Malibu, Solstice, Trancas, and Ramirez Canyon. Additionally, mudsnail density appears to be steadily increasing at the infested sites (see Figure 5-4).

The absence of predators and parasites, coupled with mudsnails' fecundity, will make eradicating New Zealand mudsnails difficult or impossible. Scientists are currently investigating the feasibility of releasing parasites to control the mudsnail. However, using one non-native organism to control another non-native carries potential risks, including another invasion. More research needs to be conducted prior to implementing these "biocontrols" in the wild. For the time being, public education and outreach and strict adherence to contamination prevention protocols are the most effective management tools to slow the spread of New Zealand mudsnails.

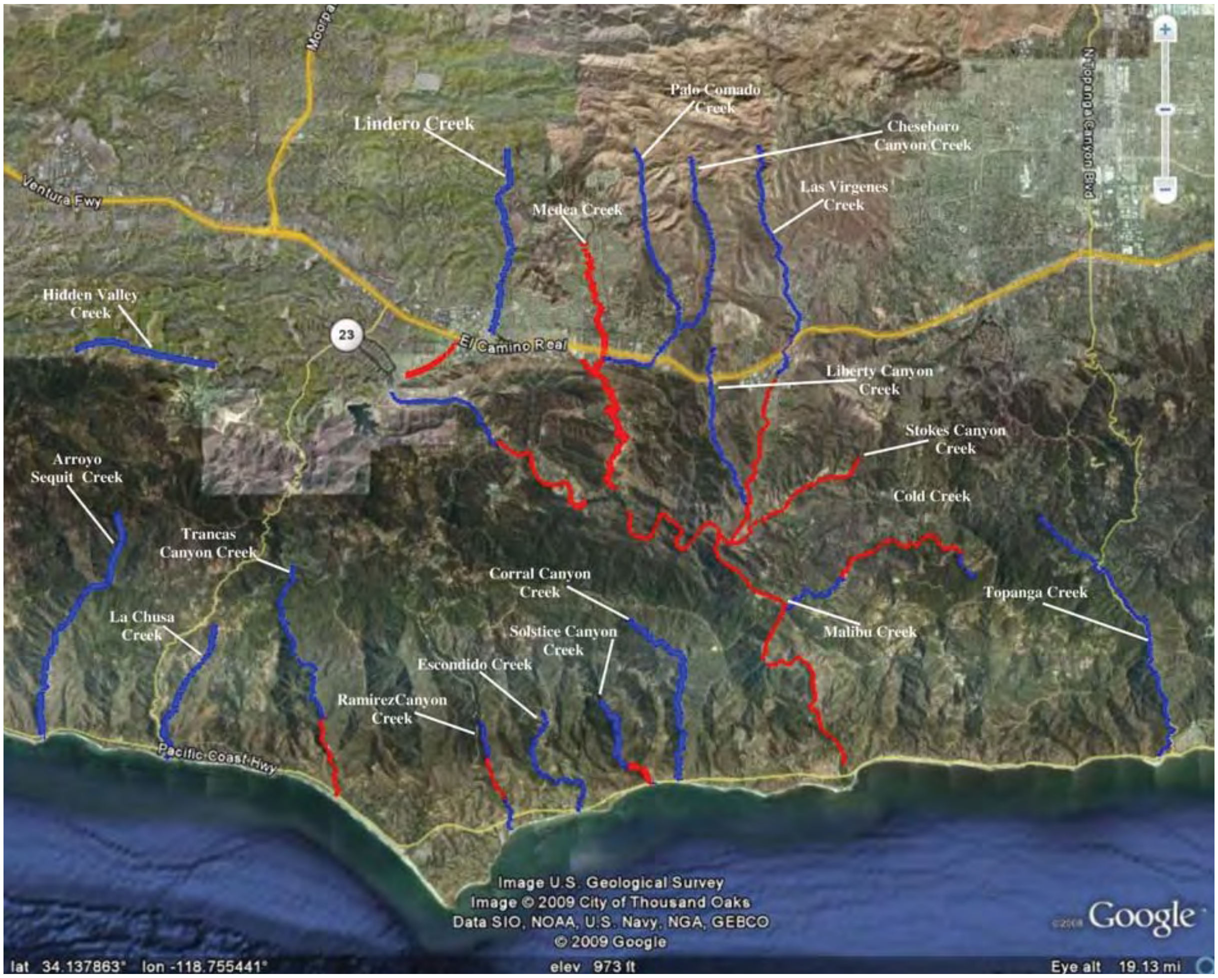


Figure 5-4. Map of the distribution of New Zealand mudsnails in the Santa Monica Mountains, as of October 2009. Surveyed streams where mudsnails are absent are colored blue. Streams where mudsnails are present are colored red. Data Source: Santa Monica Baykeeper.

Case Study: Red Swamp Crayfish:

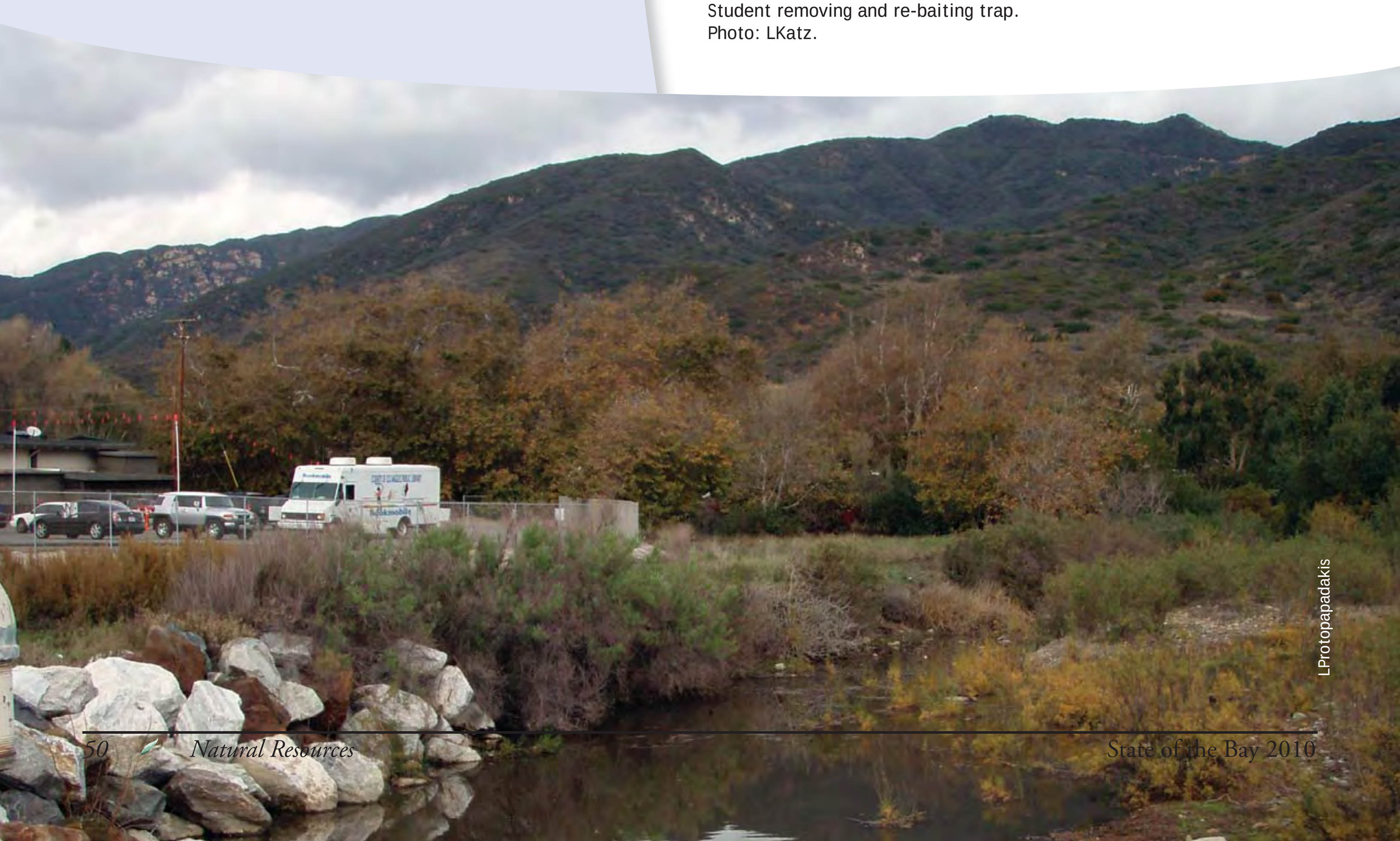
Trancas Creek is a small coastal stream located in the Santa Monica Mountains, draining to the ocean where Zuma Beach stops and Broad Beach begins. It has historically supported populations of several native amphibians, including California newts, California tree frogs, and Pacific tree frogs. However, in recent years, the populations of these amphibians had been threatened by the non-native red swamp crayfish *(Procambrus clarkii)*. Studies have shown that the red swamp crayfish attacks adult amphibians and preys upon the eggs and larvae of all of native amphibians.

Recognizing that sensitive native species were at risk of local extinction because of the red swamp crayfish, researchers and students from Pepperdine University developed and implemented a three-year project, funded by SMBRC, to manage non-native crayfish in Trancas Creek. More than 13,000 crayfish were trapped and removed from approximately one hundred traps, over the course of the project (Katz, 2008).

In 2002, there were almost no recordings of California tree frog larvae or California newt adults, eggs, or larvae. Since the crayfish removal project was implemented in 2003, numbers of native amphibians have soared. Once virtually extirpated locally, amphibian numbers in Trancas Creek are the highest since 1995, when observations were first recorded. At the beginning of the study, three hundred California newt egg masses were observed. After just three years, 887 egg masses were recorded, the highest number ever recorded in the Santa Monica Mountains. Building on this success, the researchers have also engaged local resident volunteers to help with ongoing monitoring and crayfish removal in order to ensure continued invasive species management.

Student removing and re-baiting trap.
Photo: LKatz.

Closeup of a captured crayfish.
Photo: LKatz.



LProtopapadakis

5.3 Remediation of Contaminated Sediments on the Palos Verdes Shelf

Sometimes the by-products of our chosen lifestyle can cause unexpected and long-lasting harm to the environment. An example is the past disposal of DDT, BCPs, and other organochlorine compounds into the sewer system by chemical companies, including Montrose Chemical Corporation. While legal at that time, this practice resulted in some of these chemicals passing through the JWPCP and being discharged from its outfalls off of White Point, Palos Verdes. The chemicals are still present in the sediments around the outfalls at levels of concern to humans and wildlife (see Figure 5-5), though they are slowly degrading. Although much of the contaminated sediments are now covered by cleaner sediments, biological processes, such as burrowing by the worms, ghost shrimp, and polychaetes (benthic infauna) living in the soft sediments, continue to introduce these toxic chemicals into the local food web. Once in the food web, they create health risks for apex predators, including humans. While natural degradation processes continue to slowly break down the chemicals, more of the contaminated sediments may be exposed as sedimentation of cleaner material around the outfalls has decreased, following the upgrade of the JWPCP to full secondary treatment in 2002, and ocean currents and natural erosion re-expose buried toxins over time. Therefore pro-active measures are needed to protect wildlife and human health from the impacts of consuming these harmful chemicals.

At the end of 2000, the United States Government settled legal claims against the Montrose Chemical Corporation and other defendants for the natural resource damages and remediation costs of their disposal of DDT and other chemicals in Santa Monica Bay. A total of $140 million was paid by the defendants into a fund dedicated to rehabilitating natural resources, mitigating lost fishing opportunities, protecting human health, and cleaning up the contaminants. After conducting technical studies, including a pilot capping project, ecological and human health risk assessments, and an evaluation of different potential remediation technologies, the USEPA moved forward with a preferred set of actions in September 2009. Actions include capping 320 acres of the most contaminated area with clean sediments (see Figure 5-6), monitoring the natural recovery in the rest of the site, and continuing to educate fishermen about the risk of consuming contaminated fish from the area.

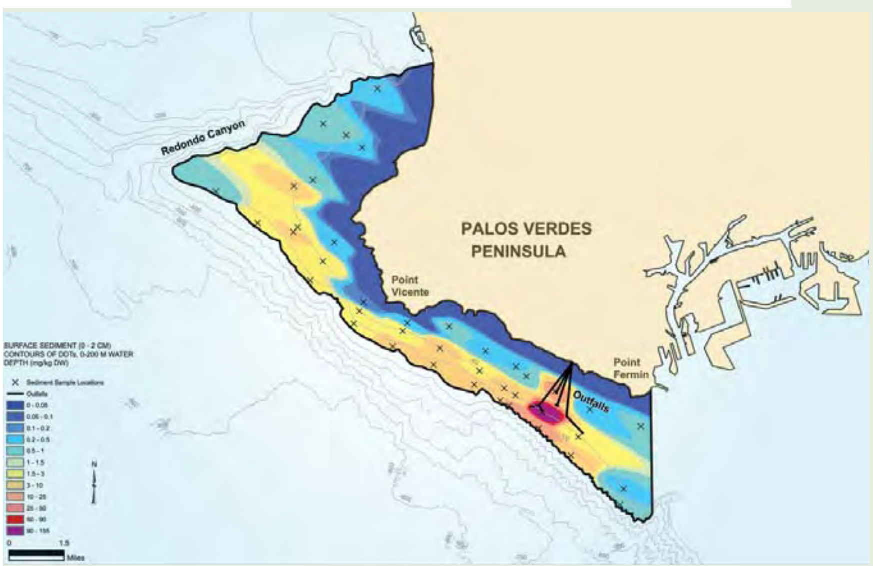


Figure 5-5: Map showing the concentration of DDT contaminated surface sediments (0-2 cm) around the White Point outfalls (200 ppm (parts per million)) and along the Palos Verdes Shelf (3-15 ppm). The deposit is over 2 feet thick with DDT concentrations ranging from 100-200 ppm (USEPA, 2008).

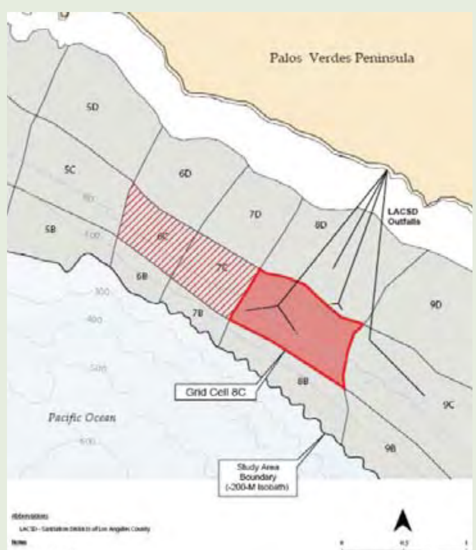


Figure 5-6: Map from the remediation plan. The red area is the preferred site for capping and covers the most contaminated sediments. The red hashed area is an additional area considered for capping (USEPA, 2009).

Natural Resources

Contaminated Sediments on the Palos Verdes Shelf

A portion of the settlement, dedicated to rehabilitating natural resources and mitigating lost fishing opportunities, is managed by the Montrose Settlements Restoration Program (MSRP) and overseen by the National Oceanic and Atmospheric Administration. The MSRP is implementing restoration projects to benefit injured animals, such as bald eagles and peregrine falcons, and to make up for lost fishing opportunities. Initial projects aimed at restoring certain seabird populations have achieved some success. The California brown pelican has been removed from the endangered species list, and the bald eagle is nesting successfully at Catalina Island for the first time in over forty years. Projects planned to mitigate for lost fishing opportunities include constructing artificial reefs in order to make it easier to catch uncontaminated fish (Sharpe, 2008). Construction of the first artificial reef, adjacent to the Belmont Pier in Long Beach, is expected to begin in the fall of 2010 (MSRP, 2009). Sites off the Palos Verdes Peninsula are under consideration for similar projects.

Human health and contaminated seafood

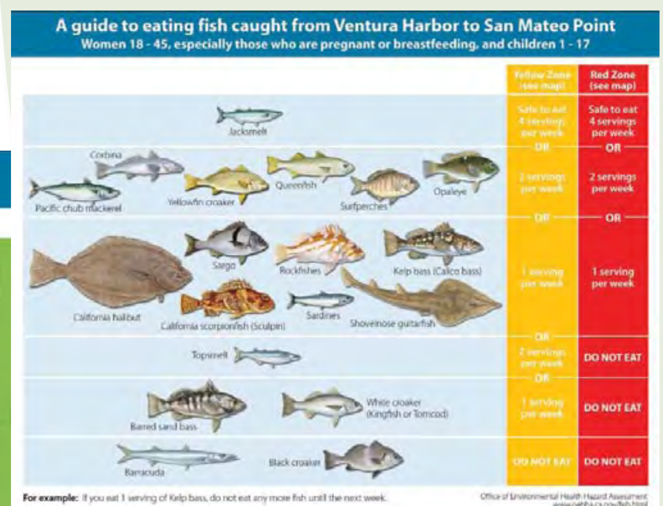
Despite the cessation of DDT and PCB discharges and the gradual decrease of their concentrations in Bay sediments, these legacy pollutants continue to move through the food web, accumulate in tissues of several sportfish species, and pose health risks to anglers and others who eat the fish. Health effects associated with DDT and PCBs include cancer, liver damage, and effects on the immune, endocrine, neurological, and reproductive systems. Infants and young children may be at higher risk either from direct exposure or pass-through during pregnancy and lactation of their mothers.

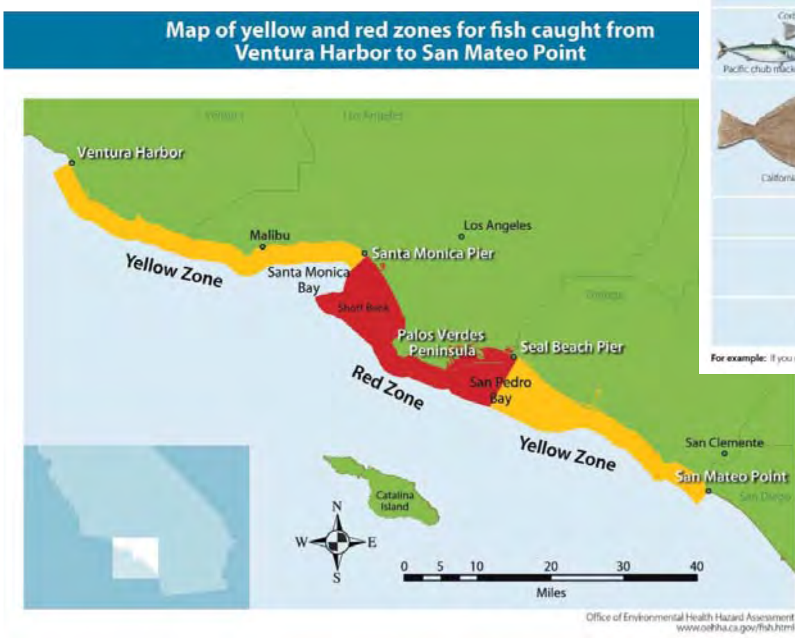
To further protect the public from the health risks of DDT and PCBs, fish consumption advisories have been issued for areas between Point Dume and Newport Beach, since 1985. Commercial fishing of white croaker, the fish species found to be most heavily-contaminated, was banned on the Palos Verdes Shelf in 1990. In early 2009, based on the latest analysis of fish samples collected in the area, the California Office of Environmental Health Hazards Assessment (OEHHA) updated the existing advisories and issued new "Safe Eating Guidelines" for fish from Ventura Harbor to San Mateo Point in Orange County (see Figure 5-7).

The new guidelines advise anglers not to consume white croaker, barred sand bass, or topsmelt caught in the "red zone" between Santa Monica Pier and Seal Beach Pier, where contaminant concentrations were highest (OEHHA, 2009). The guideline also advise limited consumption of more than fifteen other species of sportfish in the area, with stricter limits for women, ages eighteen to forty-five years, especially those who are pregnant or breastfeeding, and for children, ages one to seventeen years (see Figure 5-7). Detailed species-specific guidelines as well as additional advice on fish preparation and cooking practices can be found at OEHAA's website: http://www.oehha.ca.gov/fish/so_cal/.

In addition to the guidelines issued by OEHAA, USEPA has implemented a program of institutional controls aimed at limiting human exposure to contaminated fish, by informing the public of the risks, and by enforcing commercial fishing bans. The Fish Contamination Education Collaborative communicates the risks to anglers, ethnic communities that are most at risk, and commercial fish operations. Ongoing enforcement of the white croaker regulations for commercial and recreational anglers, along with inspection of retail food facilities, also helps reduce consumption of contaminated fish. The institutional controls program also includes periodic monitoring of contaminant levels in fish at selected locations in the ocean, markets, landing areas and piers.

Figure 5-7: Map of the area covered under the State seafood consumption guidelines and the guideline for children and women of childbearing age (the most sensitive populations). There is also a consumption guideline for the general population (not shown), which can be found at OEHAA's website (http://www.oehha.ca.gov/so_cal). The guideline was developed by OEHHA and is based on analysis of tissue samples from twenty-two species of fish for five toxic chemicals that are known to bioaccumulate in fish tissue. Data Source: OEHHA.





Species of Special Interest

5.4 Species of Special Interest

This section discusses the status, trends, and ongoing recovery efforts for species of special interest that are resident in the Santa Monica Bay and its watershed. Species of special interest include those listed by federal or state governments as threatened, endangered, or at risk of becoming extinct due to dwindling populations. This category also includes plants and animals that are endemic or iconic to our region and which often draw great interest from the public (for example, the public appreciation of southern California's grunion runs). The figure below is a list of species of special interest found in the Bay and its watershed and the most recent population status and trends (see Table 5-8). This list is not comprehensive; it is based on the list of endangered and threatened species in the 1993 State of the Bay Report, with a few additions (SMBRP, 1993).

Species of Special Interest: Status and Trends

Table 5-8. Table of species of special concern in Santa Monica Bay that depicts population status and trends. "Recovered" refers only to species removed from endangered species lists. Data Sources: CDFG, SMBRC, and Audubon Society.

Status

- Endangered, Collapsed (red)
- Threatened (orange)
- Special, Rare (yellow)
- Iconic (blue)

Trend

- ☺ Recovered
- ↑ Increasing
- -- No Change
- ↓ Decreasing
- ? Unknown

Riparian

Status	Trend	Species
Endangered, Collapsed	?	Santa Monica Mountains dudleya (*Dudleya cymosa*)
Endangered, Collapsed	?	Lyon's pentachaeta (*Pentachaeta bellidiflora*)
Special, Rare	?	conejo buckwheat (*Eriogonum crocatum*)
Special, Rare	?	Santa Susana tarplant (*Deinandra minthornii*)
Endangered, Collapsed	☺	American peregrine falcon (*Falco peregrinus anatum*)
Threatened	?	California gnatcatcher (*Polioptila californica*)

Coastal Dunes and Bluffs

Status	Trend	Species
Endangered, Collapsed	?	Palos Verdes blue butterfly (*Glaucophsyche lygdamus*)
Endangered, Collapsed	↑	El Segundo blue butterfly (*Euphilotes battoides*)
Endangered, Collapsed	?	wandering skipper butterfly (*Pseudocopaeodes enus*)
Endangered, Collapsed	?	Pacific pocket mouse (*Perognathus longimembris*)
Special, Rare	?	silvery legless lizard (*Anniella pulchra*)
Endangered, Collapsed	--	California condor (*Gymnogyps californianus*)

Wetlands, Lagoons

Status	Trend	Species
Endangered, Collapsed	?	salt marsh bird's beak (*Cordylanthus maritimus*)
Endangered, Collapsed	↑	Belding's savannah sparrow (*Passerculus sandwichensis*)
Endangered, Collapsed	↑	California least tern (*Sterna antillarum browni*)
Endangered, Collapsed	--	willow flycatcher (*Empidonax traillii extimus*)
Endangered, Collapsed	↑	southern steelhead trout (*Oncorhynchus mykiss*)
Endangered, Collapsed	?	tidewater goby (*Eucyclogobius newberryi*)

Sandy Beach

Status	Trend	Species
Iconic	↑	grunion (*Leuresthes tenuis*)
Threatened	?	western snowy plover (*Coccyzus americanus*)

Rocky Intertidal

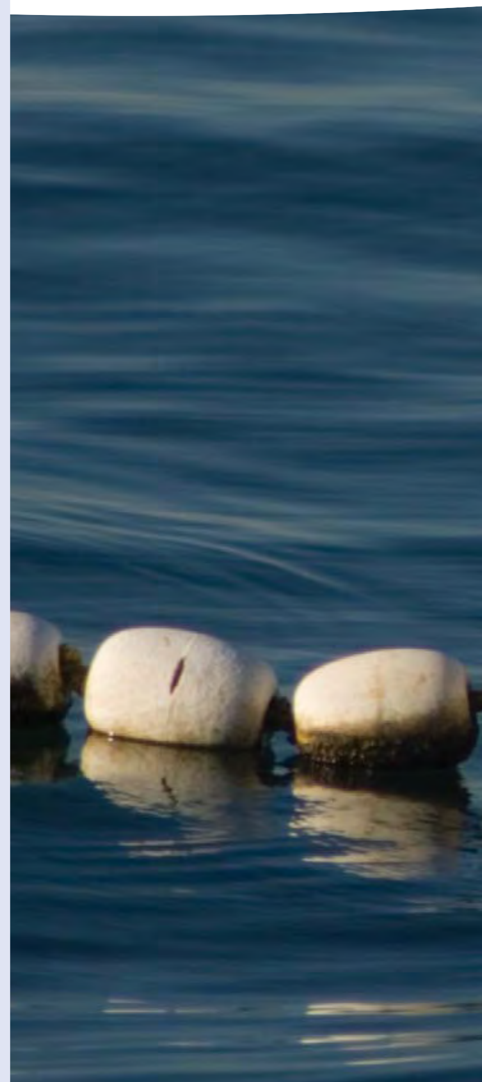
Status	Trend	Species
Endangered, Collapsed	?	black abalone (*Haliotis cracherodii*)

Rocky Reef

Status	Trend	Species
Iconic	↑	giant kelp (*Macrosystis pyrifera*)
Endangered, Collapsed	↑	giant sea bass (*Stereolepis gigas*)
Endangered, Collapsed	↓	white abalone (*Haliotis sorenseni*)

Pelagic

Status	Trend	Species
Iconic	↑	California sea lion (*Zalophus californianus*)
Endangered, Collapsed	☺	California brown pelican (*Pelecanus occidentalis*)
Endangered, Collapsed	?	blue whale (*Balaenoptera musculus*)
Endangered, Collapsed	☺	grey whale (*Eschrichtius robustus*)
Iconic	?	common dolphin (*Delphinus spp.*)
Iconic	?	bottlenose dolphin (*Tursiops truncatus*)



One great success story of the last few years is the recovery of the California brown pelican and American peregrine falcon due to reduced exposure to historical deposits of DDT on the Palos Verdes Shelf (see Section 5.3). The recovery resulted in their removal from the State's endangered species list in 2009 (the falcon was federally delisted in 1999, and the pelican is proposed to be delisted at the federal level). Several other species are discussed below. These species are selected for reporting primarily because there are new data available on their status.

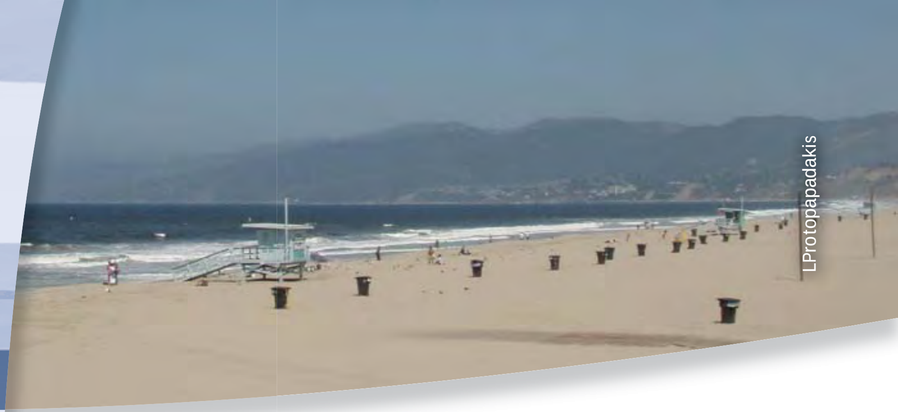
Updates from Previous State of the Bay Reports

El Segundo blue butterfly: Biologists were surprised by the El Segundo blue butterfly's rapid re-colonization of recently restored beach bluffs in Redondo Beach and Torrance in 2007, where the butterfly had not been seen for decades (see Section 5.1 for a description of the restoration) (Dalkey 2007). In addition to their reappearance at this site, the existing population at the protected coastal dunes near LAX continues to thrive. Although this species is still imperiled, we can build on the recent success by restoring more of its habitat, of which thirty-eight acres have been identified as potential sites for future restoration (Longcore, T. (Eds.), 2005).

California least terns: The Venice Beach colony of California least terns continues to increase in population since their status was first reported in 1998. After managers nearly doubled the size of their nesting area enclosures to 3.3 hectares in 2005, the number of nesting pairs has increased from one hundred pairs in 2005 to 468 pairs in 2008. In order to facilitate continued recovery, efforts are underway to revegetate valuable nesting areas and protect terns from crow predation and human trampling during the breeding season from early March to mid-August (Ryan & Vigallon, 2008).

Belding's savannah sparrow: A population of Belding's savannah sparrow continues to thrive in the coastal marsh habitat of the Ballona Wetlands. The endangered bird creates nesting areas in the dense pickleweed, often supplementing its insect diet with pickleweed seeds. Statewide, these birds have declined over time, due mostly to the loss of coastal marsh habitat. However, surveys conducted by biologists for the City of Los Angeles Environmental Monitoring Division (CLA-EMD) indicate that the productivity of the population has remained steady over the last ten years. Particularly encouraging is that the number of family groups has increased from two in 2004 to twelve in 2008 (CLA-EMD, 2008). Although predation and the replacement of native pickleweed by non-native species remain a threat, habitat restoration planned for the Ballona Wetlands could help alleviate some of these issues.

Species of Special Interest



New Report: Western Snowy Plover

Several wide, sandy beaches in the Bay watershed support overwintering populations of the western snowy plover. However, plover populations have suffered as human activities such as beach grooming and trampling have forced them to abandon roosting sites. In 2008, biologists conducted a comprehensive survey to identify important roosting areas and count the number of plovers in each area (Office of Spill Prevention and Response, 2009). During the winter 2008-2009 season, they discovered approximately 250 plovers overwinter at Los Angeles County beaches. Zuma beach supports nearly 60% of the wintering population in the Bay watershed, and Malibu Lagoon supports approximately 25% (sixty-seven birds). The third largest population utilizes Santa Monica Beach (see Figure 5-9). This area is important because researchers have observed many plovers remain well into the nesting season, one sign of nesting behavior. There is an opportunity to help these populations by reducing human, vehicle and dog traffic at the sensitive beach habitats. Beach managers have responded to plover protection by placing seasonal or permanent enclosures near Malibu Lagoon, Santa Monica State Beach, and Dockweiler State Beach.

Snowy plover standing in a vehicle track.
Photo: Audubon Society

Nesting enclosure placed in Santa Monica after snowy plover nesting scrapes were observed. In 2005, the City of Santa Monica Environmental Programs Division placed enclosures within 100 feet of the shoreline to protect a large wintering population. Photo: Audubon Society

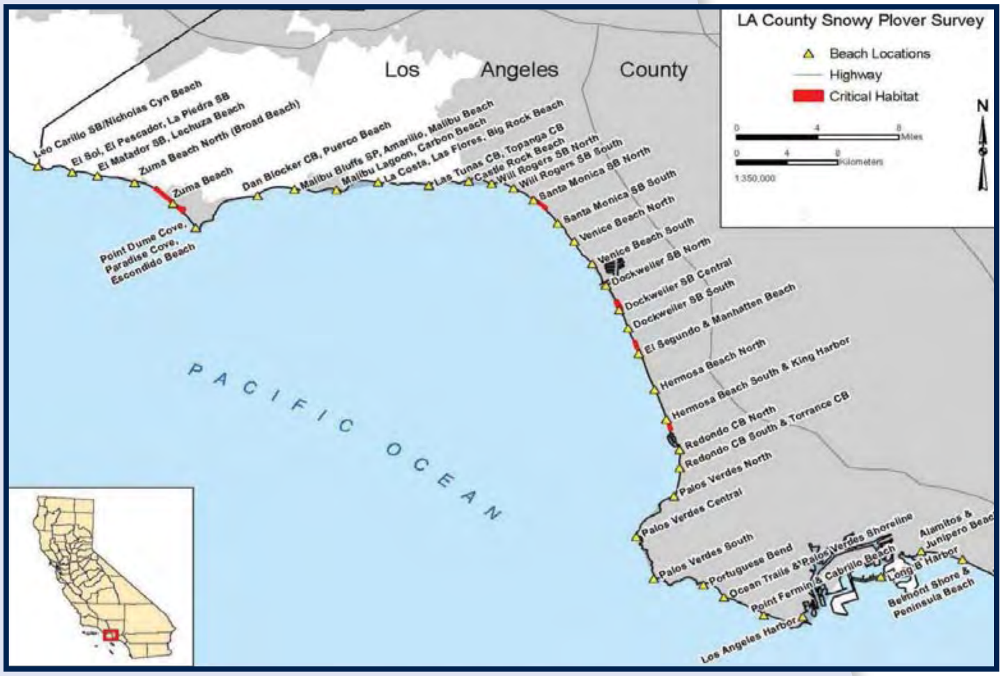


Figure 5-9. Critical habitat areas identified in red at Zuma Beach, Santa Monica State Beach, Dockweiler Beach, El Segundo and Hermosa Beaches by the Los Angeles County Snowy Plover Survey (CDFG, 2009).

New Report: Giant Sea Bass

The giant sea bass is a long-lived apex predator that lives on California's near shore rocky reefs. Because giant sea bass grow slowly and mature at a relatively old age, they are particularly susceptible to overfishing. The gillnet fishery was responsible for incidentally killing most of these fish, but spawning aggregations off rocky headlands and kelp beds were also targeted, first by commercial fisheries and then by recreational fishing (Figure 5-10 shows the historical decline in giant sea bass landings). As a result, this species nearly disappeared by the mid 1970s when the last few spawning aggregations were thought to be gone. In 1981, CDFG reduced giant sea bass bycatch limits to one fish per day but sightings remained rare from the 1970s to 1990s.

In 1994, CDFG banned gillnet fishing in all nearshore waters (within three nautical miles of the coast). Despite the reduction in fishing pressure, no giant sea bass were observed during quarterly scuba diving surveys conducted from 1974-2001. Then in 2002, a giant sea bass was observed during a scuba survey, the first since the fishing ban (see Figure 5-11). Subsequent sightings in the Bay and beyond suggest that the population may be increasing throughout the southern California bight (Pondella & Allen, 2008).

Giant Sea Bass Commercial Landings 1916-1999

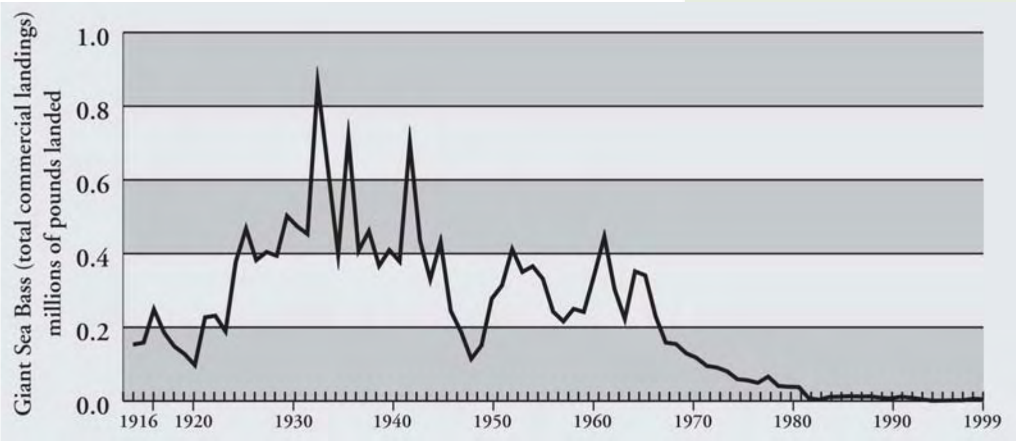


Figure 5-10. Commercial Landings 1916-1999, Giant Sea Bass. Data reflects catch from both California and Mexican waters landed in California (CDFG, 2001).

Number of giant sea bass observed at Palos Verdes Point: 1974-2004

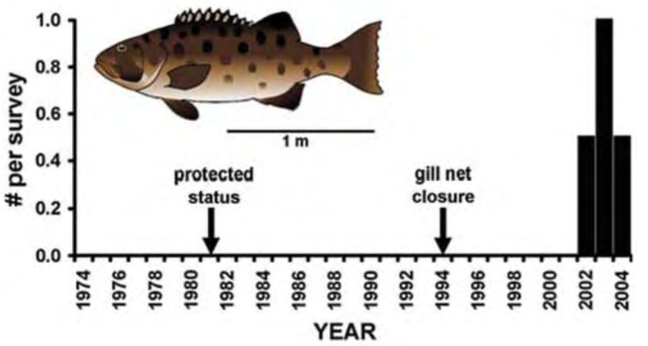


Figure 5-11. Number of giant sea bass observed per quarterly survey at Palos Verdes Point, Rancho Palos Verdes, Los Angeles County from 1974-2004 (Pondella & Allen, 2008).

New Report: Steelhead Trout

Southern steelhead trout are anadromous rainbow trout. At one time they ranged from northern Santa Barbara to as far south as Northern Baja. However, they are currently endangered through much of their range (CDFG, 2009). Steelhead trout still inhabit creeks within the Santa Monica Bay watershed, including Topanga and Malibu. However, loss of habitat from dams and other migration barriers blocking creeks and streams, declining water quality, and invasions of aquatic species have reduced the southern steelhead trout population to a fraction of historic levels. The largest run in the Bay watershed is in Malibu Creek, which now supports fewer than five hundred individuals. The loss of and modification to habitat in Malibu Creek is primarily responsible for the decline.

Since habitat loss is the primary factor in the decline of steelhead trout populations, the removal of barriers that impede their migration is critical to the species' recovery. In collaboration with the CDFG, the SMBRC funded a study to identify and prioritize restoration actions for steelhead in the northern Santa Monica Bay sub-watersheds. The resulting 2006 Santa Monica Mountains Steelhead Habitat Assessment also recommended specific projects for implementation (California Trout, 2006).

This study found that barriers to steelhead trout migration in the Santa Monica Mountains, the largest and most important of which is Rindge Dam on Malibu Creek. This one hundred-foot tall concrete arch dam blocks access to more than six miles of suitable habitat. The Army Corps of Engineers is now in the final stages of a multi-year study, funded in part by SMBRC, to determine the feasibility of removing the dam.

Some progress has been made to restore steelhead trout access to suitable habitat, including some locations identified in this study, such as the removal of the berm in Topanga Creek (see Section 5.1 for a description of the project). Other projects include the removal of an at-grade (Arizona) crossing on lower Malibu Creek and installation of a bridge, the removal of a 220-foot long, 30-foot wide, elevated (Texas) crossing in Malibu Creek State Park, and the retrofitting and removal of small check dams, road crossings and culverts on Solstice and Zuma Creeks. More projects are planned for Arroyo Sequit, Las Virgenes, Zuma, and Corral Canyon Creeks among others. If all the projects in the Santa Monica Mountains Steelhead Habitat Assessment were implemented, an additional twenty-nine miles of stream habitat would be available to steelhead (California, Trout 2006).

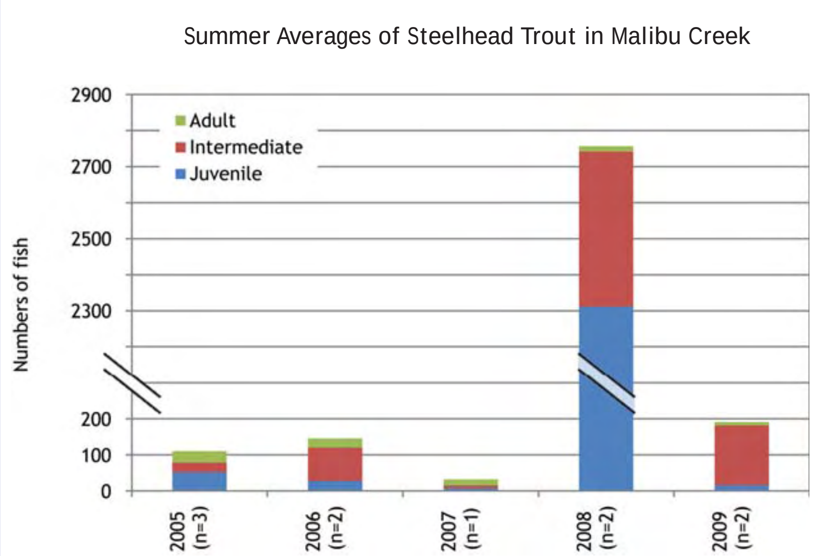
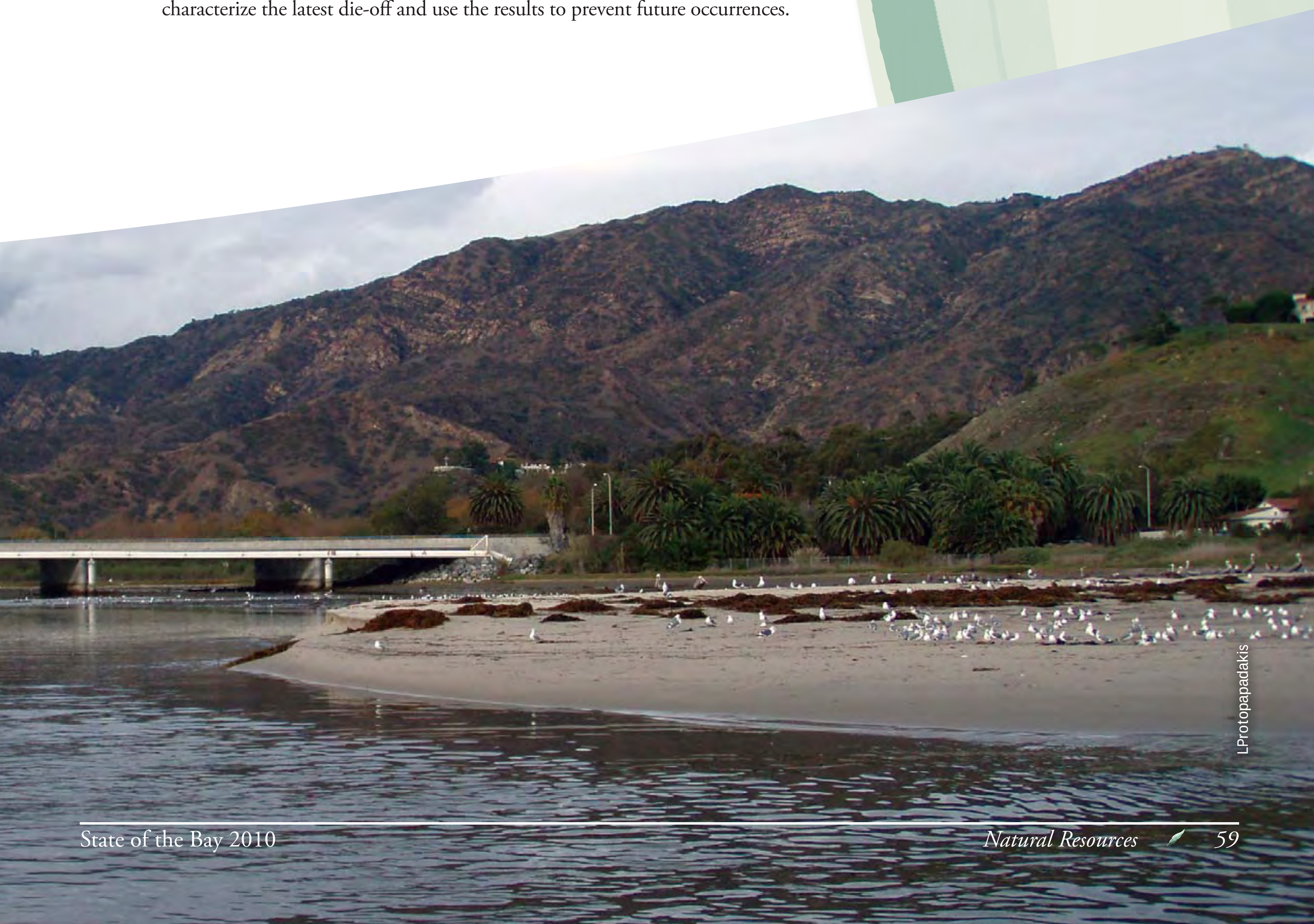


Figure 5-12. Southern steelhead trout population in Malibu creek. Snorkel surveys were conducted by the Resource Conservation District year-round since June of 2005. Surveys are not conducted during all months in all years, but do occur most consistently in the summer months. The number of summer months in which surveys were conducted are noted next to the year, with a maximum of n=3 possible. Only one survey was conducted during the summer of 2007 (following the 2006 die-off). However surveys were conducted in eight months in 2007, all returning a total count of less than 32 (the count in June). Data Source: Resource Conservation District.

The positive effects of these completed barrier removal projects may already be apparent. In 2008 the Resource Conservation District of the Santa Monica Mountains (Resource Conservation District) recorded the highest numbers of migrating steelhead trout in five years of surveys (Dagit, et al., 2009) (see Figure 5-12). However, because the steelhead population is extremely small, they remain vulnerable to stresses. In 2006 a mysterious die-off of steelhead trout and other aquatic life occurred between Rindge Dam and Malibu Lagoon during a three-month period. Scientists attributed the 2006 die-off to a combination of high water temperatures, reduced dissolved oxygen, low water flow from the Tapia Water Reclamation Facility upstream, algal growth and the smothering presence of decomposing diatoms (single-celled microalgae). Determining the cause of the die-off and preventing future events are increasingly important, as warning signs of a new die-off began to appear in the summer of 2009. After the 2006 event, the Resource Conservation District established a rapid response team to monitor any future events and determine causes. The response team plans to characterize the latest die-off and use the results to prevent future occurrences.


LProtopapadakis

Natural Resources

Species of Special Interest

New Report: Marine Mammals and Sea Birds

The deep pelagic habitat and undersea canyons that come close to shore in some areas of the Bay are preferred foraging grounds for dolphins, whales, sea lions, seals, and seabirds. Observational studies partially funded by SMBRC and conducted by the Ocean Conservation Society from 1997-2007 indicate that resident populations of bottlenose dolphins and short and long beaked common dolphins are present year-round, often traveling and diving less than half a kilometer from the shoreline (Bearzi, 2005). The study also demonstrates that these species congregate and feed offshore along the Santa Monica and Redondo submarine canyons where food is more plentiful. Furthermore, while sea lions often travel alone, they appear to aggregate with the dolphins as a way of finding food. The size of these aggregations largely depends on how much prey is available (see Figure 5-13).

Orange County Sheriff's Department's Marine Operations Bureau (OCSD Marine Operations Bureau)

The study also quantified skin lesions, physical deformities and parasites observed on dolphins in the Bay. It was observed that 67% of the coastal and offshore dolphins had at least one skin lesion, raising concerns over their health. Skin lesions can be induced by urban pollution, and coastal bottlenose dolphins can be particularly vulnerable because they spend the majority of their time within 1 km of the shore, where urban pollution inputs are the greatest. The seventeen square mile area off the Palos Verdes Peninsula, where sediments are contaminated by historical deposits of DDT and PCBs, is also a concern (see Section 5.3 for more), partly because this area is adjacent to the submarine canyons which are areas of active foraging and feeding for dolphins and sea lions. However, currently there is no clear evidence that these lesions are caused by contaminants in the Bay or elsewhere. More research will be needed to connect the lesions to contaminants.

While populations of marine mammals in the Bay seem to be stable in recent years, they remain vulnerable to acoustic pollution, entanglement with marine debris, harmful algal blooms, and ship strikes. In 2007 a toxic algal bloom in the Los Angeles coastal waters lasted three months (for more see Section 6.2). A large number of sea lions and dolphins stranded on beaches because of neurological damage caused by the toxin associated with these blooms (domoic acid). California brown pelicans and other seabirds experienced similar symptoms, sometimes resulting in death. In total, twenty-five California sea lions, fifty dolphins, a minke whale, and scores of seabirds were killed in the Santa Monica Bay (Cordero, 2007).

Another threat also impacted marine mammals in 2007. When four blue whales died from ship strikes in the Santa Barbara Channel. This was the highest number of fatalities in one year off the CA coast since whaling was banned in the 1970s. The most likely cause was a relatively shallow and dense aggregation of krill in the shipping lanes through the channel. The shipping lanes north of the Ports of Los Angeles and Long Beach cross the entrance of Santa Monica Bay, bend slightly off of Point Hueneme to continue through the Santa Barbara Channel. Large whales are known to forage in the canyon off of Point Dume not far away from the shipping lane, making ship strikes in the Bay a possibility. The United States Coast Guard, Channel Island National Marine Sanctuary, and National Marine Fisheries Service developed a response plan that includes tracking large cetaceans, developing best management practices for ships when cetaceans are in the area, and responding to strikes when they occur. These measures may help to ensure that our children's children will still be able to watch these magnificent animals as they migrate up and down the coast.

Map Demonstrating How California Sea Lions Use Dolphins to Locate Food

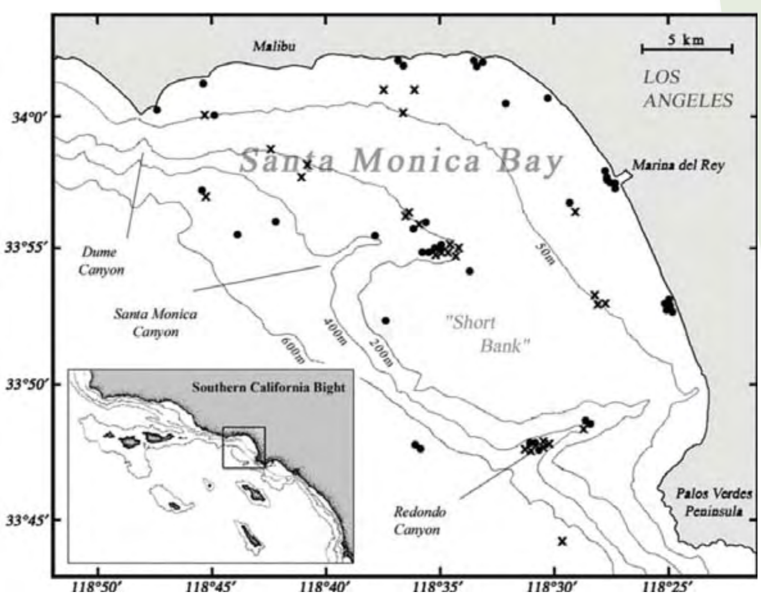
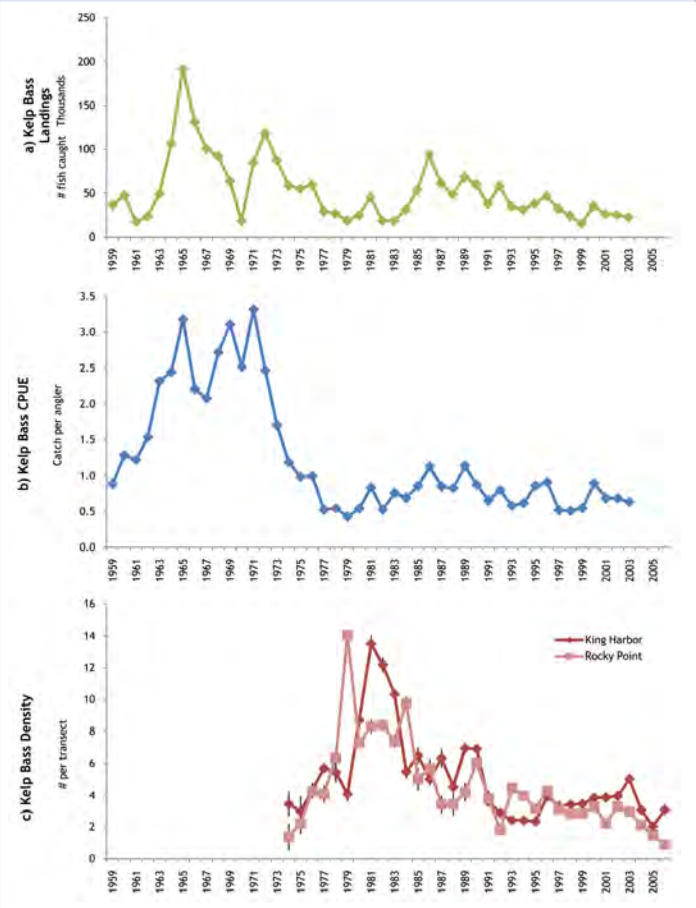


Figure 5-13. Map demonstrating how California sea lions use dolphins to locate food. The symbols indicate the distribution of bottlenose dolphins (•) and two species of common dolphins (x) in aggregations with California sea lions during surface-feeding activities in the bay. Each symbol represents initial GPS coordinates of feeding effort during a sighting (Bearzi, 2006).

Natural Resources
Fish, Fishing, and Fisheries Management

5.5 Fish, Fishing, and Fisheries Management

The Bay's wide range of habitats supports rich and diverse communities of marine life. Some five thousand different species of marine organisms live in the beaches, rocky tide pools, sea grass beds, kelp forests, deep rocky reefs, and submarine canyons of Santa Monica Bay. Because of its productivity and diversity, the Bay has supported commercial and recreational fisheries for over a hundred years (CDFG, 1965). Many of the important commercial and recreational fish species caught in the Bay, such as white seabass and California market squid, are wide-ranging in the Southern California Bight, while other species are resident in the Bay for most or all of their lives. The most popular among the Bay's resident species are kelp bass (calico bass), California halibut, California sheephead, and barred sand bass.



As the effects of overfishing in the Bay became evident in the 1950s, more and more restrictions were enacted to protect fish populations, including the prohibition of most commercial fishing inside a line extending across the Bay from Malibu Point (near Malibu Creek) in Malibu to Rocky Point in Palos Verdes (Schroeder & Love, 2002). Now, the only large commercial fisheries allowed inside the Bay are diving for red sea urchins and bait hauling (seining of small pelagic fish such as mackerel, anchovies, and sardines to sell as live bait to the sportfishing boats).

In contrast, recreational fishing is still allowed everywhere in the Bay. Whether it is spearfishing or angling from shore, pier, kayak, or boat, recreational fishing is a very popular activity for sustenance and for sport. The cumulative total of these various recreational fishing activities is substantial, and species popular with sport fishermen, such as kelp bass, are showing signs of decline. Kelp bass are a sport fishermen's prime target in a kelp forest, and are also highly prized by commercial passenger fishing vessels (CPFVs), recreational boaters, shore fishermen, and kayak fishermen. After the closure of the commercial kelp bass fishery in the 1950s due to overfishing, the recreational catch and catch per angler of kelp bass in Santa Monica Bay increased throughout the 1960s, only to decline precipitously from 1971-2003 (see Figure 5-14a and b). Fishing pressure on kelp bass comes mostly from anglers originating in Redondo Beach's King Harbor and is greatest along the northwest portion of the Palos Verdes Peninsula (Malaga Bay to Long Point). Long-term monitoring at Rocky Point shows that kelp bass have declined in density by 94% from 1979-2006, due to recreational fishing pressure (Figure 5-14c)[1]. A recent underwater survey (2007-2008) found that this area of the Bay holds the lowest density of kelp bass, indicating a broader trend of low densities of kelp bass at heavily fished spots (Figure 5-15).

[1] Researchers believe that low densities of kelp bass on the Palos Verdes Shelf observed in the 1970s can be attributed to the discharge of untreated or modestly treated wastewater off White Point from 1928 to 1983. Favorable climate conditions in the 1980s aided the increase in kelp bass density. However, these

favorable conditions continued and dominated the 1980s and 1990s (International Research Institute for Climate Change, 2007), but kelp bass densities fell.

Reliable assessments of the status and trends of fish communities require fishery-independent data, including population size, natural mortality rate, and rate of replacement. However, these data are exceedingly difficult to obtain due to the challenges posed by the immense study areas, high mobility of organisms, and cost of conducting surveys. The National Marine Fisheries Service and CDFG conduct stock assessments on only a handful of the most heavily-fished species under their fishery management plans. To date, CDFG only has established four fishery management plans: white seabass, market squid, abalone, and nearshore finfish (mainly rock fish, but also includes California sheephead and California scorpionfish). However, the CDFG does report on the status of all California fisheries. Reports are completed annually for one quarter of all fisheries, which means that status reports are supposed to be made for each species every four years. However, the last time CDFG reported on the status of one two popular sport fish in the Bay under management, California sheephead, was in 2001 (CDFG, 2001a). For species not included in a fishery management plan, the CDFG is expected to monitor landing data, looking for anomalies that may indicate changes in the status of the populations of these species (Weber & Heneman, 2000).

Available data indicate that white seabass are recovering under the existing fishery management plan (see Figure 5-16). On the other hand, the population of California sheephead, also covered under an existing fishery management plan, is not yet showing significant recovery (see Figure 5-17a). Data also reveal broad declines in other species that have some management measures in place, but are not covered by management plans, such as kelp bass and California halibut (see Figures 5-14c, and 5-17b). Data also show a potentially emerging fishery for

Kelp Bass Density in Santa Monica Bay

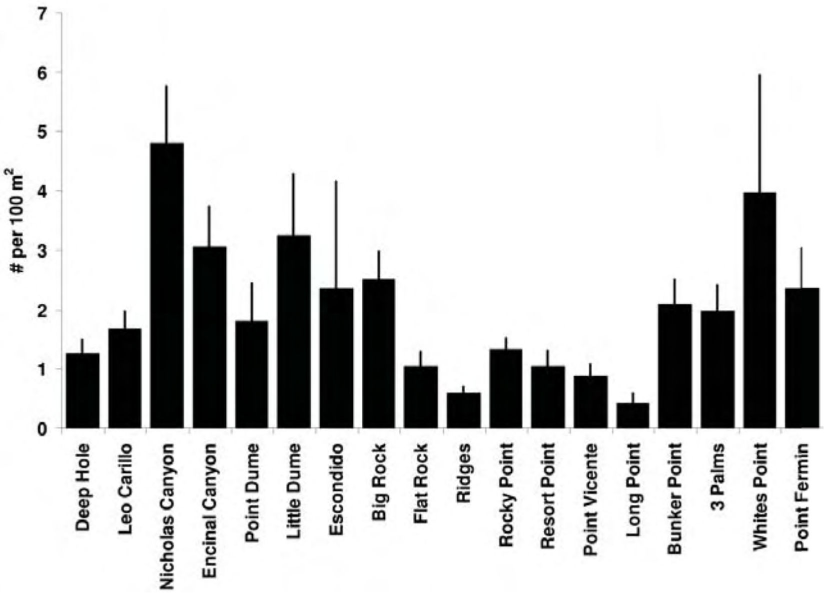


Figure 5-15. Kelp bass densities in 2008-2009 at different reefs in Santa Monica Bay, arranged from north to south. Heavily fished reefs, such as Deep Hole, Leo Carrillo, Flat Rock, and Long Point, all have lower densities of kelp bass than other less heavily fished reefs. Data Source: Vantuna Research Group.

Natural Resources

Fish, Fishing, and Fisheries Management

White seabass replenishment efforts

White seabass used to be one of the most important commercial and recreational fisheries in southern California, but the ever increasing catch of these fish led to the collapse of the population in the late 1970s (Allen, et al., 2007). Several management measures were enacted to restore this species, including the development of a hatchery program. The hatchery program began in 1982, and the full scale Carlsbad-based hatchery began operating in 1995. Fry are sent to twelve grow-out pens between Santa Barbara and San Diego, before they are released into the wild (CDFG, 2002). Grow-out pens are supported and maintained by volunteer sport fishermen, who have released over one million fish into the Southern California Bight. Two of these pens are in the Santa Monica Bay, one at King Harbor and the other in Marina del Rey. The Marina del Rey pen is operated by the Marina del Ray Anglers sportfishing club. Together, these two pens have reared and released 130,000 juvenile white seabass since 1994 (Brown, 2008).

Despite successes and the recapture of many tagged fish throughout the Bight, anglers in Santa Monica Bay have yet to catch one of the tagged fish released in the Bay. Meanwhile, the white seabass population has recovered, largely as a result of the ban on gill nets, enacted in 1994 and the limits set by the Department of Fish and Game (Allen, et al., 2007) (see Figure 5-16). The Marina del Rey Anglers are now shifting their attention to a potential hatchery program for California halibut, hoping that released halibut fry will benefit from restored natural nursery areas when the Ballona Wetlands restoration project is implemented.

a small and previously undesirable resident fish, the blacksmith (see Figure 5-17c). The commercial catch of some coastal pelagic species, such as market squid, are also increasing, possibly due to the overfishing of their predators (Worm, et al., 2009).

For the majority of species, managers still rely on fishery-dependent data to determine whether a fish stock is stable or changing. Fishery-dependent data are statistics, such as landings (measured in pounds, commercially and number of fish, recreationally) and catch per unit effort (CPUE) or "effort", which is a measure of how hard it is to catch a fish. These data provide indirect measures of population size and may be inaccurate or misleading. The comparison in Figure 5-14 of a fishery-independent survey with

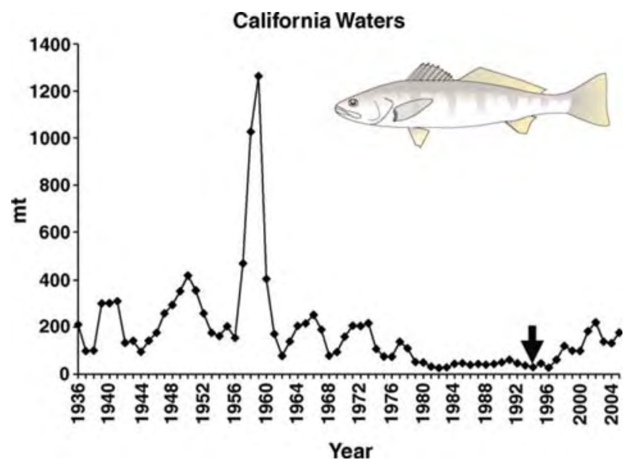


Figure 5-16. Commercial catches of white seabass in California waters from 1936 to 2004. Arrow denotes the implementation of the nearshore gill net ban by California State Proposition 132 (Allen, et al., 2007).

fishery-dependent data (landings and effort) for kelp bass over the same time period demonstrates the value and limitation of fishery-dependent data. During a decline in kelp bass population (observed by the diver surveys), the increase in landings is most likely due to increased "effort." The fishery-dependent data only suggests the decline, when looking at them together. Additionally, the landings and "effort" data did not identify the population rebound observed by the diver surveys, because fisherman had most likely begun to target other species.

Another major limitation of most existing data series, fishery dependent or independent is that they do not go back far enough to make historical comparisons and may be easily misinterpreted. In many cases where a species appears to be recovering from declines, current biomass could still be well below historical levels, as is the case for giant sea bass (see Section 5.4).

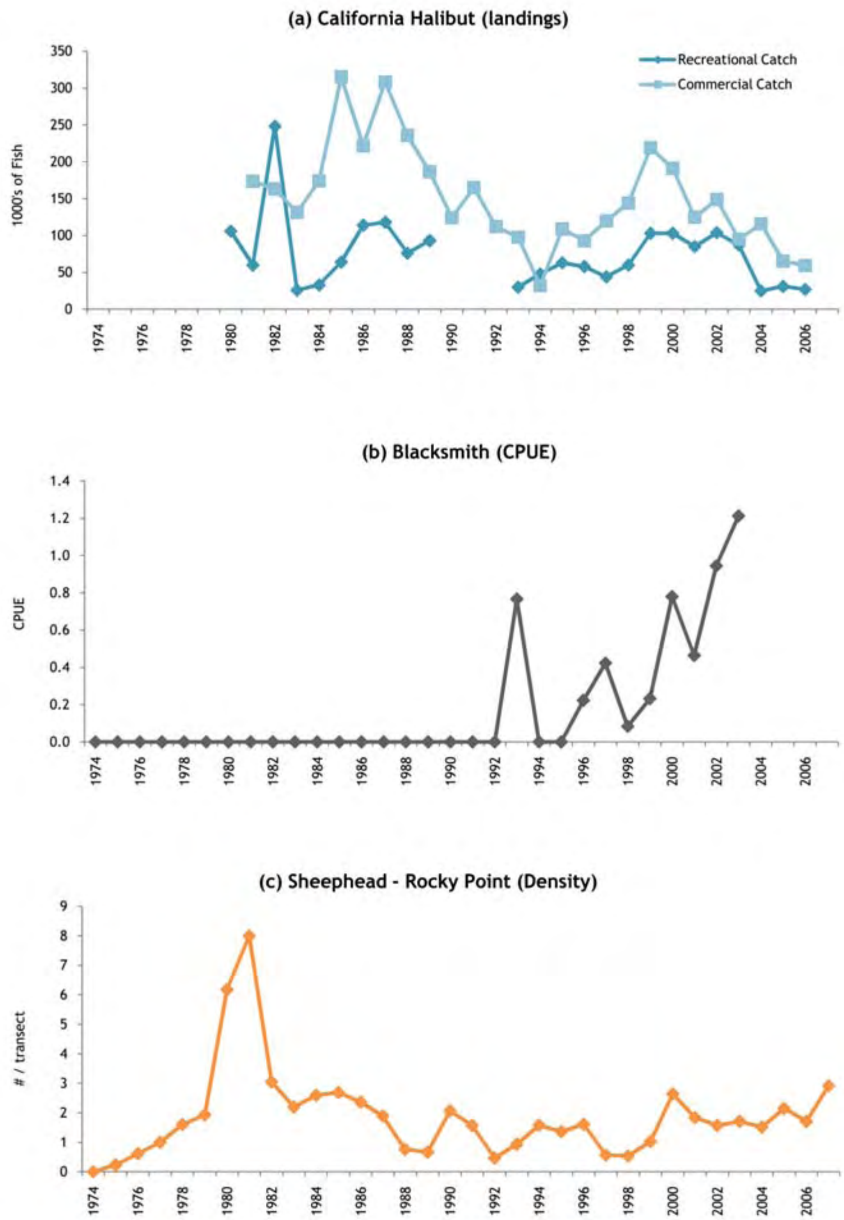


Figure 5-17. Available data for resident fish populations in the Bay: (a) diver surveys of density of California sheephead, (b) landings and CPUE for California halibut, and (c) landings and CPUE for blacksmith. Data Sources: CDFG and Vantuna Research Group.

Some fishery-independent data exist for a few resident species of the Bay, from years of research trawls and diver swimming of transit lines. Resident populations of fish and invertebrate species remain within the Bay for most of their lives and reflect trends that are specific to the Santa Monica Bay. Unfortunately, the monitoring data are only reliable in describing relative trends, and not sufficient for assessing population health. More robust fishery-independent surveys should be conducted for populations of all resident species in the Santa Monica Bay. Perhaps with the coming of Marine Protected Areas (MPAs) (see Section 5.6) and associated monitoring programs, this will be forthcoming.

5.6 Marine Protected Areas

The California State Legislature passed the Marine Life Protection Act (MLPA) in 1999 to improve the state's existing MPAs, and to improve protection for the diversity and abundance of California's marine life and habitats. The MLPA requires evaluating and redesigning existing MPAs with the goals of sustaining, conserving and protecting marine life populations; protecting marine ecosystems; improving recreational, educational and study opportunities provided by marine ecosystems; and protecting our marine natural heritage.

The MLPA was enacted because of the overwhelming evidence that marine life and habitats in California were not in good health. Despite improvements in water quality and fisheries management, marine life and habitats are still under stress. While fisheries management has reduced the impact of fishing on selected fish stocks, its single-species approach fails to protect a wide variety of organisms, trophic structure, habitats, or the ecosystem. A different and more long-term approach is needed to protect marine life and those who depend on it.

MPAs are tools for reducing human disturbance in a given area, similar to national parks. MPAs are not new—over 125 have been created in forty-five countries and territories around the world since the 1950s. Research into the effectiveness of no-take marine reserves, one of the more protective types of MPAs, shows that the protected ecosystems are more robust with bigger, more numerous, and a wider variety of fish, enabling marine communities to persist through good years and bad (Lester, et al., 2009). While many MPAs already exist in California State waters and have benefited select species, most California MPAs have not been as successful as others around the world, likely because they are too permissive, and in some cases too complicated to enforce (Tetreault & Ambrose, 2007).

The state is implementing the MLPA through a innovative process that incorporates community-based public involvement into traditional rulemaking. This process requires that MPA proposals be developed by a group of stakeholders in accordance with scientific guidelines on size, spacing, and

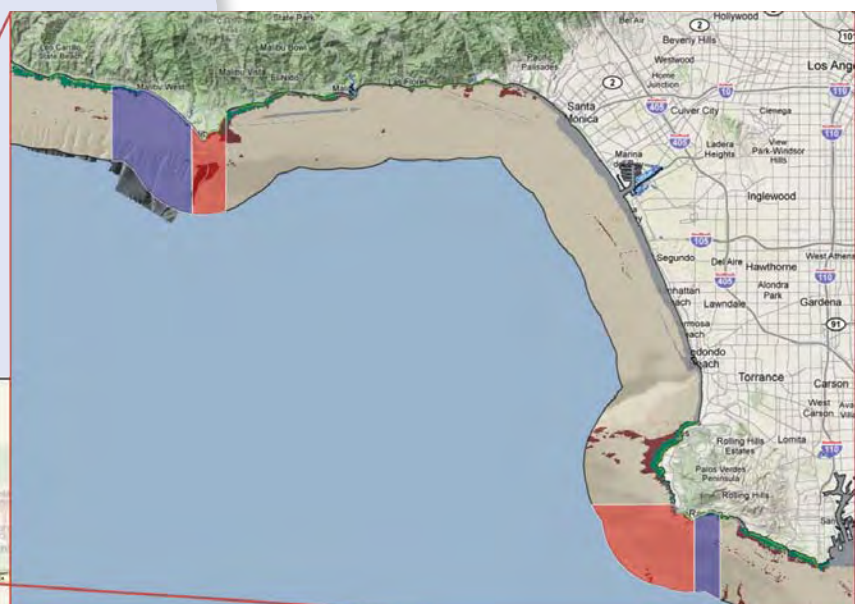
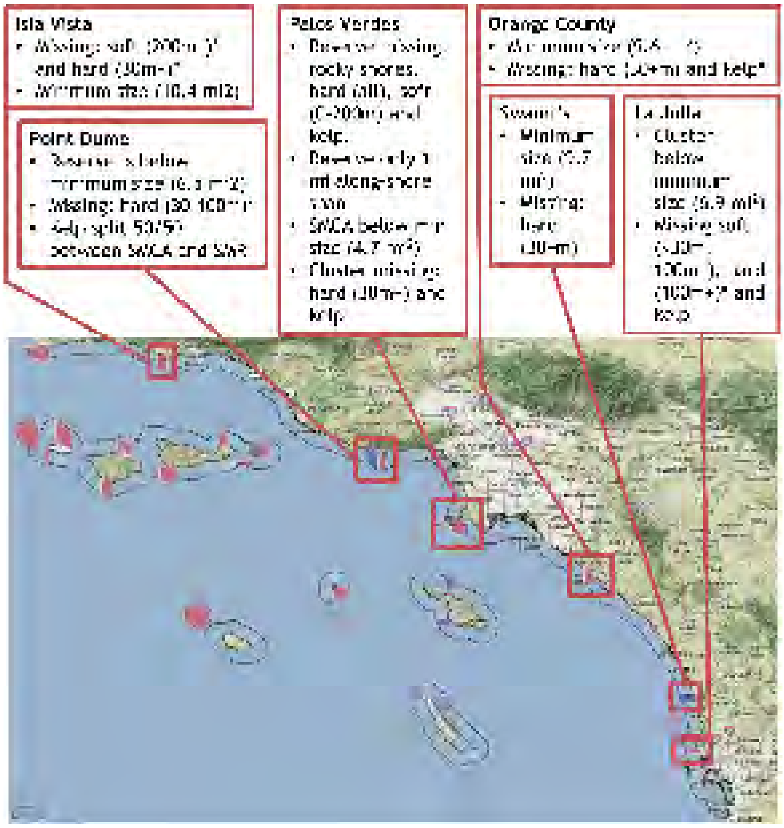


Figure 5-18. Map of the integrated preferred alternative and a blow-up of those in the Santa Monica Bay. Data Source: MarineMap Consortium.

habitat replication. Each proposal is evaluated for how well it meets the science guidelines as well as the predicted economic impact on associated coastal communities. Based on the stakeholder-developed proposals, a Blue Ribbon Task Force (Task Force), appointed by the California Resources Agency, develops and recommends a preferred alternative to the CDFG for approval.

The stakeholder process in the South Coast region (Point Conception to Mexican Border) was initiated in December 2008 and ended in December 2009. The preferred alternative recommended by the Task Force includes two MPAs in the Bay. On the north side, the proposal includes a cluster of MPAs, comprised of a state marine conservation area off Zuma Beach (which would allow some take, including commercial seining of market squid) and an adjacent small, no-take reserve off Point Dume (see Figure 5-18). On the south side of the Bay, the proposal recommends another cluster composed of a reserve off Long Point on the southwest corner of the Palos Verdes Peninsula, and a small conservation area adjacent to it, off Abalone Cove on the Peninsula's south face.

Figure 5-19. Map of Task Force proposal with elements that do not meet science guidelines. The most conspicuous effects created by each MPA's failings are: a lack of required replication of 30 meter and greater hard-bottom habitats, and approximately 110 miles between protected kelp habitats (the maximum recommended spacing gap is 62 miles). Both of these effects are likely to result in failure to protect these key ecosystems, and could be ameliorated by placing a protected area off the north and/or west faces of the Palos Verdes Peninsula.



While this proposal will add to and expand existing MPAs in the Bay, it fails to meet several of the science guidelines established for MPAs in our region (see Figure 5-19). The biggest of these failures occurs in the Palos Verdes cluster, on the south end of the Bay, which fails to protect some of the region's critical habitats, including kelp forests, and the associated biodiversity. Furthermore, this cluster is close to the Portuguese Bend Landslide, the DDT- and PCB-contaminated site on the Palos Verdes shelf (see section 5.3), and the JWPCP outfall, making it less desirable and potentially less likely to succeed than other possible sites in the area. Another major failure of the proposal is the relatively small size of nearly all the reserves in the network—many are below the minimum size recommended by the scientific guidelines. Whether or not these failures will compromise the effectiveness of the reserves remains to be seen.

The MLPA does require monitoring and adaptive management be incorporated into the network design, which allows for adjustments to the network if sufficient data warrant the change. SMBRC is working with the State to develop an MPA monitoring framework that will provide the data needed to evaluate and improve effectiveness of MPAs in Santa Monica Bay.

6. Looking Ahead

6. Looking Ahead

Southern California, including Santa Monica Bay, faces several new challenges in the coming years that local residents responsible agencies must address. This section identifies the foremost emerging challenges for Santa Monica Bay and its watershed, summarizes the current state of knowledge of their likely impacts, and discusses actions needed to address the problems. These challenges range in scope from global, unprecedented issues, such as climate change, to more regional or local issues, such as harmful algal blooms. The common theme among all of the issues is that each has the potential for substantial adverse consequences if we do not take action immediately, and in some cases, even if we do. There are things that can be done at the local level to improve or adapt to new conditions, even though the causes may be regional or global.

LProtopapadakis


HBeral

6.1 Climate Change:

Drought, Sea Level Rise, and Ocean Acidification

Although experts predict a wide range of effects due to climate change, including more frequent and pronounced droughts, sea level rise, and more frequent severe storm events, there is broad consensus that communities must respond by implementing adaptation strategies for these impacts. In the Santa Monica Bay, a changing climate will likely mean hotter and drier weather that will lead to an increase in drought severity and fire risk. It will also mean rising sea level and stronger, more frequent storms, both of which will intensify beach erosion. Some of these impacts are familiar, such as drought, and known mitigation strategies, such as water reclamation and conservation, can be used. Others, such as sea level rise, will require new and creative solutions.

Drought

Drought is not a new issue in the Santa Monica Bay watershed. The climate is naturally arid with limited rainfall even in "wet" years, making this region prone to droughts. In fact, the entire state of California has been in a drought since 2006; 2007 was the driest year in Los Angeles in 130 years. Drought differs from aridity in that a drought is not solely a physical phenomenon. Rather, it originates from the interplay between natural events (less rainfall than expected) and demand on the water supply, resulting in a water shortage (National Drought Mitigation Center, 2006). Southern California is prone to drought because demand for water regularly exceeds the local supply, so the region relies on imported water, from sources such as the Colorado River and Sierra snowpack, to satisfy the difference. However, climatic factors can aggravate drought and many scientists are now predicting that global climate change will exacerbate drought-inducing climatic conditions. A new report from the United States Global Change Research Program finds that the entire Western United States is likely to experience more severe drought in the coming years (United States Global Change Research Program, 2009), affecting the sources of Southern California's imported water.

Furthermore, the population in southern California and the Santa Monica Bay watershed continues to grow, placing an ever increasing demand on the water supply. The severity of the current drought combined with predictions that it will become a permanent, rather than temporary, condition both point to the need for more drastic and far-reaching measures to conserve our limited water resources. More concerted efforts through interagency and community cooperation are needed to shift to less water-consuming practices in our homes and businesses. These efforts include replacing turf and exotic plants with native vegetation, using permeable land cover, harvesting rainwater, and finding new and appropriate uses for recycled wastewater. Greater use of recycled water for groundwater recharge will be necessary in our developed urban areas, where re-plumbing to separate indoor from outdoor uses is not practical. Increasing incentives for water conservation, implementing stream restoration and stormwater infiltration projects, and developing new technologies for water reclamation and treatment are also needed.

Looking Ahead
Climate Change

Sea Level Rise

Another challenge associated with climate change is rising sea level and with it, increased beach erosion and flooding of coastal lowlands. Between the years 1900 and 2000, the level of the ocean has risen nearly 0.20 meters (eight inches) along the California coast (Herberger, et al., 2009). Various model scenarios have predicted sea level rise ranges of 0.19 meters to 1.4 meters between 2000 and 2100 (Meehl, et al., 2007; Herberger, et al., 2009 respectively). Recent, more accurate sea level measurements show that sea level is rising faster than previously predicted. Furthermore, climate models used to make these predictions do not include ice-melt from the large ice sheets in Greenland and Antarctica. These two factors suggest that the potential increase in sea level may even be higher than 1.4 meters (Herberger, et al., 2009).

According to a recent study by the Pacific Institute that modeled the impacts of predicted sea level rise in Los Angeles County, 14,000 people would be vulnerable to flooding from a 100-year flood if sea level were to rise 1.4 meters by 2100 (Herberger, et al., 2009). This is a 270% increase over the 3,700 people vulnerable to the same flood today. It is estimated that the capital cost of the defenses needed to guard against flooding could total $2.6 billion in 2000 dollars. A 1.4 meter rise in sea level would also inundate most of the remaining wetlands in the Bay.

Sea level rise does not just increase the area subject to flooding during storms. In some locations it will exacerbate erosion of the coastline. Many other factors also contribute to coastal erosion, such as the weight of housing developments located on coastal slopes and saturation from irrigation and septic systems. Some factors, such as hillsides denuded by fire, may become worse as a result of climate change. As beaches erode, coastal homes, roads, and other infrastructure will be threatened. However, the Pacific Institute study did not calculate the impacts of sea level rise on beach erosion in southern California, because it was outside the scope of the modeling, which could not account for the extensive coastal armoring along our shoreline. Regardless, few would doubt that people and structures in places like Malibu and Marina del Rey, which are close to sea level and already experiencing significant erosion, are among the most at risk (see Figure 6-1). Sea level rise and associated coastal erosion set a new bar for the type of adaptation strategies needed to combat this coming coastal squeeze.

Important next steps are to complete modeling for more detailed information on local impacts of climate change, including shoreline erosion, to gain a more accurate assessment of local impacts. A comprehensive adaptive strategy and action plan should then be developed and implemented, with structural and non-structural methods to address impacts such as sea level rise. For example, structural methods such as levees and seawalls, and non-structural methods such as restoration of native vegetation, beach nourishment, creating buffers for landward migration of wetlands, land-use restrictions, innovative re-development of existing infrastructure, more stringent restrictions on construction in vulnerable areas, and planned relocation of some structures need to be considered along the Bay's coastline and watershed.

Figure 6-1. This map shows the flood risk in the cities now occupying the historic Ballona wetlands. The area shaded in light blue is the area predicted to flood if the 100-year storm were to happen at today's sea-level. The area shaded in darker blue is the area predicted to flood in a 100-year storm if sea-level rises 1.4 meters from present levels (Herberger, et al., 2009).

Ocean Acidification

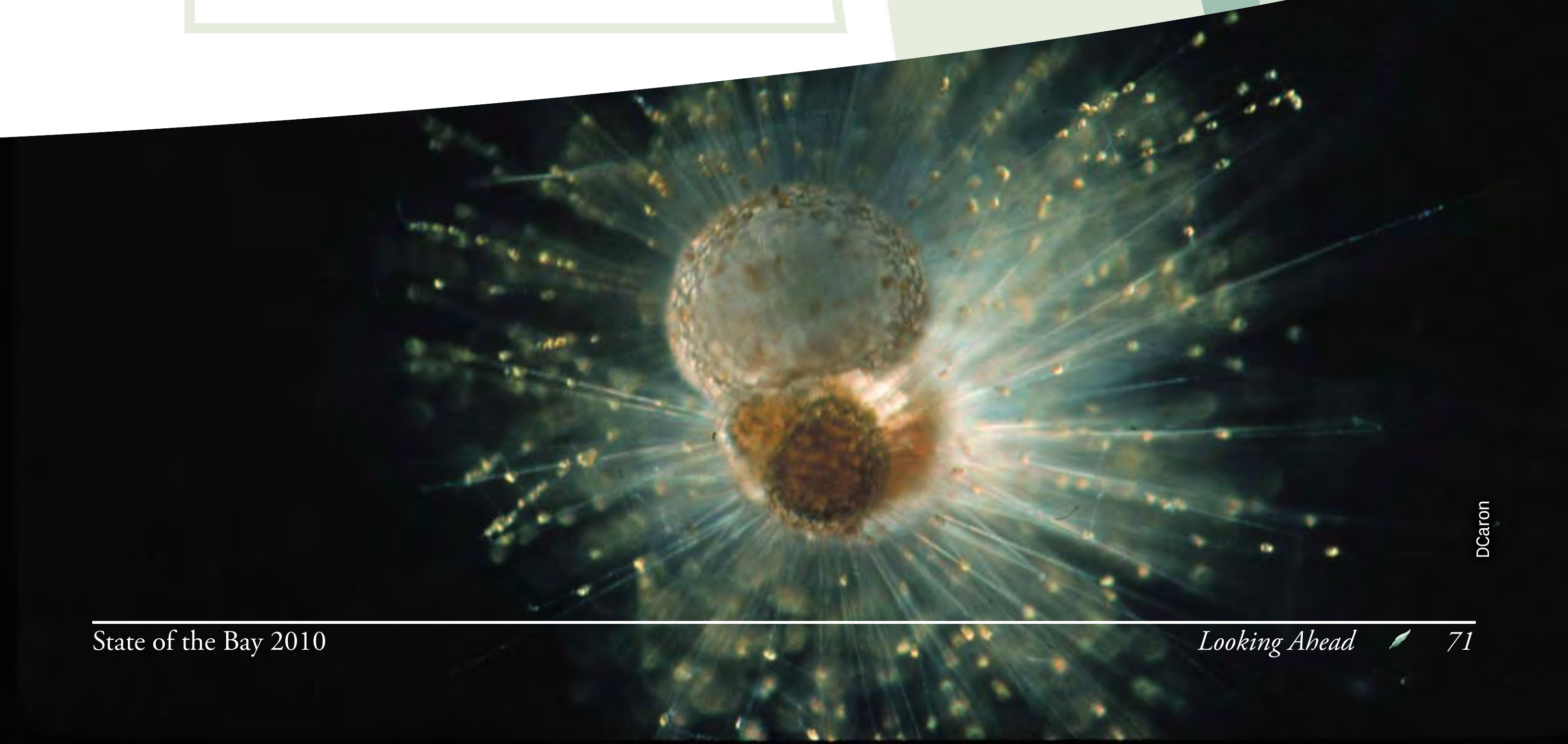
Ocean acidification, the rise in acidity of marine waters, is caused by the increased uptake of carbon dioxide (CO_2) from the atmosphere. CO_2, released as the result of burning fossil fuels and deforestation among other activities, is one of the greenhouse gasses primarily responsible for climate change. Increasing CO_2 in the atmosphere causes more CO_2 to dissolve in ocean waters, where it forms carbonic acid. This results in the increasing acidification of ocean waters. Since the industrial revolution, the surface pH of the ocean has dropped 0.1 points or roughly 25% (Caldeira & Wickett, 2003), a direct result of human-induced inputs of CO_2 to the atmosphere. Without drastic reductions in CO_2 emissions, decreases in pH may be on the order of 0.2-0.5 by the end of this century (Caldeira & Wickett, 2003, and Caldeira 2007). This projected acidification of the ocean is a dangerous threat to all marine ecosystems because it would dramatically alter the basic chemical balance that marine life has evolved with and depends upon.

Can we adapt?

Working with local agencies, SMBRC is beginning to include climate change scenarios into our project planning. The SMBRC is working with the California Coastal Conservancy to model changes in erosion envelopes in our region under different climate change scenarios and plan to do local-scale modeling of climate change impacts on habitats in the Ballona watershed. The Ballona Wetlands Restoration Plan will also incorporate climate change into the project design, using models of what the wetlands will look like under different sea level rise scenarios to help design the restoration. Adjusting to a changing climate is a daunting challenge. However, it is also an opportunity to implement a new vision for the Bay—one that incorporates integrated water resource management and other sustainable practices.

Though research into the long-term ecosystem impacts of ocean acidification is just beginning, there are indications that ocean acidification may cause changes in species distributions and abundances. Such changes could ripple through the entire marine food web (Guinotte & Fabry, 2008). The most obvious effects of ocean acidification are likely to occur in organisms that form shells and other hard parts through calcification. Organisms that could be affected range from phytoplankton (such as foraminifera, pictured on this page) to algae (coralline red algae) to invertebrates (clams). Clams, oysters and mussels that settle in coastal estuarine areas may be particularly vulnerable to ocean acidification (Guinotte & Fabry, 2008). The calcification rates of California mussels and Pacific oyster have been demonstrated to decline linearly with increasing CO_2 concentrations in marine water (Gazeau, et al., 2007). If the levels become too high, mussel and oyster shells will dissolve.

More studies are needed throughout the Southern California Bight to identify regions and species that are most vulnerable to ocean acidification. One important first step is to collect data on a finer scale. A group of water resource managers and POTWs in collaboration with SCCWRP have begun to explore means for providing these data. However, early indications are that existing monitoring programs would need to upgrade equipment and change current monitoring protocols, which may prove challenging.



DCaron

Looking Ahead
Harmful Algal Blooms

6.2 Harmful Algal Blooms

Certain species of microalgae produce powerful neurotoxins or other noxious substances. When their populations proliferate during a bloom, the resulting high concentrations of these toxins can disrupt food web structures and cause illness or death in marine animals. Since the 1990s, marine researchers have noted a global increase in the frequency and severity of harmful algal blooms and California's coastline is no exception (Anderson, et al., 2008). Some stunning examples from the Santa Monica Bay and other nearby coastal waters are the blooms of *Pseudo-nitzschia*, a microscopic alga that produces the powerful neurotoxin domoic acid. Domoic acid poisoning can result in hundreds of thousands of dead or stranded marine mammals and seabirds when the toxin is transmitted through the pelagic food web. Humans are also vulnerable to domoic acid poisoning if they eat shellfish that have recently fed on *Pseudo-nitzschia*. Toxins produced by these microalgae can also cause respiratory irritation in humans. On occasion, sea-lions sick from eating poisoned fish have reportedly attacked swimmers (Wohlsen, 2006; Weiss, 2006). New studies in the San Pedro and Santa Barbara Channels demonstrate that rapid sinking of toxic cells transports significant amounts of domoic acid to local sediments, where it is stored (Sekula-Wood et al., 2009). Potentially, domoic acid could bioaccumulate in benthic organisms and poison marine-life higher up in the food-web, even without a bloom. However, the overall importance of this process is still poorly known. Toxins produced by algal blooms are not the only cause for concern. These blooms remove oxygen from surface waters, sometimes killing fish and other marine species. This occurred in King Harbor in 2005, when a large fish kill resulted from a bloom of a more common dinoflagellate, *Lingulodinium*.

The exact role of anthropogenic sources of nutrient, trace metals, and other biologically reactive chemicals in the occurrence of toxic algal blooms in California's coastal waters is not fully understood. However, circumstantial evidence suggests that nutrients and trace metals in streams, storm drains and wastewater discharges can stimulate or exacerbate these blooms (Anderson, el al., 2008). Many studies are underway, including multidisciplinary research programs that attempt to tease apart the relative contributions of natural and anthropogenic sources of nutrients, to assess the ability of different nutrient sources to stimulate the growth of toxic algae, and to understand how the effects of harmful blooms are propagated through coastal food webs. The Southern California Coastal Ocean Observing System (SCCOOS) maintains pier sampling for harmful algal blooms at five sites in southern California including the Santa Monica Pier. These observations are linked with oceanographic observations from other sources (i.e. satellite) to provide the context under which these blooms occur. This information, as well as climate-related issues, such as temperature, solar input, and storm events, must be obtained and evaluated in order to understand and develop effective management approaches to harmful algal blooms. The next step will be to predict algal bloom occurrences and develop means to reduce their frequency back to baseline levels. An important question is whether urban regions, such as Los Angeles, are causing increases in the frequency and intensity of these blooms locally, or if these algal blooms are being triggered by the changes in climate, ocean chemistry, and the marine food-web caused by globally scaled human activities. In 2006, researchers detected large concentrations of other species of concern that were previously unknown in the Bay, including the 'red tide' forming dinoflagellate, *Cochlodinium* (Reifel, 2009). While *Cochlodinium* frequently causes fish kills in other parts of the world, it has not caused any in Santa Monica Bay yet. Monitoring toxic and non toxic microalgae species, even those not previously present in large numbers in southern California, will also be important in the future.

6.3 Atmospheric Deposition

Many types of contaminants, such as metals, petroleum combustion products, and nutrients, are associated with small particles in the atmosphere (aerosols). These contaminants originate from a variety of urban and agricultural sources, including automobiles, industries, and road dust. Atmospheric deposition is a chronic source of contaminants to the watershed, and occurs mainly when raindrops pick up suspended contaminants and carries them to land surfaces, or by settling out of contaminated particulates during dry weather. The deposition of pollutants from the air onto land and surface water is also an international environmental issue; regional and global transport of pollutants can be a significant contributor to problems such as ocean acidification and nutrient over-enrichment of coastal waters.

Local studies have shown that atmospheric deposition is a dominant source of loadings to Santa Monica Bay for trace metals such as copper, zinc, and lead (Stolzenbach, 2009). Major sources of these metals include transportation-related road dust, tire wear, diesel and jet fuel combustion, and construction dust (see Figure 6-2). As in the rest of arid Southern California, most of the pollutants entering the Bay arrive there by way of daily deposits of particles on land and other surfaces in the watershed during dry weather. Particles accumulate and then wash into the bay during storm events. Only a small portion of these loads are deposited directly onto the Bay. Estimates suggest that between 57% and 100% of the trace metal load in storm water running off impervious surfaces may be due to atmospheric deposition (Sabin, et al., 2005).

Looking Ahead

Atmospheric Deposition

Because atmospheric transport and deposition can add significant quantities of some contaminants to the Bay and its watershed, it should not be overlooked in efforts to address nonpoint source pollution, such as TMDL development. In addition, because aerial transport and subsequent deposition may complicate efforts to identify and control pollution sources by redistributing contaminants over a wide region, it should be addressed at both local and regional levels. Perhaps most challenging will be connecting air and water quality management to ensure air quality monitoring and regulations address the potential impacts of atmospheric deposition on watersheds or aquatic environments, such as Santa Monica Bay, not just the human health impacts of breathing polluted air.

Additional research is needed to quantify the loads of other types of contaminants and nutrients from atmospheric deposition so that their relative contributions can be determined. Local TMDL programs that deal with metal contaminants and storm water should also consider atmospheric deposition and transport in order to provide accurate sources and load allocations. This may require a regional or multi-watershed approach to TMDLs instead of current programs that are limited to discrete water bodies. At the state level, coordination between the Air Resources Board and the State Water Board is also essential to developing approaches to study and address the environmental effects of atmospheric deposition. This process has already begun, with a joint meeting in 2007 between these two agencies to explore the issue and potential actions. It is hoped that these discussions will lead to a new regulatory framework and more coordination between the air and water quality regulatory agencies with the goal of achieving a significant reductions in pollutant loading from atmospheric deposition.

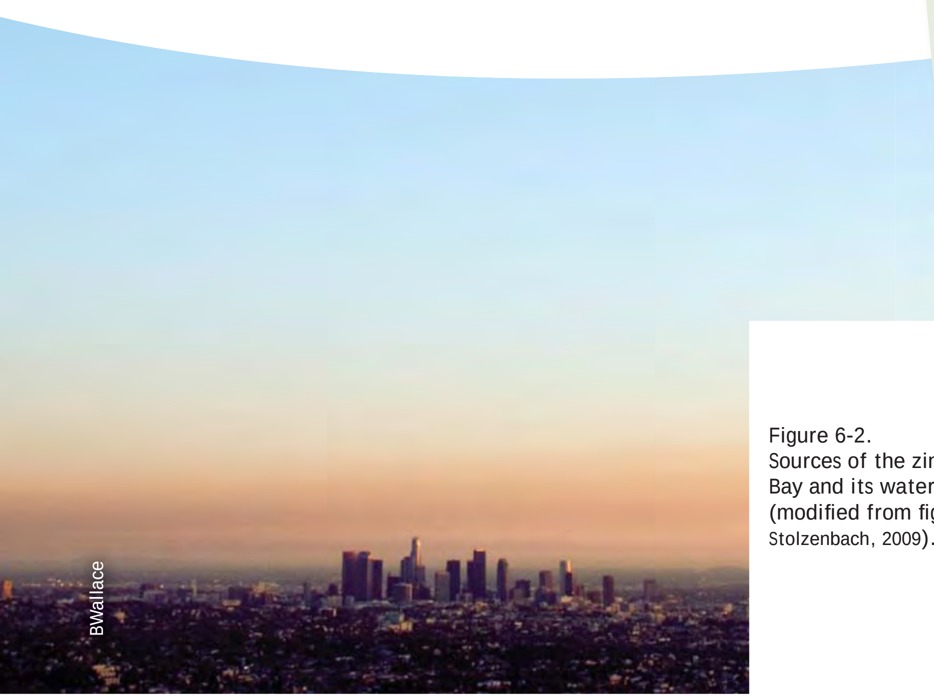


Figure 6-2.
Sources of the zinc in the Bay and its watersheds (modified from figure in: Stolzenbach, 2009).

Looking Ahead

Emerging Contaminants

6.4 Contaminants of Emerging Concern

Santa Monica Bay receives discharges from many sources, including treated municipal wastewater and urban runoff. Our regulatory system does not require risk assessments of most synthetic chemicals prior to their introduction into the marketplace, so little is known about their fates and effects in aquatic ecosystems. Some of these chemicals, known as contaminants of emerging concern, are widely used, have the potential to accumulate in organisms and disrupt biological processes, are present in wastewater discharges, and have been found in both surface and groundwater (see Table 6-3). Toxicity testing to detect unregulated chemicals or chemical mixtures that pose a threat to wildlife is required for all discharges from the POTWs and from Malibu Creek and Ballona Creek. However, this testing focuses on relatively short-term effects, compared to the possible lifetime and even second generation effects that these compounds may have. Furthermore, toxicity testing of discharges only indicates the presence of something toxic in the effluent. Identifying the toxin and tracing it back to the sources is still nearly impossible, given the tens of thousands of chemicals in use throughout the Santa Monica Bay watershed.

There are many data gaps regarding the types, sources, and effects of these contaminants once they are discharged into the coastal environment. Therefore, it is difficult for water quality managers to determine which management actions should be taken. Part of the difficulty is that these contaminants represent a diverse array of chemicals, such as prescription and over-the-counter medicines, personal care products, agricultural and household pesticides, detergents, nanomaterials, flame retardants, and additives to plastics and electronics. While some of these contaminants are known to have potent adverse effects on animals and aquatic life (e.g., pharmaceuticals), others do not appear to pose a significant threat to the environment. Furthermore, the cumulative effects many of these contaminants have on aquatic life are poorly understood. Without better information and tools to assess the environmental risks they pose, managers will be unable to identify important chemical stressors in the Bay and take effective actions to maintain and improve water quality.

Common Sources and Pathways for Contaminants of Emerging Concern to enter waterways

	Category	Examples	Sources	Potential Pathways
	Pharmaceuticals and personal care products	Birth control pills, tranquilizers, pain relievers, antibacterial agents, sunscreen, nanoparticles	Over the counter and prescription medicines, soaps and cleaning agents, cosmetics, sunscreen, clothing, veterinary drugs	Municipal wastewater, bio-solids, reclaimed water irrigation
	Pesticides in current use	Pyrethroids, fipronil	Agriculture, residential pest control	Agricultural and urban runoff, atmospheric deposition
	Natural Hormones	Estrogen, testosterone	Human metabolism, livestock feeding operations	Municipal wastewater, agricultural runoff
	Industrial and commercial chemicals	Bisphenol A, nonylphenol, flame retardants	Industrial and commercial manufacturing	Municipal wastewater, industrial discharges, runoff

Table 6-3. Concentration of selected legacy contaminants and contaminants of emerging concern in (a) sediment and (b) flatfish liver tissue. In this chart, DDTs are the sum of DDD, DDE, and DDT; PCBs are the sum of polychlorinated biphenyl congeners, PBDEs are the sum of polybrominated diphenyl ethers. Data Source: SCCWRP.

Researchers at SCCWRP, wastewater treatment agencies, and universities are investigating the sources, fates, and effects of contaminants of emerging concern in Southern California. They have detected a wide array of pharmaceuticals, personal care products (e.g., antibacterials, shampoos, and sunscreen), natural hormones, and other chemicals in samples of municipal wastewater, seawater, and sediment (Bay, 2008). Sewage treatment plants were not designed to treat these chemicals and thus they are not necessarily able to remove them from the municipal wastewater stream. Urban runoff is another important source of contaminants of emerging concern, especially pesticides and industrial/commercial chemicals used in a wide variety of consumer goods. Some of these contaminants persist in the environment and accumulate in marine life, similar to some of the banned or restricted compounds that we now consider "legacy pollutants" (PCBs and DDT). For example, the livers of southern California marine flatfish contain elevated concentrations of brominated flame retardants (PBDEs), a common flame retardant with the potential to disrupt hormonal activity (Figure 6-4). Southern California sea lions contain some of the highest concentrations of PBDE ever reported in marine mammals. Recent studies have detected biochemical markers suggestive of endocrine disruption in fish, but more research is needed to interpret the significance of these findings and determine whether these contaminants are responsible.

Water quality agencies throughout the nation recognize that the mechanisms currently used to establish monitoring programs and water quality standards has been ineffective for contaminants of emerging concern. These agencies have begun to prioritize contaminants for potential inclusion in monitoring programs and establish improved methods to evaluate risk, and monitor the occurrences and effects of these compounds in the environment. Over the next five years it will be important to determine the types, levels, and effects these contaminants have once they are discharged into the Southern California Bight from both point and nonpoint sources. This will help determine the need for management actions to reduce risks to marine life.

A second approach is to place more emphasis on preventing pollutants from entering waterways. The potential harmful effects new chemicals have on humans and biota need to be evaluated before they are introduced into the marketplace. An initial step in this direction was recently taken in California with the passage of Assembly Bill 1879, which created the Green Chemistry Initiative in the California Department of Toxic Substances Control. Green Chemistry is a new approach to designing consumer products and manufacturing processes that considers the effects the product may have on public health and the environment (California Department of Toxic Substances Control, 2007). The Green Chemistry Initiative will improve disclosure of the chemicals used in consumer products, expand product stewardship programs, make information about chemicals more readily available, and establish a systematic method for evaluating new chemicals, among other things (California Department of Toxic Substances Control, 2007).

"No Drugs Down the Drain" Program

Although research is ongoing to determine the level of risk and long-term effects of contaminants of emerging concern on fresh water and marine ecosystems, it is prudent to adopt a more proactive approach by minimizing the amounts of these compounds entering the sewage system. The City of Los Angeles in conjunction with Los Angeles County and Orange County Sanitation Districts have proposed and adopted a "No Drugs Down the Drain" (N3D) Program to implement a regional approach in educating the general public of the potential risks of contaminants of emerging concern. Instead of flushing unwanted or expired medication down the toilet, drain, or kitchen sink, the N3D Program recommends taking the unwanted or expired medications to a local household hazardous collection center.

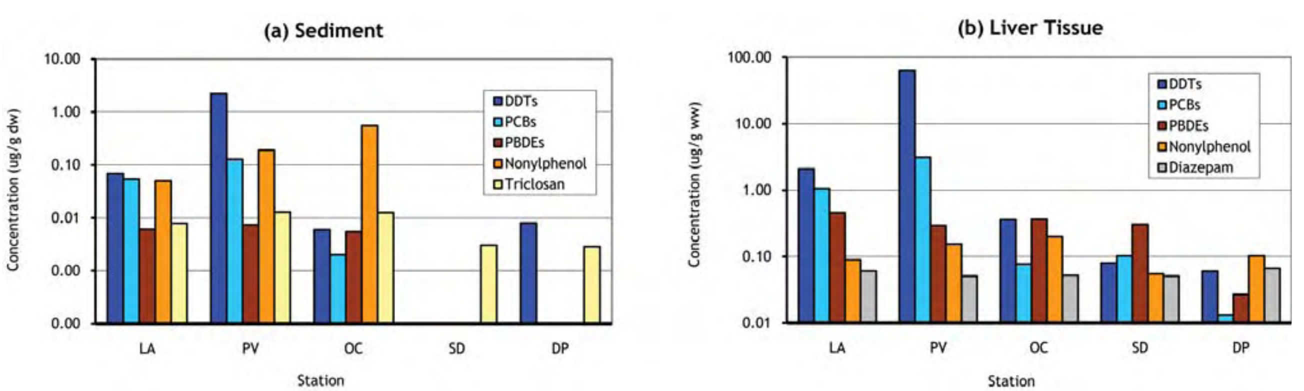


Figure 6-4. Concentration of selected legacy contaminants and contaminants of emerging concern in (a) sediment and (b) flatfish liver tissue. In this chart, DDTs are the sum of DDD, DDE, and DDT; PCBs are the sum of polychlorinated biphenyl congeners, PBDEs are the sum of polybrominated diphenyl ethers. Data Source: SCCWRP.

Conclusion

CONCLUSION

Above all, 2010 is a time to celebrate our remarkable accomplishments since the first State of the Bay Report in 1993. Monitoring data collected over the years clearly show ongoing improvements in the Bay's overall environmental condition—a trend which began approximately forty years ago, despite the ever-growing human population and pressures of urbanization. Nonetheless, the improvement is uneven, with progress more evident in some areas, such as wastewater treatment, and less so in others, such as restoration of degraded wetlands and other native habitats. The good news is several breakthroughs have occurred in the last five years that have allowed us to make inroads in some languishing areas. More integrated water management and a focus on low impact development techniques that benefit water quality and the water supply; restoration of wetlands at Ballona and Malibu; implementation of TMDLs that are reducing trash and bacteria in our rivers and beaches; and creation of MPAs that may benefit the Bay's marine ecosystems are among the many events that have increased the momentum toward restoring the Bay and its watershed.

Many challenges and obstacles remain. Further population growth will increase demand for water, amplify development in remaining open spaces, and intensify fishing efforts for food or sport. Preservation and protection of our limited and increasingly valuable resources will become even more difficult. In addition, we must cope with the unpredictable but potentially disastrous impacts of several new threats including climate change, ocean acidification, harmful algal blooms, contaminants of emerging concern, and others.

These new challenges and obstacles are calls for action and, more than ever, for creative ideas and innovative approaches. In many respects, the achievements of the last few decades are the low-hanging fruit: the problems that had relatively straightforward, readily-available technical solutions, like wastewater treatment and stormwater diversion. In contrast, the remaining and emerging problems we must address today involve diffuse sources, unknown causes, and in some cases unknown consequences. These issues also cut across many different agency jurisdictions and demand integrated solutions, including modifications to deeply ingrained behaviors in our society.

Water quality improvement and habitat protection programs have increasingly become interrelated and combined with water conservation, air quality, and alternative energy development programs, to name a few. Inevitably these programs are becoming intertwined with issues of sustainable development, environmental justice, climate change, and globalization. It is encouraging to see public agencies, once confined to working within their own traditional silos (whether water supply, water quality, or flood control), embracing a new paradigm of integrated water resource management and collaborating to find solutions and implement multi-benefit programs. Even greater integration and visionary solutions will be required to address complex issues such as the impacts of climate change.

SMBRC and its partners are equipped to confront these new challenges. The 2008 Bay Restoration Plan lays out strategies and approaches designed to address the most pressing and emerging issues, as discussed in this State of the Bay report (a summary of the Bay Restoration Plan can be found on the inside front cover). More importantly, the 2008 Bay Restoration Plan reaffirms the strong resolve of SMBRC and all our stakeholders to work collaboratively toward our common goal. With this broad partnership and the aggressive actions in the new framework, we have reason to be optimistic that we can achieve some of the long-desired goals, so the Santa Monica Bay and its watersheds will once again be a place where:

- our waterways, harbors, and beaches are free of trash and beach-goers go for a swim without fear of contracting an infection;
- Ballona and other coastal wetlands along the Bay provide residents with an escape into a natural environment teeming with native birds, fish, and other wildlife;
- fishermen can provide a healthful meal of locally-caught seafood for their families;
- divers flock to the Bay to see the rich marine life; and
- hikers in Malibu Creek State Park see steelhead trout jumping as they migrate into the upper stream reaches to spawn.

A. REFERENCES

Allen, L. G., Pondella, D. J., & Shane, M. A. (2007). Fisheries Independent Assessment of a Returning Fishery: Abundance of Juvenile White Seabass *(Atractoscion nobilis)* in the Shallow Nearshore Waters of the Southern California Bight 1995-2005. *Fisheries Research , 88*, 24-32.

Altstatt, J., & Engle, J. (2009). Reported Eelgrass from Compiled Reports. *Personal Communication* .

Ambrose, R. F., & Smith, J. (2004). *Restoring Rocky Intertidal Habitats in Santa Monica Bay: Draft*. Los Angeles: Prepared for: Santa Monica Bay Restoration Commission.

Anderson, D. M., Burkholder, J. M., Cochlan, W. P., Gilbert, P. M., Gobler, C. J., Heil, C. A., et al. (2008). Harmful Algal Blooms and Eutrophication: Examining Linkages from Selected Coastal Regions of the United States. *Harmful Algae , 8*, 39-53.

Bay, S. (2008). *Sources and Effects of Endocrine Disrupters and other Contaminants of Emerging Concern in the Southern California Bight Coastal Ecosystem, Summary of Results to Date*. Costa Mesa: Southern California Coastal Water Research Project.

Bearzi, M. (2005). Aspects of the ecology and behavior of bottlenose dolphins *(Tursiops truncatus)* in Santa Monica Bay, California. *Journal of Cetacean Research and Management , 7* (1), 75-83.

Bearzi, M. (2006). California sea lions use dolphins to locate food. *Journal of Mammalogy , 87* (3), 606-617.

Brown, L. (2008). *Marina del Rey White Sea Bass Program*. Retrieved from Sportfishingreport.com: http://www.sportfishingreport.com/pages/detail_saltwater.php?id=11461

Caldeira, K. (2007). What Corals are Dying to Tell Us About CO2 and Ocean Acidification. *Oceanography , 20* (2), 188-195.

Caldeira, K., & Wickett, M. E. (2003). Anthropogenic Carbon and Ocean pH. *Nature , 425* (365).

California Coastal Conservancy. (2006). *Ballona Existing Conditions Report*. Prepared by Phillip Williams & Associates, Ltd.

California Department of Toxic Substances Control. (2007). *What is Green Chemistry?* Retrieved 2009, from California Department of Toxic Substances Control: http://dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/index.cfm?CFID=9318111&CFTOKEN=23667590

California Trout. (2006). *Santa Monica Mountains Steelhead Habitat Assessment: Final Project Report*. Prepared for: California Department of Fish and Game, California Coastal Conservancy, and Santa Monica Bay Restoration Project.

(CDFG) California Department of Fish and Game. (1965). *Fish Bulletin 128: An Analysis of California's Albacore Fishery*. Retrieved 2009, from The Resources Agency of California, Department of Fish and Game: http://content.cdlib.org/ark:/13030/kt4s2003r4/

(CDFG) California Department of Fish and Game. (2001). *California's Living Marine Resources: A Status Report, Giant Sea Bass*. Sacramento: The Resource Agency of California, Department of Fish and Game.

(CDFG) California Department of Fish and Game. (2001a). *California's Living Marine Resources: A Status Report (2001)*. Retrieved 2009, from California Department of Fish and Game, Marine Region: http://www.dfg.ca.gov/marine/status/status2001.asp

(CDFG) California Department of Fish and Game. (2002). *White Seabass Fishery Management Plan, Chapter 4*. Sacramento: The Resources Agency, California Department of Fish and Game.

(CDFG) California Department of Fish and Game. (2009). *State and Federally Listed Endangered and Threatened Animals of California*. Retrieved 2009, from The Resources Agency of California, Department of Fish and Game: http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf

City of Los Angeles Department of Public Works. (2002). *High Trash-Generation Areas and Control Measures*. Los Angeles: City of Los Angeles.

City of Los Angeles Department of Water and Power. (2008). *Securing L.A.'s Water Supply*. Los Angeles: City of Los Angeles.

City of Los Angeles Stormwater Program. (2008). *Compliance Report for the Trash TMDL in the Los Angeles River and Ballona Creek and Wetland Watershed – Year 2008*. Los Angeles: City of Los Angeles.

(CLA-EMD) City of Los Angeles Environmental Monitoring Division. (2008). *Focused Surveys for Belding's Savannah Sparrow at the Ballona Wetlands, 2008: FINAL Report*. Prepared by: Keane Biological Consulting, Long Beach.

Community Conservancy International. (2008). *The Green Solution Project: Creating and Restoring Park, Habitat, Recreation and Open Space on Public Lands to Naturally Clean Polluted Urban and Stormwater Runoff*. Prepared for: California Coastal Conservancy, Santa Monica Bay Restoration Commission, Santa Monica Mountains Conservancy, and San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy.

Cordero, J. (2007, June 6). Sea Lions Hit by High Levels of Acid Poison in California. *New York Times* .

Dagit, R., Adams, S., & Drill, S. (2009). Die Off and Current Status of Southern Steelhead Trout in Malibu Creek, Los Angeles County, USA. *Southern California Academy of Sciences Bulletin* .

Dalkey, A. (2007). Press Release: Beach Bluffs Restoration Project. *San Francisco Chronicle (Jul 19), USA Today (Jul 26), Boston Globe (Jul 29), Chicago Tribune (Aug 1)* . Redondo Beach, CA: Beach Bluffs Restoration Project.

Egstrom, G. H. (1974). *The Los Angeles County Underwater Resource Inventory: Oct. 1972-Sept. 1974*. Narragansett Bay: NOAA Office of Sea Grant.

Gazeau, F., Quiblier, C., Jansen, J., Gattuso, J., Middelburg, J., & Heip, C. (2007). Impact of Elevated CO2 on Shellfish Calcification. *Geophysical Research Letters , 34* (7).

Guinotte, J. M., & Fabry, V. J. (2008). Ocean Acidification and Its Potential Effects on Marine Ecosystems. *Annals of the New York Academy of Sciences , 1134*, 320-342.

Gumprecht, B. (1999). *The Los Angeles River: Its Life, Death, and Possible Rebirth*. Baltimore: Johns Hopkins University Press.

Herberger, M., Cooley, H., Herrera, P., Gleick, P. H., & Moore, E. (2009). *The Impacts of Sea-Level Rise on the California Coast*. Prepared for: The California Energy Commission, the California Environmental Protection Agency, Metropolitan Transportation Commission, California Department of Transportation and the California Ocean Protection Council.

International Research Institute for Climate Change. (2007). *Overview of the ENSO System*. Retrieved 2009, from International Research Institute for Climate Change: http://iri.columbia.edu/climate/ENSO/background/pastevent.html

Katz, L. (2008). *Trancas Creek Amphibian Restoration Final Report*. Prepared for: Santa Monica Bay Restoration Commission.

Lester, S. E., Halpern, B. S., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B. I., Gains, S. D., et al. (2009). Biological Effects within No-take Marine Reserves: a Global Synthesis. *Mar Ecol Prog Ser , 384*, 33-46.

Longcore, T. (Ed.). (2005). *Beach Bluffs Restoration Project Master Plan*. Redondo Beach: Beach Bluffs Restoration Project Steering Committee.

Los Angeles County Department of Public Works. (2009). Los Angeles County 2008-2009 Stormwater Monitoring Report, Appendix I: Ballona Creek Watershed Trash Compliance Monitoring Report. Los Angeles County Department of Public Works.

Maalouf, S., Vidaurrazaga, A., Kim, Y. C., & Elwany, H. (2001). Evaluation of the Reliability of an Existing Coastal Structure. *21st: Century: New Era for Hydraulic Research and Its Application." XXIX International Association of Hydro-Environment Engineering and Research Congress Proceedings*. Beijing.

Meehl, G., Stocker, T., Collins, W., Friedlingstein, P., Gaye, A., Gregory, J., et al. (2007). Global Climate Projections. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt, et al. (Eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom: Cambridge University Press.

Meyers, R. A., & Worm, B. (2003). Rapid Worldwide Depletion of Predatory Fish Communities. *Nature , 23*, 280.

Moffatt & Nichol. (2005). *Final Malibu Lagoon Restoration and Enhancement Plan*. Malibu: Prepared for: California Coastal Conservancy and California Department of Parks and Recreation in association with Heal the Bay.

(MSRP) Montrose Settlements Restoration Program. (2009). *Restoration Activities, Case: Montrose/PV Shelf*. Retrieved November 12, 2009, from Damage Assessment Remediation and Restoration Program, Southwest Region: <http://www.darrp.noaa.gov/southwest/montrose/reefs.html>

National Drought Mitigation Center. (2006). *What is Drought*. Retrieved 2009, from National Drought Mitigation Center: http://drought.unl.edu/whatis/concept.htm

A. REFERENCES

Natural Resources Defense Council. (2008). *Comment on AB32 Scoping Plan Appendices - Water Sector*. Natural Resources Defense Council.

Ocean Conservancy. (2007). *International Coastal Cleanup Day Report*. Washington D.C.: The Ocean Conservancy.

(OEHHA) Office of Environmental Health Hazards Assessment. (2009). *Safe Eating Guidelines for Fish from Coastal Waters of Southern California: Ventura Harbor to San Mateo Point Fact Sheet*. Retrieved 2009, from Office of Environmental Health Hazards Assessment: http://www.oehha.ca.gov/fish/so_cal/pdf_zip/SoCalFactsheet61809.pdf

Office of Spill Prevention and Response. (2009). *The Western Snowy Plover in Los Angeles County, California: Annual Report 2008*. Pasadena: Prepared By Ryan Ecological Consulting for California Department of Fish and Game Office of Spill Prevention and Response.

Orr, J. C., Fabry, V. J., Aumont, O., Bopp, L., Doney, S. C., Feely, R. A., et al. (2005). Anthropogenic Ocean Acidification Over the Twenty-First Century and its Impact on Calcifying Organisms. *Nature* , 681-686.

Pondella, D. (2009). *The Status of Nearshore Rocky Reefs in Santa Monica Bay*. Los Angeles: Prepared for: Santa Monica Bay Restoration Commission.

Pondella, D., & Allen, L. (2008). The Decline and Recovery of Four Predatory Fishes from the Southern California Bight. *Marine Biology , 154*, 307-313.

Reifel, K. M. (2009). *Optical Properties of Urban Runoff and its Effect on the Coastal Phytoplankton Community*. Los Angeles: Ph.D. Dissertation, University of Southern California.

Ryan, T., & Vigallon, S. (2008). *Report to Volunteers: Breeding Biology of the California Least Tern at Venice Beach, Marina del Rey, California in the 2008 breeding season*. West Hollywood: Los Angeles Audubon.

Sabina, L. D., Limb, J. H., Stolzenbach, K. D., & Schiffa, K. C. (2005). Contribution of Trace Metals from Atmospheric Deposition to Stormwater Runoff in a Small Impervious Urban Catchment. *Water Research , 39*, 3929-3937.

Santa Monica Baykeeper. (2006). *Kelp Restoration and Monitoring Project, 2006 Annual Progress Report*. Santa Monica: Prepared by: Bodensteiner, L., Ford, T.

Santa Monica Baykeeper . (2007). *Kelp Restoration and Monitoring Project, 2007 Annual Progress Report*. Santa Monica: Prepared by: Meux, B., Ford, T.

Santa Monica Baykeeper. (2008). *Kelp Restoration and Monitoring Project, 2008 Annual Progress Report*. Santa Monica: Prepared by: Ford, T., Meux, B., and Fejtek, S.

Schroeder, D. M., & Love, M. S. (2002). *Recreational Fishing and Marine Fish Populations*. CalCOFI.

Sekula-Wood, E., Schnetzer, A., Benitez-Nelson, C. R., Anderson, C., Berelson, W. M., Brzinski, M. A., et al. (2009). Rapid Downward Transport of the Neurotoxin. *Nature Geoscience , 10*, 1-4.

Sharpe, P. B. (2008). *Restoration and Management of Bald Eagles on Santa Catalina Island, California, 2007*. Long Beach: Montrose Settlements Restoration Program .

(SMBRC) Santa Monica Bay Restoration Commission. (2004). *State of the Bay: 2004 Progress and Challenges*. Los Angeles: Santa Monica Bay Restoration Commission.

(SMBRC) Santa Monica Bay Restoration Commission. (2007). *Comprehensive Monitoring Program for Santa Monica Bay*. Los Angeles: Santa Monica Bay Restoration Commission.

(SMBRC) Santa Monica Bay Restoration Commission. (2008). *Bay Restoration Plan: 2008 Update*. Los Angeles: Santa Monica Bay Restoration Commission.

(SMBRP) Santa Monica Bay Restoration Project. (1990). *An Assessment of Inputs of Fecal Indicator Organisms and Human Enteric Viruses from Two Santa Monica Bay Storm Drains*. Santa Monica Bay Restoration Project.

(SMBRP) Santa Monica Bay Restoration Project. (1991). *Storm Drains as a Source of Surf Zone Bacterial Indicators and Human Enteric Viruses to Santa Monica Bay*. Santa Monica Bay Restoration Project.

(SMBRP) Santa Monica Bay Restoration Project. (1992). *Pathogens and Indicators in Storm Drains within the Santa Monica Bay Watershed*. Santa Monica Bay Restoration Project.

(SMBRP) Santa Monica Bay Restoration Project. (1993). *State of the Bay 1993: Characterization Study of the Santa Monica Bay Restoration Plan*. Santa Monica Bay Restoration Project.

(SMBRP) Santa Monica Bay Restoration Project. (1996). *An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay*. Santa Monica Bay Restoration Project.

South Coast Science Advisory Team. (2009, May). *Draft Methods Used to Evaluate MPA Proposals in the MLPA South Coast Study Region, Chapter 10: Water and Sediment Quality*. Retrieved 2009, from Department of Fish and Game, Marine Life Protection Act: http://www.dfg.ca.gov/mlpa/pdfs/agenda_050509e1.pdf

Stolzenbach, K. (2009). Air Meets Water: Atmospheric Deposition on the Horizon. *Urban Coast, 1* (1), 28-32.

Tetreault, I., & Ambrose, R. F. (2007). Temperate Marine Reserves Enhance Targeted But Not Untargeted Fishes in Multiple No-take Reserves. *Ecological Applications, 17*, 2251-2267.

Tiszler, J. (2001). *Implementation of the Lower Zuma Creek and Lagoon Restoration Project, Santa Monica Mountains National Recreation Area: Final Report.* Prepared for: Santa Monica Bay Restoration Commission.

United States Global Change Research Program. (2009). *Global Climate Change Impacts in the United States.* (R. Thomas, J. Melillo, & T. Peterson, Eds.) New York: Cambridge University Press.

United States Census Bureau. (2008). Los Angeles County QuickFacts. Retrieved 2009, from Census QuickFacts: http://quickfacts.census.gov/qfd/states/06/06037.html

(USEPA) United States Environmental Protection Agency. (2008). *Palos Verdes Superfund Site - Remedial Investigation Report Completed; Feasibility Study Underway.* San Francisco: United States Environmental Protection Agency, Region 9.

(USEPA) United States Environmental Protection Agency. (2009). Palos Verdes Shelf Superfund Site Proposed Plan. Retrieved 2009, from Environmental Protection Agency: http://www.epa.gov/region09/superfund/pvshelf/pdf/pvs-proposed-plan-Jun09.pdf

Weber, M., & Heneman, B. (2000). *Guide to California's Marine Life Management Act.* Bolinas: CommonKnowledge Press.

Weiss, K. (2006., August 1). Altered Oceans, Part Three: Dark Tides, Ill Winds. *Los Angeles Times.*

West Basin Municipal Water District. (2008). Water Reliability 2020. Retrieved 2009, from West Basin Municipal Water District: http://www.westbasin.org/files/pdf/UWMP_2005.pdf

West Basin Municipal Water District. (2008a). *Draft Environmental Impact Report for the Temporary Ocean Water Desalination Demonstration Project.* Carson: West Basin Municipal Water District.

Wohlsen, M. (2006, November 28). California Sea Lions Attack Humans. *San Francisco Gate.*

Worm, B., Hilborn, R., Baum, J. K., Branch, T. A., Collie, J. S., Costello, C., et al. (2009). Rebuilding Global Fisheries. *Science*, 325, 578-585.

B. LIST OF FIGURES AND TABLES

1. Introduction

1-1 Santa Monica Bay and its watershed

2. Accomplishments

2-1 System flow and suspended solids discharged for Hyperion and JWPCP.

2-2 Timeline showing major wastewater treatment milestones achieved in the Santa Monica Bay.

2-3 Benthic Response Index at the Hyperion and JWPCP outfalls in the Santa Monica Bay.

2-4 Sewer line maintenance, sewage spills, and beach closures.

2-5 Map of low-flow diversions installed at Santa Monica Bay Beaches.

2-6 Percentage of Bay beaches receiving A or B beach grades during dry weather on Heal the Bay's Annual Beach Report Card.

2-7 Map of properties acquired in the Santa Monica Bay, for the purpose of creating or protecting open space.

3. Habitat Conditions

3-1 Map of major Santa Monica Bay habitats.

3-2 Habitat condition characterization for the Santa Monica Bay.

3-3 Current conditions of the rocky reef habitat in Santa Monica Bay.

3-4 Current conditions of the soft-bottom habitat in Santa Monica Bay.

4. Focus on Water Quality

4-1 Table of TMDLs implemented or planned for the major water bodies in the Santa Monica Bay and its watershed.

4-2 Number of samples exhibiting bacterial TMDL exceedances at Santa Monica Bay beaches, 2005-2008.

4-3 Eight Santa Monica Bay beaches where summer and winter dry weather samples often exceed TMDL standards.

4-4 Percentage of all C, D, and F beach grades received during wet and dry weather, 2000-2008.

4-5 High trash generating areas in the City of Los Angeles.

4-6 Annual tonnage of trash removed from beaches managed by Los Angeles County, 2005-2008.

4-7 Trash associated with shoreline and recreational activities collected in California on the 2007 Coastal Cleanup Day.

4-8 Current and projected increases to water supply from local sources for the City of Los Angeles and West Basin.

4-9 Los Angeles water demand and population growth, 1970-2007.

4-10 Increases in wastewater recycling and its use.

5. Focus on Natural Resource

5-1 Map showing the locations of some of the restoration projects in the Santa Monica Bay and its watershed.

5-2 Kelp canopy coverage off Malibu and Palos Verdes, 1911-2008.

5-3 Table of notorious invasive species in the Santa Monica Bay and watershed.

5-4 Map of the spread of the New Zealand mudsnail in the Santa Monica Bay watershed, 2006-2009.

5-5 Map of sediment contaminated with DDT and PCBs around White Point outfall.

5-6 Map showing the preferred capping site and additional areas under consideration in the Palos Verdes Shelf remediation plan.

5-7 Map of the area covered under the California seafood consumption advisory and the consumption advisory.

5-8 Table of Species of Special Concern in the Santa Monica Bay and its watershed.

5-9 Map of habitat critical for the Western snowy plover in the Santa Monica Bay watershed.

5-10 Commercial landings of giant sea bass, 1916-1999.

5-11 Number of giant sea bass observed during diver-surveys on Palos Verdes, 1974-2008.

5-12 Summer averages of southern steelhead trout in Malibu Creek, 2005-2009.

5-13 Map showing feeding aggregations of California sea lions, common dolphins, and bottlenose dolphins in the Santa Monica Bay.

5-14 Comparison of landings, effort, and density data for kelp bass, 1959-2008.

5-15 Kelp bass densities at different reefs in Santa Monica Bay, 2007-2008.

5-16 Commercial catch of white sea bass in California waters, 1936-2004.

5-17 Density of California sheephead and landings of California halibut and blacksmith in Santa Monica Bay, 1980-2006.

5-18 Map of integrated preferred alternative for Southern California and blow-up of the Santa Monica Bay.

5-19 Map showing the failings of the integrated preferred alternative and how they could be rectified.

6. Looking Ahead

6-1 Map of projected flood risk for the Ballona Wetlands and surrounding cities.

6-2 Atmospheric sources of zinc to the Bay and its watershed.

6-3 Table of common sources and pathways for contaminants of emerging concern to enter waterways.

6-4 Concentrations of selected legacy contaminants of emerging concern in sediment and flatfish tissues.

C. ABBREVIATIONS

AB411	Assembly Bill 411
CDFG	California Department of Fish and Game
CDS	Continuous Deflective Separation Units
CEQA	California Environmental Quality Review
CLA-EMD	City of Los Angeles Environmental Monitoring Division
CO_2	Carbon dioxide
CPFV	Commercial Passenger Fishing Vessel
CPUE	Catch per unit effort. Also "effort"
DDT	dichlorodiphenyl-trichloroethane
JWPCP	Joint Water Pollution Control Plant
LACSD	Sanitation Districts of Los Angeles County
LAX	Los Angeles International Airport
LID	Low Impact Development
MLPA	Marine Life Protection Act
MPA	Marine Protected Area
MRT	Mountains Restoration Trust
MSRP	Montrose Settlements Restoration Program
NPDES	National Pollution Discharge Elimination System
OEHHA	Office of Environmental Health Hazards Assessment
PBDE	Brominated flame retardants
PCB	Polychlorinated biphenyls
POTW	Publically owned treatment works
PVPLC	Palos Verdes Peninsula Land Conservancy
SCCOOS	Southern California Coastal Ocean Observing System
SCCWRP	Southern California Coastal Water Research Project
SMBRC	Santa Monica Bay Restoration Commission
SMBRP	Santa Monica Bay Restoration Project
SMMC	Santa Monica Mountains Conservancy
SUSMP	Standard Urban Storm Water Mitigation Plan
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency

D. GLOSSARY

Armoring
Placement of fixed engineering structures, typically rock or concrete, on or along the shoreline to reduce coastal erosion.

Area of Special Biological Significance (ASBS)
Areas along the coast or offshore islands that have been designated by the State Water Resources Control Board as having unique biological value or fragility and deserving of protection. The California Ocean Plan prohibits the discharge of waste to these areas.

Benthic macro invertebrates
Animals without backbones, which are visible to the eye and which live on, under, and around rocks and sediment on the bottoms of streams, lagoons, oceans and other waterbodies.

Biodiversity
The genetic diversity of plant and animal life in an ecosystem.

Biogeographies
The geographical distribution of animals and plants.

Culvert
A metal, concrete, or plastic pipe through which water is carried, usually under a road, building or other structure.

DDT (dichlorodiphenyl-trichloroethane)
A toxic insecticide banned in 1970 and eliminated from discharges to the Bay by 1989, but still widely found in water and fish samples because of its stability in the environment.

Ecosystem function
Services performed by the ecosystem as a whole and the organisms in the system, such as energy flow, nutrient cycling, and population regulation, that result from naturally occurring processes.

Estuary
A semi-enclosed coastal body of water with one or more rivers or streams flowing into it, and with a connection to the open sea

Full-capture systems
Any single or series of devices that traps all particles greater than five millimeters in diameter and also has a design capacity capable of capturing all the trash in a flow resulting from a one-year, one-hour storm.

Impervious surface
A hard surface that does not allow water to pass through; the primary cause of urban runoff.

Indicator bacteria
Bacteria (disease-causing or otherwise) whose presence in water indicates the possibility of pathogens in the water.

Infiltration
Flow of water through the ground into subsurface soil .

Low-flow diversion
Systems installed in storm drains that divert low volume flows to a treatment facility. These systems are not usually designed to handle the large volumes of water that occur during a rain event and therefore usually operate only during dry-weather.

LID (low impact development)
An approach to land use planning and development that uses design practices and technologies to improve stormwater management. This approach combines on-site landscape features with small-scale engineered hydrologic controls to replicate the pre-development hydrologic regime of watersheds including, infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.

Loading (of pollutants)
The concept of "loading" is used to quantify how much pollution is entering the Bay. Pollutant loads are estimates of the total amount of pollutants entering a waterbody from various sources. Loading is usually expressed in weight per unit time per unit area (i.e. tons/year or tons/acre).

Pathogen
A disease-producing agent, usually a virus, bacterium or other microorganism.

PCB (polychlorinated biphenyls)
An extremely toxic group of industrial chemicals used in capacitors, transformers, and carbonless paper. Manufacturing of PCBs was banned in 1976 and its use is discouraged. It is also persists in the environment.

Pelagic
The part of the open sea or ocean comprising the water column, i.e., all of the sea other than that near the coast or the sea floor.

Pervious pavement
A hard surface that allows significant amounts of water to pass through.

POTW (Publicly-Owned Treatment Works)
A publicly owned sewage treatment plant.

Restoration
Altering an area in such a way as to re-establish an ecosystem's structure and function.

Riparian
Refers to the banks of a stream or river, usually characterized by hydrophilic (water-loving) vegetation.

Runoff
Runoff is the water from rainfall or other sources (i.e. from irrigation) that flows over hard surfaces such as pavement or over saturated soils; it is the excess water, from rain, snowmelt, or other sources that flows over the land.

Secondary treatment
Sewage treatment that removes over 90% of organic and inorganic solids found in sewage after primary treatment. Solids are removed by introducing microorganisms to feed on organic material. Oxygen is introduced to accelerate the biological process. Remaining solids are again settled and removed.

Southern California bight
The area of coastal ocean between Point Conception, the US-Mexican border and the Channel Islands.

Stock assessment
The most precise method currently used to quantify the population status of targeted fish and invertebrate species that uses abundance, length, and age structure measurements to calculate status.

Stormwater
Water from precipitation that flows over hard surfaces and into creeks or storm drain systems.

TMDL (total maximum daily load)
A regulatory term defined in the Clean Water Act. It is the maximum amount of a pollutant (or an allocation of the maximum amount) that a body of water can receive while still meeting water quality standards that support beneficial uses.

Wastewater
Water that has been used, for example for washing, flushing, or in a manufacturing process, and contains waste products; sewage.

Watershed
The entire geographical area drained by a river and its tributaries; an area characterized by all runoff being conveyed to the same outlet.


MFlynn

E. PHOTO CREDITS

Front Cover	Rocky Point, by Dan Pondella
Inside Front Cover	Beneath the Santa Monica Pier, by Lia Protopapadakis
Table of Contents	Dockweiler Beach at Sunset, by Lia Protopapadakis

Page i	Scattergood Generating Station from Sea, by Dan Pondella
Page ii	Point Fermin Light House, by Dan Pondella
Page ii	Tide Pooling, by Mas Dojiri
Page iii	Beachgoers at a Santa Monica Bay Beach, by Charlotte Stevenson
Page iv	Occidental College Students on a Field Trip to White Point, by Lia Protopapadakis
Page v	Trash Net Stretched Across the Ballona Creek Channel, by Karina Johnston
Page v	28th Street Drain in Manhattan Beach, by Lia Protopapadakis
Page vi	Next to Zuma Lagoon, by Lia Protopapadakis
Page vii	Algal Bloom near a Pier, by Dave Caron
Page vii	House Condemned Due to Coastal Erosion in North Carolina's Outer Banks, by Lia Protopapadakis
Page 1	Rocky Intertidal: Inset of Point Fermin Light House, by Dan Pondella
Page 2	Rocky Point, by Dan Pondella
Page 4	Offshore of Hyperion, by Lia Protopapadakis
Page 5	Marina del Rey and Ballona Wetlands from the Air, by Lia Protopapadakis
Page 6	People Playing at the Shoreline, by Charlotte Stevenson
Page 6	Surfers Entering the Water at County Line, by Charlotte Stevenson
Page 8	Sand Dollars, by Dan Pondella
Page 8	Great Blue Herons on the Ballona Wetlands, by Sarah Woodard
Page 9	King Gillette Ranch, by Santa Monica Mountains Conservancy
Page 11	Solstice Creek Meets the Sea, by Lia Protopapadakis
Page 12	Cut-out of Solstice Creek Meets the Sea, by Lia Protopapadakis
Page 13	Creek, by Charlotte Stevenson
Page 14	Pacific Coast Highway Bridge over Malibu Creek, by Lia Protopapadakis
Page 15	Ice Plant Covering the Redondo Beach Bluffs, by Guangyu Wang
Page 15	El Segundo Blue Butterfly, by Ann Dalkey
Page 16	Grunion Run, by Dan Pondella
Page 16	Zuma Beach Runner, by Lia Protopapadakis
Page 17	Rock Crab, by Dan Pondella
Page 17	SeaStar, by Charlotte Stevenson
Page 18	Surfgrass, by Dan Pondella
Page 19	Surfgrass and sheephead, by Dan Pondella
Page 20	Pisaster and Anemone, by Charlotte Stevenson
Page 20	Macrocystis, by Charlotte Stevenson
Page 21	Urchin Barren, by Dan Pondella
Page 22	Flatfish Hiding, by Dan Pondella
Page 23	Sheep Crab, by Dan Pondella
Page 24	California Sea Lion off Santa Barbara Island, by Michael Flynn
Page 25	Schooling Baitfish, by Dan Pondella
Page 26	Northern Zuma Beach, by Lia Protopapadakis
Page 27	Beach Warning at 26th Street in Manhattan Beach, by Lia Protopapadakis
Page 28-29	Paradise Cove Storm Drain, by Lia Protopapadakis
Page 30-31	Trash behind the Trash Net in the Ballona Creek Channel, by Karina Johnston
Page 32	Trash in Ballona Creek, by Jonathan Coffin
Page 33	Water Droplet, by Lia Protopapadakis
Page 34-35	A Channel in Malibu Lagoon, by Lia Protopapadakis
Page 36	Intake Pipe for a Desalination Plant, by Silke Baron
Page 36-37	Surface Water: Inset of Rocky Point, by Dan Pondella
Page 38	Ballona Pedestrian Bridge, by Jonathan Coffin
Page 39	Fish: Inset of Sheephead over Surfgrass, by Dan Pondella
Page 40-41	Inset of Creek Bed, by Charlotte Stevenson
Page 42-43	Mouth of Malibu Creek, by Lia Protopapadakis
Page 43	Bridge Pilings in Ballona Lagoon, by Karina Johnston
Page 44	Blue El Segundo Blue Butterfly, by Ann Dalkey
Page 44	Redondo Beach View South, by Guangyu Wang
Page 45	Cutout of Looking Down on a Kelp Forest, by Dan Pondella
Page 46-47	Pampas Grass in Ballona, by Karina Johnston
Page 47	Feral Cat at White Point, by Lia Protopapadakis
Page 48	New Zealand Mudsnail Close Up, by Dan Gustafson
Page 49	Lots of New Zealand Mudsnails, by Dan Gustafson
Page 50	Trancas Creek, by Lia Protopapadakis
Page 52-53	Fishing from Paradise Cove Pier, by Lia Protopapadakis
Page 54-55	Cormorant, by Charlotte Stevenson
Page 56	Santa Monica Beach, by Lia Protopapadakis
Page 57	Looking Down on a Kelp Forest, by Dan Pondella
Page 58-59	Malibu Creek, by Lia Protopapadakis
Page 60	Flying Dolphin, by William Nelson of the Orange County Sheriff's Department's Marine Operations Bureau (OCSD Marine Operations Bureau)
Page 60-61	Sea Lions at Sunset, by Pat Douglass of the OCSD Marine Operations Bureau
Page 62-63	Shorefishing from the Rocks at White Point, by Lia Protopapadakis
Page 63	Los Angeles Sportfishing Harbor, by Lia Protopapadakis
Page 64-65	Dana Point East Basin, by Pat Douglass of the OCSD Marine Operations Bureau
Page 66-67	Boat Fishing off a Kelp Forest, by Lia Protopapadakis
Page 68	View North from Point Fermin, by Lia Protopapadakis
Page 68-69	Blue Shark, by Hal Beral
Page 71	Foraminifer, by Dave Caron
Page 72	Harmful Algal Bloom, by Chris Willey on flickr.com
Page 73	Los Angeles's Smog-filled Skyline, by Brian Wallace
Page 74	Long Beach Containers, by Charlotte Stevenson
Page 76-77	Pelicans in Flight, by John Hollenbeck of the OCSD Marine Operations Bureau
Page a-iv	Rockfish, by Dave Witting
Page c-i	Creek Bed, by Charlotte Stevenson
Page d-ii	Red Gorgonian, by Michael Flynn

F. ACKNOWLEDGEMENTS

The 2010 State of the Bay Report was the collaborative work of SMBRC staff and the SMBRC's Technical Advisory Committee. Special appreciation goes to Rich Ambrose, Chair of the Technical Advisory Committee, and Steve Bay, Vice Chair of the Technical Advisory Committee. The Report would not have been possible without their leadership and guidance. Additional appreciation is also extended to other Technical Advisory Committee members, especially Mas Dojiri, Dan Pondella, and Burton Jones, as well as Joe Gully of the LACSD, all of whom contributed significantly to the writing and review of this document.

SMBRC Technical Advisory Committee

Dr. Richard F. Ambrose, Chair, University of California Los Angeles

Steve Bay, Vice-Chair, SCCWRP

Dr. David Caron, University of Southern California

Dr. Mas Dojiri, City of Los Angeles Bureau of Sanitation

Dr. Linda Fernandez, University of California Riverside

Dr. Rainer Hoenicke, San Francisco Estuary Institute

Dr. Jenny Jay, University of California Los Angeles

Dr. Burton Jones, University of Southern California

Dr. Karen Martin, Pepperdine University

Dr. Dan Pondella, Occidental College

In addition to members of the Technical Advisory Committee, the following individuals also provided data, additional content and or valuable feedback, and their contributions are gratefully acknowledged.

Rosi Dagit, Resource Conservation District of the Santa Monica Mountains

Ann Dalkey, Palos Verdes Peninsula Land Conservancy

Tom Ford, Santa Monica Baykeeper

Dr. Mark Gold, Heal the Bay

Christopher Sellers, LA County Beaches and Harbors

Rorie Skei, Santa Monica Mountains Conservancy

Charlotte Stevenson, Heal the Bay

Dr. Keith Stolzenbach, University of California Los Angeles

SMBRC Project Team

Dr. Shelley Luce, Executive Director

<u>Project Manager & Editor</u>

Lia Protopapadakis

<u>Contributing Authors & Editors</u>

Dr. Guangyu Wang

Jack Topel

Sean Bergquist

<u>Copy Editor</u>

Sarah Woodard

<u>Graphic Design</u>

Joel Hanson

<u>Research and Design Interns</u>

Lorna Apper

Carla Navarro

bay restoration commission

STEWARDS OF SANTA MONICA BAY

Santa Monica Bay Restoration Commission

320 West Fourth Street, Suite 200

Los Angeles, CA 90013

santamonicabay.org

This Report has been funding wholly or in part by the United States Environmental Protection Agency using Clean Water Act grant funds under Assistance Agreements to the State Water Resources Control Board and to the Santa Monica Bay Restoration Foundation. The contents of this document do not necessarily reflect the views and policies of the USEPA, the State Water Resources Control Board, or of any other funding organization, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Printed on Recycled Paper