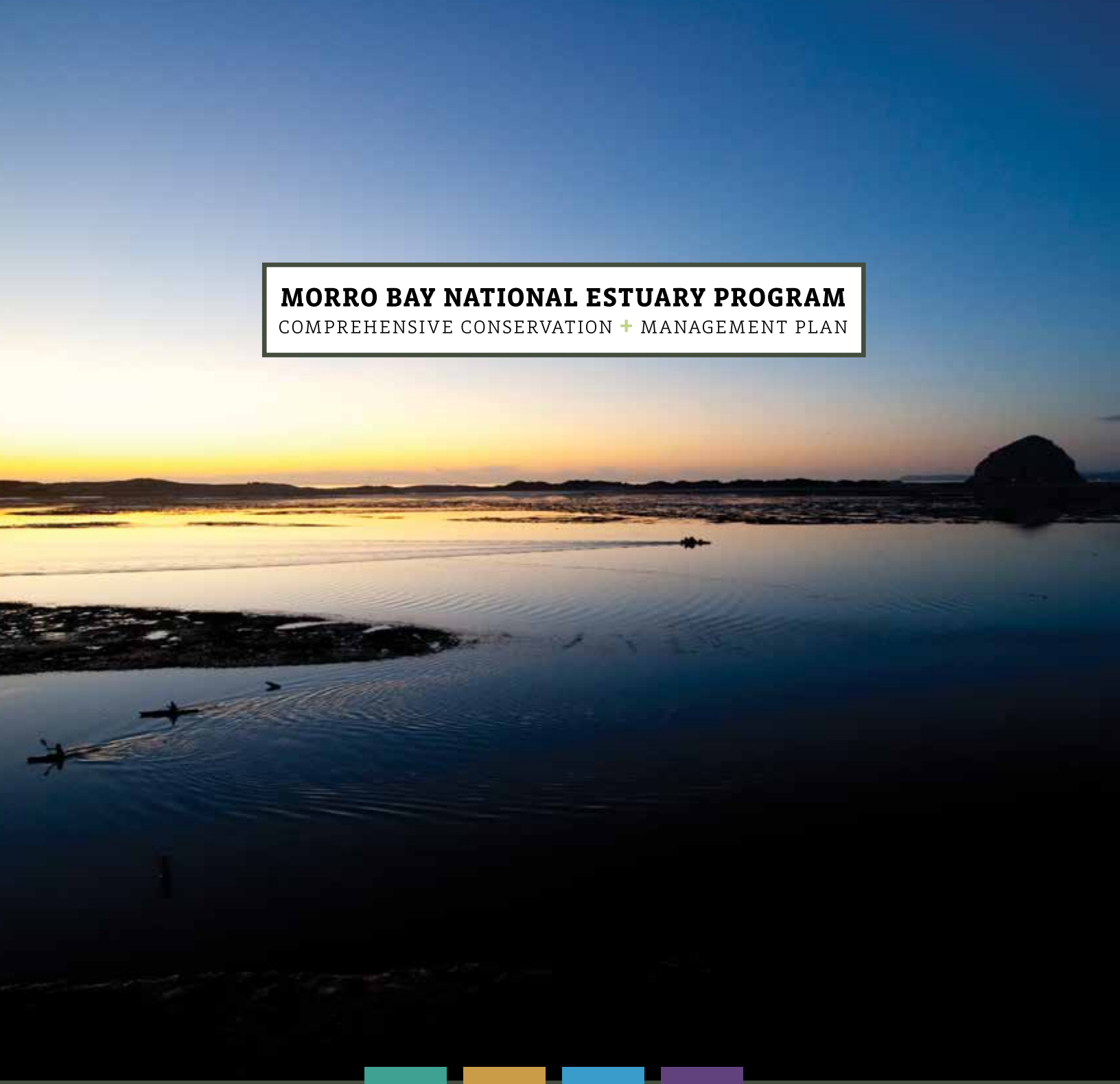

MORRO BAY NATIONAL ESTUARY PROGRAM

COMPREHENSIVE CONSERVATION + MANAGEMENT PLAN

2022 Update

Prepared by: Morro Bay National Estuary Program

Morro Bay, California

MORRO BAY
NATIONAL ESTUARY PROGRAM

2022 UPDATE

PREPARED BY: MORRO BAY NATIONAL ESTUARY PROGRAM
MORRO BAY, CALIFORNIA

This document represents the third version of the Comprehensive Conservation and Management Plan (CCMP) for the Morro Bay estuary. Approved in 2001 by the U.S. Environmental Protection Agency (USEPA) and the Governor of California, the original CCMP identified seven priority issues that threaten the ecological and economic resources of the estuary and watershed, and included 61 action plans to address those threats. The document was written with the help of hundreds of volunteers and many partner organizations (see Appendix B). The 2012 revision addressed many of the same priority issues and action plans while also identifying new issues and approaches to conservation. The 2022 CCMP Update addresses prior Action Plans to reflect their current status. However, priority issues and goals remain unchanged from the 2012 CCMP. In this update, 10 action plans were removed from the document or their tasks were shifted to other action plans with similar goals and implementation activities. The changes can be found in the Appendix item "CCMP 2022 Update Action Plan Status". This update was conducted per the May 2016 version of the National Estuary Program Comprehensive Conservation and Management Plan Revision and Update Guidelines. The Morro Bay National Estuary Program would like to acknowledge the hard work and invaluable contributions of the many individuals and organizations that assisted with this update (see Acknowledgements section).

Funding for this effort was provided by the United States Environmental Protection Agency.

Cover Photo : Dean Sullivan

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Executive Summary

The Morro Bay National Estuary Program works to protect and restore the Morro Bay estuary for people and wildlife. The Estuary Program is a collaborative, non-regulatory, nonprofit organization that brings citizens, local governments, nonprofit organizations, state and federal agencies, and landowners together to support a healthy environment and vibrant local communities.

The Morro Bay estuary is a 2,300-acre semi-enclosed body of water where freshwater flowing from the land mixes with the saltwater of the sea. The estuary environment encompasses the lower reaches of Chorro and Los Osos creeks, a wide range of wetlands, salt and freshwater marshes, intertidal mud flats, eelgrass beds, and other subtidal habitats. Morro Bay hosts one of the most significant and least disturbed wetland systems on the central and southern California coast.

The Comprehensive Conservation and Management Plan (CCMP) defines the priority issues facing the health of the Morro Bay estuary and watershed and presents action plans to effectively address those issues. The CCMP is the guiding document for the Estuary Program.

The Estuary Program has four watershed goals:

- Water Quality Protection and Enhancement – Water quality in the Morro Bay watershed and estuary supports diverse habitats and wildlife populations, recreation, clean drinking water, and well-balanced economic uses.
- Ecosystem Restoration and Conservation – The Morro Bay watershed and estuary sustain a resilient community with high habitat connectivity, ample biological integrity, proper ecosystem function, and a vibrant economy.
- Public Education, Outreach, and Stewardship – Citizens and visitors around Morro Bay understand basic estuary science and the impacts of specific actions on estuary health, and are engaged stewards of the Morro Bay estuary and watershed.
- Fostering Collaboration – Local citizens, local government, nonprofits, state and federal agencies, and public and private landowners collaborate and leverage resources to facilitate effective management and increased scientific knowledge of the Morro Bay estuary and watershed.

The CCMP describes seven priority issues impacting the health of the Morro Bay estuary and watershed. These issues were identified through grassroots public participation, scientific study, and more than a decade of conservation and restoration experience. The priority issues, explained in detail in Chapter 2, are

- Accelerated sedimentation
- Bacterial contamination
- Elevated nutrient levels
- Toxic pollutants
- Scarce freshwater resources
- Preserving biodiversity
- Environmentally balanced uses

To have meaningful impact on these issues over the next five years, the Estuary Program will direct its work toward addressing a primary focus for each priority issue. Relevant action plans will then serve as tools to achieve results in this area. The focus areas are not meant to limit the Estuary Program or its partners but instead to provide strategic direction about what projects and partnerships to pursue. This approach is described with more detail in the beginning of Chapter 3.

Sedimentation Primary Focus: Upland Erosion Sources

- Goal: Address erosion problems in the upper watershed, including improvements to rural roads and fire management, and develop a better understanding of relative erosion from individual sub-watersheds to help prioritize upland implementation projects.
- Outcome: Upgrade high priority eroding roads and reduce sediment delivery to Chorro Creek and its tributaries.
- Measure: Estimated sediment load reductions; miles of roads upgraded. Updated fire management plan for the watershed.

Bacteria and Nutrients Primary Focus: (These two priority issues overlap in the case of some sources and solutions, so one focus area was chosen to address both. In addition, a second focus area was identified for bacteria in the estuary.)

- **Stormwater management (to address bacteria and nutrients)**

  Goal: Strengthen the collective understanding of the dynamics of stormwater as a mechanism for transporting bacteria and nutrients and implement best management practices and projects to address pollutant sources.
  Outcome: Estuary Program supports partner efforts (including data sharing) to increase the understanding of stormwater dynamics. Estuary Program directly supports the implementation of best management practices (BMPs) to address nutrient and bacteria sources.
  Measure: The volume of stormwater is subject to BMPs. Estimated reductions in pollutants due to BMPs implemented by the Estuary Program and partners.

- **Disposal of waste in the estuary (to address bacteria)**

  Goal: Continue to support city efforts to maintain functioning and easily accessible pump-out facilities, encourage alternative pump-out options, and educate the boating public about proper waste disposal.
  Outcome: Estuary Program participates in city efforts to install or upgrade pump-out facilities and actively encourages alternative pump-out options. Estuary Program and partners complete at least two seasons of a boater education campaign that addresses bacteria and toxics, reaching a majority of slip and mooring renters. (See also the focus area for Toxic Pollutants).
  Measure: Amount of waste diverted by pump-out facilities and alternative options. Number of education campaigns completed and number of boaters reached.

Toxics Primary Focus: Marina and Boat-related Toxics

Goal: Implement projects designed to reduce toxic inputs to the bay from marina and boating activities, such as: removal of abandoned vessels and illegal moorings, purchasing supplies for oil spill preparedness, and facilitating access to disposal facilities. Implement education and outreach activities to increase awareness among the boating public about proper disposal of hazardous waste and use of bay-friendly alternatives.
Outcome: Estuary Program continues strong partnership with city of Morro Bay to address derelict boats and illegal moorings as they occur. City of Morro Bay's capacity to address oil spill is maintained at existing levels. Estuary Program and partners complete at least two seasons of a boater education campaign that addresses bacteria and toxics, reaching a majority of slip and mooring renters.
Measure: Amount of toxics diverted, if applicable to projects completed. Capacity to address oil spills and number of incidents addressed by local responders. Number of education campaigns completed and number of boaters reached.

Freshwater Resources Primary Focus: Water Budgets and Water Conservation

- **Water budgets**

  Goal: Participate in efforts to define water budgets for Chorro Creek and Los Osos Valley watersheds to better inform water conservation and freshwater flow management.
  Outcome: Estuary Program and partners define a water budget for Los Osos Valley and Chorro Creek watersheds. Water budgets are shared with relevant stakeholders and managers.
  Measure: Completion of water budget for Los Osos Valley and Chorro Creek watersheds and dissemination of information to stakeholders.

- **Water conservation**

  Goal: Engage in outreach and education efforts concerning water conservation and support local agencies and partners in improving water conservation at a broader scale.
  Outcome: Estuary Program continues implementation of the "Clean Water, Great Life" campaign and creates at least 3 new outreach tools based on the campaign. Estuary Program actively supports local agencies and partners in improving water conservation within the watershed.
  Measure: Number of projects that Estuary Program collaborates on with local agencies and partners. Change in local water use and conservation at the household/landowner level.

Biodiversity Primary Focus: Informing EffectiveRestoration

Goal: Identify a network of interconnected lands to focus conservation efforts that provide critical habitat for sensitive species; high biodiversity patterns; essential ecosystem services and functions; and provide the greatest opportunity for biodiversity to adapt naturally in a changing and variable environment
Outcome: The Estuary Program is completing a Conservation Planning Initiative to develop goals for biodiversity conservation. This plan is currently in development and will be completed by 2025. The Conservation Planning Initiative will identify areas of focus for conservation and restoration efforts based on the following criteria: critical habitat for sensitive species; high biodiversity patterns; essential ecosystem services and functions; and providing opportunity for adaptation and preserving resilience in a changing and variable environment.
Measure: Completed conservation plan as described, with implementation goals for next five years. Implementation goals for this area are being developed and will be complete by 2025.

Environmentally Balanced Uses Primary Focus: Define Future Efforts

Goal: Over the next five years, the Estuary Program will focus its efforts to address environmentally balanced uses on determining the key areas of concern under this priority issue and developing approaches to address those concerns.
Outcome: Estuary Program engages partners and stakeholders in developing a plan for implementing actions that address environmentally balanced uses.
Measure: Completed plan to address the priority issue that engages partners and outlines specific actions, with implementation goals for the next five years.

To address the priority issues and primary focus areas for the next five years, the CCMP outlines a number of action plans to bring about positive environmental change in the watershed and estuary. Many of these actions plans are based on those described in the 2001 CCMP and 2012 revision. All of the action plans are presented in Chapter 3 and are organized based on general type of action. Each action plan can address multiple priority issues and focus areas. The action plans are tools to achieve conservation success, and they will be implemented as they are relevant to the focus areas and priority issues of the Estuary Program. The Estuary Program prepares an annual workplan that specifies the action plans to be implemented each year.

Acknowledgements

2022 Update

The Estuary Program would like to thank the many individuals and organizations that have participated in the 2022 update to the CCMP.

Estuary Program Staff: Alexandra Bell, Tim Delany, Carolyn Geraghty, Ann Kitajima, Chrystina Newton, Rachel Pass, Karissa Willits, and Melodie Grubbs

With additional support from our Environmental Planning Interns: Miles Barker, Jennifer Hooper, Justin Klaparda, Troy Lawson, and Ayla-Louise Mateo

Executive Committee Members: Tim Duff (*State Coastal Conservancy*), Bruce Gibson (*San Luis Obispo County*), Suzanne Marr (*U.S. Environmental Protection Agency*), Bill Henry (*Bay Foundation of Morro Bay*), Marshall Ochylski (*Los Osos Community Services District*), Jennifer Epp (*Central Coast Regional Water Quality Control Board*), Trudy O'Brien (*Local Fisheries*), Ethan Bell (*Environmental Interests*), Sam Schuchat (*State Coastal Conservancy*), Jeff Heller (*Morro Bay City Council*), John Flaherty (*Business/Tourism Interests*), Kristin Hardy (*Science and Research*), Becka Kelley (*Last Implementation Committee Chair*)

2012 Revision

The Estuary Program would like to thank the many individuals and organizations that have participated in the 2012 revision to the CCMP.

Public meeting participants and those who submitted comments as part of the public process: Don Asquith, Carolyn Atkinson, Greg Barker, Al Barrow, Ian Bell, Janis Bell, David Broadwater, Syd Brown, Marla Jo Bruton, Evan Buddenhagen, Dave Chipping, Vince Cicero, Chris Clark, Mike Cooper, Jeff Eckles, Jeff Edwards, Matthew Ferdon, Linda Fidell, Dan Gillenwater, Gary Grabowsky, Henriette Groot, Damaris Hanson (*for City of Morro Bay*), Jan Harper, Gordon Hensley, John Hughes, Susan Hughes, Nancy Laurson (*for U.S. EPA*), Gary Karner, Carol Kirkpatrick, Christopher Kitts, Kyla Kitts, Jack McCurdy, Bill Martony, Neal Maloney, Ron Melcer, Lynn Meissen, Vicki Milledge, Keith Mueller, David Nelson (for CAPE), Monique Nelson, Adam Obaza (*for NOAA NMFS*), MaryAnn Otter, Linde Owen, Bernadette Pektrer, Joey Racano, Ron Rasmussen, B.K. Richard, Dominic Roques, Chris Rose (*for Water Board*), Gary Ruggerone, Richard Sadowski, Lawson Schaller, Carolyn Skinder (*for Monterey Bay National Marine Sanctuary*), Holly Sletteland, Marie Smith, Patrick Smith, Brian Stacy, Julie Tacker, Alex Tacket, George Trevelyan, Elaine Watson, Betty Winholtz, Karen Worcester (*for Water Board*), and Morro Bay National Estuary Program Education and Outreach Working Group (RuthAnn Angus, Wendi Craig, Terre Dunivant, Ron Ruppert, and Sidonie Wiedenkeller)

Technical Working Group Participants: Jill Baltan (*California Department of Public Health*), Rachel Couch (*State Coastal Conservancy*), Sylas Cranor (*County of San Luis Obispo*), Mark Davis (*County of San Luis Obispo*), Margaret Falkner (*Los Osos Community Services District*), Henriette Groot (*Sierra Club*), Adrienne Greve (*California Polytechnic University*), Dan Gilmore (*Los Osos Community Services District*), Damaris Hanson (*City of Morro Bay*), Meredith

Hardy (*California Conservation Corps*), Mark Horney (*California Polytechnic University*), Darla Inglis (*Low Impact Development Initiative*), Kathleen Jenkins (*Cal-Trans*), Rob Livick (*City of Morro Bay*), Christopher Kitts (*California Polytechnic University*), Howard Kolb (*Central Coast Regional Water Quality Control Board*), Suzanne Marr (*U.S. EPA*), Matt McGoogan (*National Marine Fisheries Service*), Dennis Michniuk (*California Department of Fish and Wildlife*), Vicki Milledge (*Los Osos Community Advisory Council*), Sara Newkirk (*The Nature Conservancy*), Cathy Novak (*Cathy Novak Consulting*), Pete Riegelhuth (*Cal-Trans*), Dominic Roques (*Central Coast Regional Water Quality Control Board*), Chris Rose (*Central Coast Regional Water Quality Control Board*), Nichole Smith (*Coastal San Luis Resource Conservation District*), Kelly Sypolt (*County of San Luis Obispo*), Milena Viljoen (*National Marine Fisheries Service*), Patrick Vowell (*Golden State Water*), Stephanie Wald (*Central Coast Salmon Enhancement*), Mike Walgren (*CA State Parks*), Dean Wendt (*California Polytechnic University*), and Karen Worcester (*Central Coast Regional Water Quality Control Board*)

Estuary Program Staff: Alexandra Bell, Annie Gillespie, Adrienne Harris, Jon Hall, Anna Halligan, Ann Kitajima, Cynthia Milhem, and Shari Sullivan

Executive Committee Members: Dave Alford (*Agricultural Interests*), Daniel Bohlman (*Implementation Committee chair*), Tim Duff (*State Coastal Conservancy*), Bruce Gibson (*San Luis Obispo County*), Suzanne Marr (*U.S. Environmental Protection Agency*), Joel Neel (*Bay Foundation of Morro Bay*), Marshall Ochylski (*Los Osos Community Services District*), Dominic Roques (*Central Coast Regional Water Quality Control Board*), Sharon Rowley (*Central Coast Women for Fisheries*), Holly Sletteland (*Environmental Interests*), Sam Schuchat (*State Coastal Conservancy*), Noah Smukler (*Morro Bay City Council*), Dean Sullivan (*Business/Tourism Interests*), and Dean Wendt (*San Luis Obispo Science and Ecosystem Alliance*)

I**mplementation Committee Members:** Lana Adams, Mike Anderson, Lisa Andreano, Mark Barnett, Daniel Bohlman, Dave Bowlus, Kim Busby, Mike Bush, Bryant Chesney, Linda Chipping, Sylas Cranor, Tamara Doan, Tim Duff, Tom Edell, Melody Fountain, Jack Gregg, Henriette Groot, Meredith Hardy, Courtney Howard, Pete Jennings, Andrea Jones, Susan Lichtenbaum, Lynn Meissen, Melissa Locke, Dennis Michniuk, Dave Nelson, MaryAnn Otter, Ron Rasmussen, Janice Rohn, Gary Ruggerone, Frank Salituri, Pete Sarafian, Nichole Smith, Julie Thomas, and Cheryl Zelus

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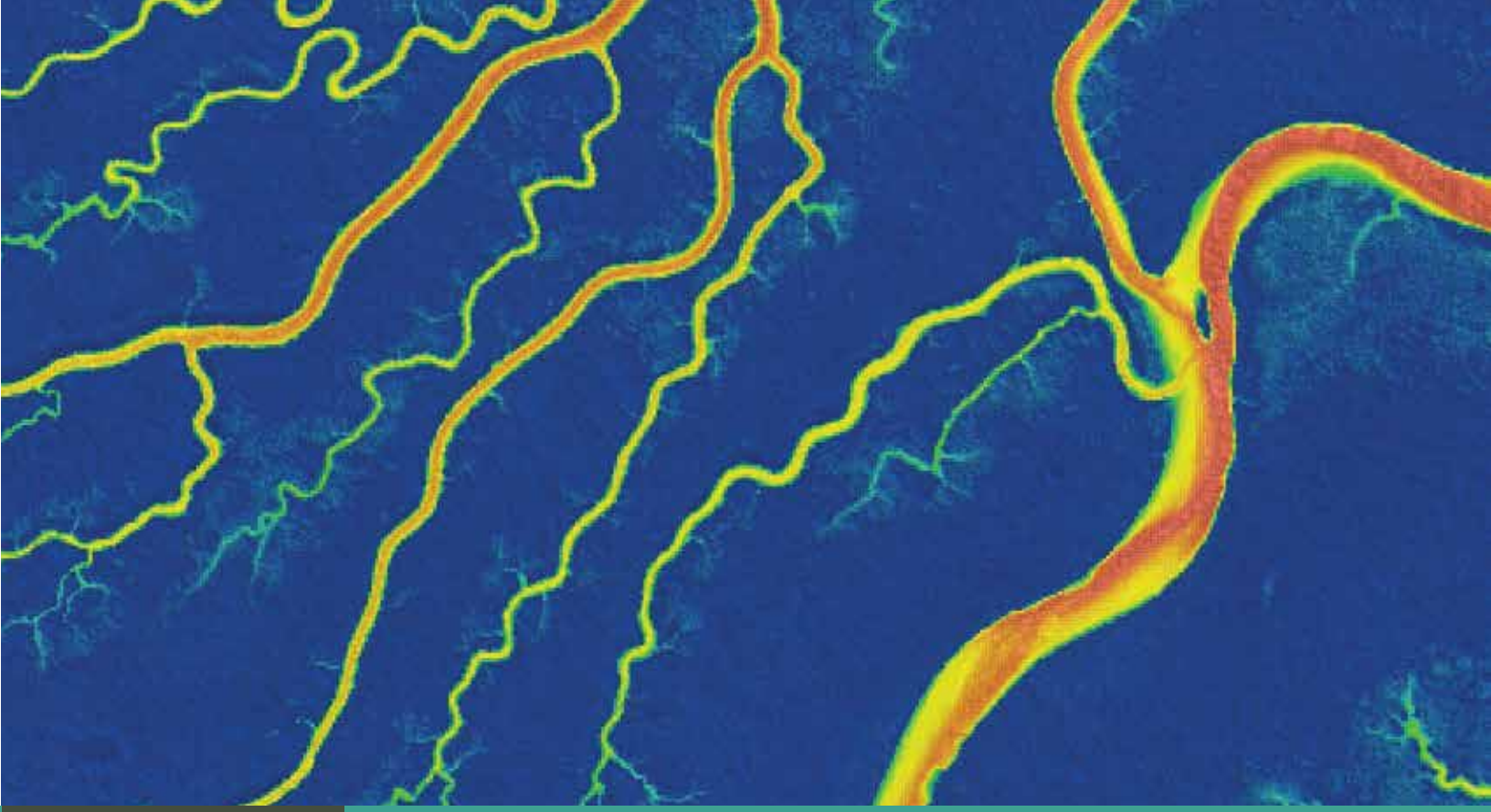
This updated document would not have been possible without the people and organizations that made the first CCMP possible. Hundreds of individuals donated countless hours to that first effort and created a strong document that provided 10 years of conservation direction to the Estuary Program. The individuals and organizations involved in the completion of the first CCMP are listed in Appendix B to this document.



Chapter 1

Introduction

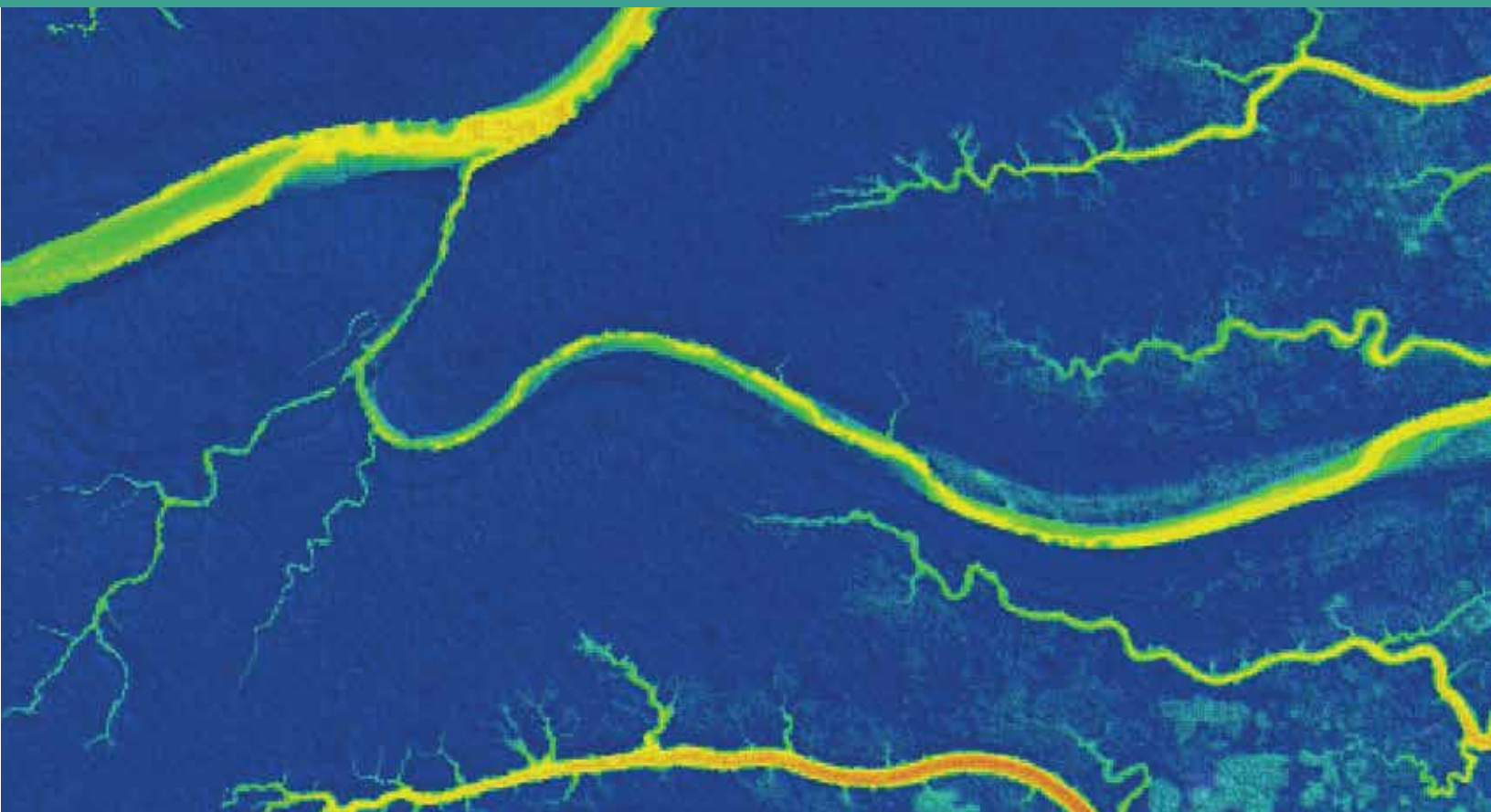


Photo : Lynda Roeller

THE MORRO BAY ESTUARY is a 2,300-acre semi-enclosed body of water where freshwater flowing from the land mixes with the saltwater of the sea. The estuary environment encompasses the lower reaches of Chorro and Los Osos creeks, a wide range of wetlands, salt and freshwater marshes, intertidal mud flats, eelgrass beds, and other subtidal habitats.

Morro Bay hosts one of the most significant and least disturbed wetland systems on the central and southern California coast. It serves as a vital stopover and wintering ground for migratory birds and is home to a diverse assembly of habitats and plant and wildlife species, many of which are not found anywhere else in the world. The estuary and its watershed also support exceptional natural beauty and pleasing rural ambiance, and accommodate popular outdoor recreational activities. Residents and visitors enjoy fishing, birding, hiking, wildlife watching, mountain biking, camping, golfing, horseback riding, and a variety of water-based sports.

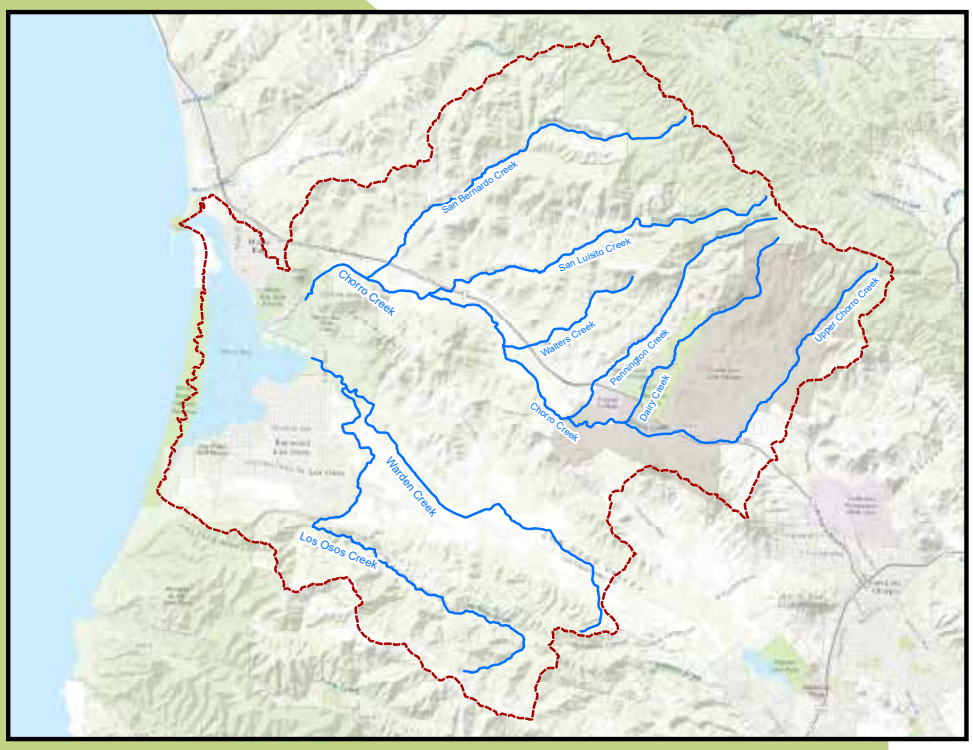
THE WATERSHED THAT DRAINS INTO MORRO BAY COVERS APPROXIMATELY 48,000 ACRES, OR 75 SQUARE MILES

The local economy of Morro Bay depends on the estuary and fishing port. The working waterfront supports both commercial fishing enterprises and recreational opportunities. In addition, local tourism activity is inspired by the natural beauty of the estuary and the heritage of local fishing industries. Other bay-dependent uses include commercial oyster cultivation and a thriving tourism industry.

The watershed that drains into Morro Bay covers approximately 48,000 acres, or 75 square miles. It is composed of two major sub-watersheds that drain into Chorro and Los Osos creeks. The Chorro Creek sub-watershed accounts for about 60 percent of the total land area draining into the estuary. Much of the watershed remains in open space that is used primarily for agriculture and a range of public uses, including parks, golf courses, nature preserves, a military base, and university-owned rangeland (California Polytechnic State University). The developed portions of the watershed include the community of Los Osos/Baywood Park, parts of the City of Morro Bay, Cuesta College, the California Men's Colony, and various facilities of the County of San Luis Obispo.

Morro Bay Watershed Boundary

The Morro Bay Estuary Watershed covers approximately 48,000 acres of land and includes the city of Morro Bay, the town of Los Osos, Cuesta College and a state prison.



San Francisco

Morro Bay

Pacific Ocean

Los Angeles

Changes to the Bay

Both the bay and its watershed have been altered from their natural conditions by human activities.

The current form of the harbor area was largely set in the 1940s when the U.S. Navy requested Morro Bay be developed to serve as a training and coastal patrol base. Work by the Army Corps of Engineers included the reinforcement of the causeway between Morro Rock and the mainland (the causeway was originally built in 1911); installation of revetment to solidify the Embarcadero between Coleman and Tidelands parks; construction of the north and south jetty breakwaters; and dredging to deepen the main navigation channels. Later, a stone groin was added within the harbor mouth to capture littoral sand at the north end of the sand spit. In the 1950s, a power plant, which extracts cooling water from the estuary, was built near the harbor mouth. By the early 21st century, the operation of the power plant was limited to times of peak power demand, and the plant was mothballed in 2014.

During the 20th century, the community of Los Osos grew as houses were developed on coastal dune habitat at the south end of the bay. In the city of Morro Bay, the harbor improvements built for the Navy were converted to civilian uses, and the Embarcadero evolved into a popular tourist area. The upper watershed was mined for chromium and nickel; oak savannah and scrub areas were converted to grazing land; and floodplains were cleared and diked for cropland. All of these activities contribute to accelerated erosion and sedimentation in the bay. Some impacts from these activities have now been mitigated, in part, by the work of the Estuary Program and its many partners, through improved grazing and farming practices, floodplain restoration, and remediation of mines that are no longer used. Significant portions of the watershed are now preserved through conservation easements or publicly owned open space.

WHAT IS THE NEP?

The National Estuary Program (NEP) was established in 1987 by amendments to the Clean Water Act, with the intent to protect and restore nationally significant estuaries. The program focuses not only on water quality but also on the integrity of the entire estuarine system, including its physical, biological, economic, and recreational values.

The Morro Bay National Estuary Program is one of 28 NEPs working to safeguard and improve the health of some of the nation's most important coastal waters.

The National Estuary Program and the CCMP

In the 1980s, concerned citizens and public officials organized a conference on the changing conditions of the bay to raise public awareness of threats to the ecosystem's health. By the 1990s, citizens that recognized the significance of the estuary and were concerned about its future formed a grassroots coalition called the Morro Bay Task Force. The efforts of this coalition led to Morro Bay being designated California's first State Estuary. Shortly thereafter, Morro Bay was accepted into the National Estuary Program (NEP) with approval from the U.S. Congress. A number of studies were commissioned to determine environmental conditions in the bay and watershed. Hundreds of citizen volunteers, along with staff from federal, state, and local agencies, developed "action plans" to address the highest priority problems defined by these studies and other scientific work.

In 2001, after several years of intensive study and public participation, the first Comprehensive Conservation and Management Plan (CCMP) was completed and approved by both the U.S. Environmental Protection Agency (USEPA) and the Governor of California (Morro Bay National Estuary Program (MBNEP), 2001).The primary purpose of the CCMP is to identify problems that threaten the ecological and economic resources of the estuary and watershed, and to define various action plans to effectively reduce those problems. The original CCMP included 61 action plans that the Estuary Program and its partners could implement to begin to address the threats to the estuary. By 2010, all the action plans had been initiated. Most of them are now ongoing in some form; some were limited enough in scope to be fully completed, and a few were found to be ineffective and discontinued. By 2022, all the action plans had been initiated. Ten were determined to be duplicative or completed and were either removed from the CCMP or combined with other action plans.

2012 CCMP Revision

Although noteworthy progress has been made in addressing the priority issues from the 2001 CCMP, they are still largely relevant today. Over the last decade, the understanding of some of these issues has increased through experience in the field, new research, and environmental monitoring, much of which has been supported by the Estuary Program and its partners. Improved approaches to addressing the priority issues and areas warranting further study have been identified. In addition, new issues not recognized in the first CCMP, notably the effects of climate change, need attention. These developments catalyzed the effort to revise the CCMP and its action plans.

In the spring of 2011, the Estuary Program held a public workshop to review the status of the original action plans and to solicit ideas about new and emerging issues facing the bay and watershed. During the following summer, four technical working groups of scientific experts and local resource managers provided input on some challenging topics: the status of stormwater management in the watershed, climate change impacts and adaptations, the management of freshwater resources, and environmental monitoring. All working group meetings were open to the public.

Using public input and the technical advice from the working groups, Estuary Program staff drafted a new framework for the CCMP and an updated list of action plans. In September 2011, another public workshop was held to present the draft action plans and solicit public comments. Over the subsequent few months, Estuary Program staff revised the draft action plans and completed a draft document.

The draft CCMP became available for public review and comment in March 2012; a public meeting to present the draft was held on March 6th, 2012. More than 80 distinct comments were received and incorporated into the final document. The final 2012 CCMP update was approved by the Implementation Committee and Executive Committee in February 2013.

The updated CCMP will continue to guide the Estuary Program's efforts to address the priority issues facing the estuary, working toward a healthy and productive environment.

2022 Update

While the goals and priority issues are largely unchanged, action plans needed updating to reflect the current situation. Analysis determined that a full Revision per EPA's CCMP Revision and Update Guidelines (dated May 3, 2016) was not necessary, but that the changes would fall under the Update category.

The process began with staff in 2018 who reviewed all action plans to determine the implementation status. They also analyzed if the correct metrics were being used to track success. Working with staff, a list of action plans requiring update or edits was created. The list included some action plans to be eliminated due to shift in program goals or through combination with another action plan with similar goals and implementation tasks. The changes can be found in the Appendix item "CCMP 2022 Update Action Plan Status".

Next, staff edited the document to incorporate these updates. The next step in the analysis was to review the Estuary Program's Climate Vulnerability Assessment and integrate relevant activites into the action plans, per EPA Guidleines in Apepndix 2 of the FY2017 – 2019 Clean Water Act Section 320 NEP Program Funding Guidance. The Climate Vulnerability Assessment (2016) is available at www.mbnep.org/library/. The Climate Vulnerability Assessment includes several potential adaptation actions to address climate risks like dune stabilization in response to sea level rise, floodplain restoration to address loss of habitats, and rainwater harvesting to adapt to increased drought conditions. Selected adaptation actions were embedded into the CCMP update and a section titled "Climate Resilience Considerations" was added to each applicable action plan. Three actions in the CCMP specifically address climate change in the the Morro Bay watershed and surrounding communities. These actions focus on improving understanding of climate change impacts, enhancing climate and adaptation education, and assisting in the implementation of local government Climate Action Plans.

The final steps involved approval of the 2022 Update from the Management Committee, and the distribution and sharing of the update with key partners and the public.

ORGANIZATIONAL STRUCTURE

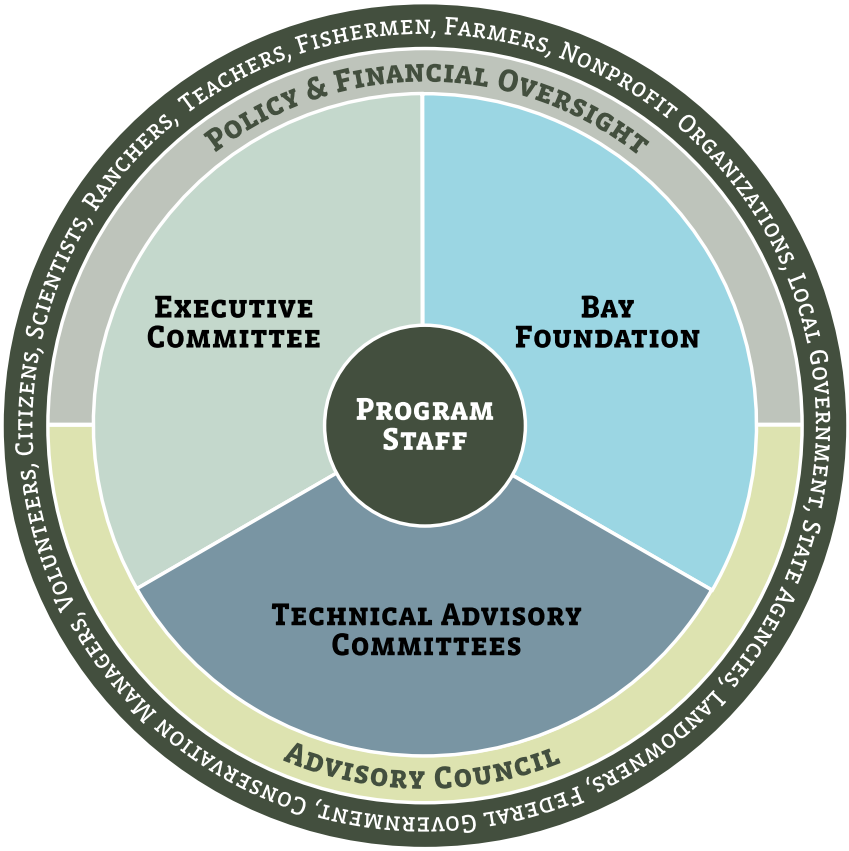
OF THE MORRO BAY NATIONAL ESTUARY PROGRAM

The Estuary Program is a collaborative organization that facilitates cooperative efforts to benefit the health of the estuary and watershed. Although the Estuary Program receives part of its funding from a USEPA grant, it is non-governmental and has no regulatory powers.

The Estuary Program is managed by stakeholder committees. An Executive Committee (EC) makes general policy decisions and evaluates progress. The EC includes representatives from the USEPA, local and state agencies, and representatives of the agricultural, commercial fishing, scientific research, tourism/recreation, and environmental communities.

The EC is advised by Technical Advisory Committees (TACs) that are made up of representatives of dozens of agencies and community organizations. The TAC also provides a forum for information exchange among groups engaged in conservation work in and around the estuary. The Estuary Program convenes additional working groups for technical advice on education/outreach and science/technical projects.

The Bay Foundation of Morro Bay is a non-profit corporation that employs Estuary Program staff, manages funding, and provides administrative oversight.



Watershed Goals

Codifying strong, visionary goals for the CCMP will help the Estuary Program and its partners maintain focus on the long-term outcomes desired for the Morro Bay estuary and watershed. The goals listed below articulate a long-term vision for the four main areas of the Estuary Program.

Water Quality Protection and Enhancement

Water quality in the Morro Bay watershed and estuary supports diverse habitats and wildlife populations, recreation, clean drinking water, and well-balanced economic uses.

One of the main tenets of the NEP is to protect and restore water quality, as the NEP is part of the federal Clean Water Act. This goal illustrates the aspiration for clean water that supports a variety of uses by people and wildlife in Morro Bay.

Ecosystem Restoration and Conservation

The Morro Bay watershed and estuary sustain a resilient community with high habitat connectivity, ample biological integrity, proper ecosystem function, and a vibrant economy.

This goal illustrates the Estuary Program's interest in conserving and restoring habitats, biodiversity, and ecosystem processes, all of which affect the local economy. The goal also envisions a healthy ecosystem and economy even in the face of change.

Public Education, Outreach, and Stewardship

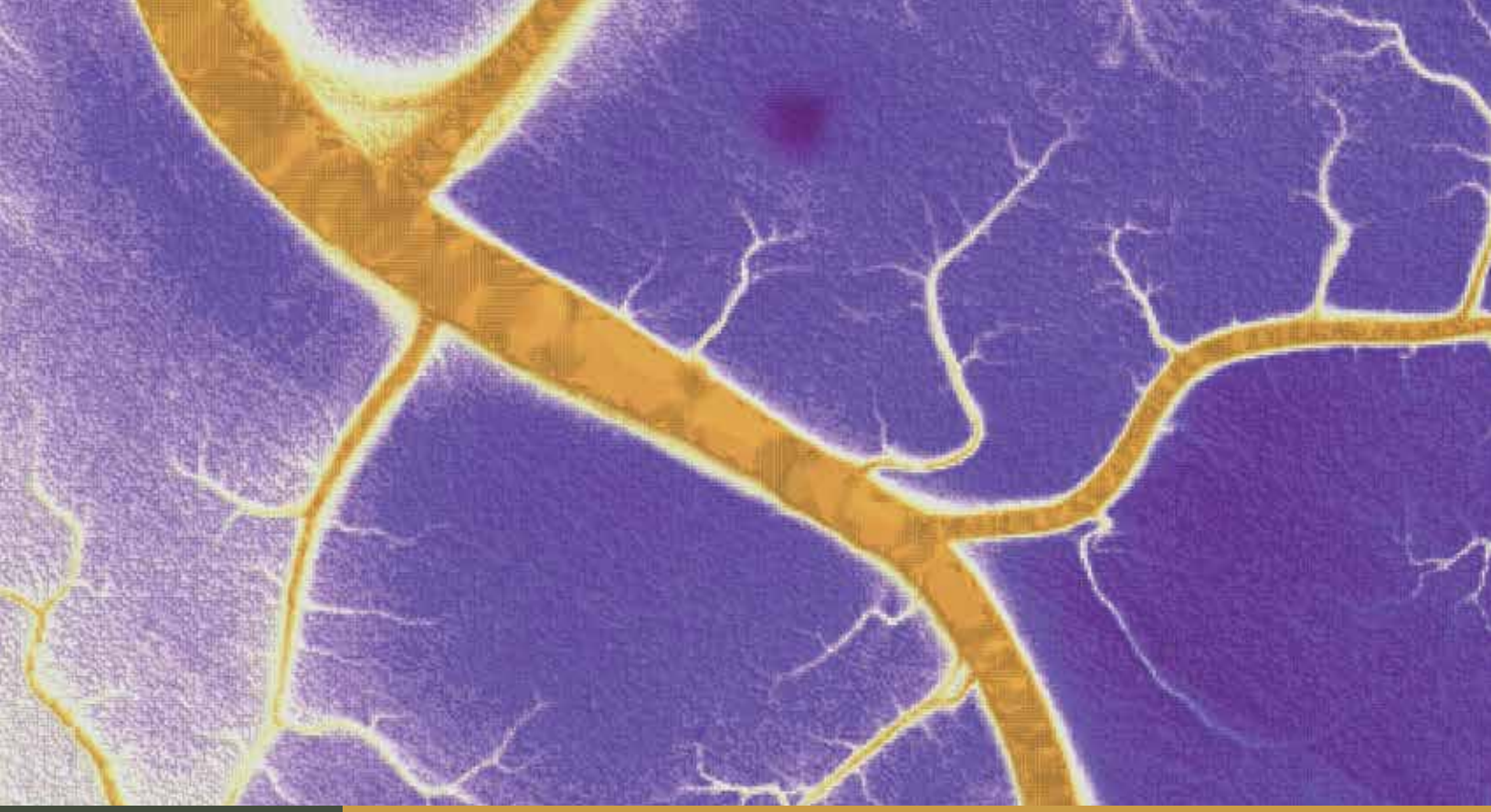
Citizens and visitors around Morro Bay understand basic estuary science and the impacts of specific actions on estuary health, and are engaged stewards of the Morro Bay estuary and watershed.

This goal represents the importance of informed and engaged citizens for the future health of Morro Bay and a vision that community members will increasingly become stewards of the estuary.

Fostering Collaboration

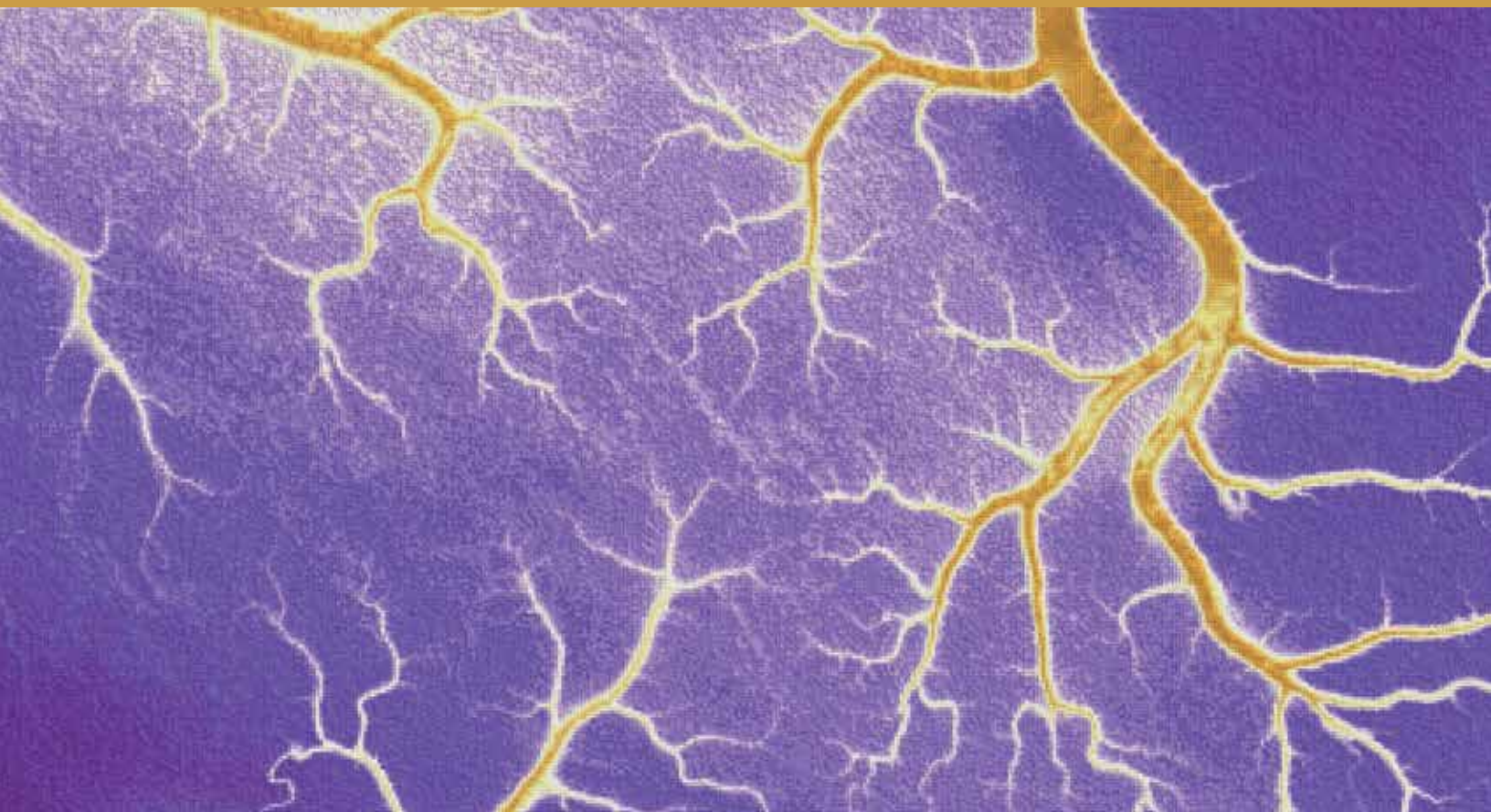
Local citizens, local government, nonprofits, state and federal agencies, and public and private landowners collaborate and leverage resources to facilitate effective management and increased scientific knowledge of the Morro Bay estuary and watershed.

Another core tenet of the NEP is collaboration, as described in the Clean Water Act. This goal showcases the Estuary Program's commitment to fostering collaboration to effectively understand and manage the resources of Morro Bay.



Chapter 2

Priority Issues



The first CCMP, which was approved in 2001, identified seven priority issues facing the estuary:

- Accelerated sedimentation
- Bacterial contamination
- Elevated nutrient levels
- Toxic pollutants
- Scarce freshwater resources
- Habitat loss
- Declining steelhead populations

These topics were considered to be the most pressing issues facing the estuary and its future health at the time the first CCMP was written. All of these issues are still relevant and continue to be high priorities for the Estuary Program, although a wealth of new information has improved the shared knowledge of how these issues impact the estuary and watershed. This new information has been critical in updating the Estuary Program's approach to addressing each of these issues, as evidenced by the updated action plans presented in Chapter 3. A greater understanding of these environmental issues has also led to the integration of two priority issues into one. After nearly two decades of monitoring, restoration, and outreach efforts, the close connection between habitat loss and the loss of critical species has been clearly demonstrated in the Morro Bay watershed. Considering this close connection and the overlapping methods that are used to address both issues, habitat loss and declining steelhead populations have been integrated into one issue – preserving biodiversity to maintain habitat and ecosystem functions. This new priority issue allows a broader, more ecosystem-based approach to addressing the important problems of loss of habitat and critical species, including steelhead.

The 2001 CCMP recognized that the estuary and watershed are critical to several human activities depending upon local natural resources, such as oyster farming, commercial fishing, recreation and tourism, farming, and ranching. The updated CCMP more explicitly addresses the inherent issue of balancing important economic and social uses with the needs of the ecosystem. One section of the updated action plans focuses on how these uses can be undertaken in more environmentally sustainable ways.

Considering these updates, the seven priority issues that the 2012 and 2022 CCMP will address are:

- Accelerated sedimentation
- Bacterial contamination
- Elevated nutrient levels
- Toxic pollutants
- Scarce freshwater resources
- Enhancing biodiversity
- Environmentally balanced uses

Each of the priority issues is discussed further below. Additional background information can be found in the 2001 CCMP document (MBNEP, 2001).

Accelerated Sedimentation

The accumulation of sediment in estuaries naturally occurs over thousands of years and may eventually result in the filling in of the estuary. Sources of sediment to the Morro Bay estuary include: creeks draining the watershed; stormwater runoff over land; ocean currents carrying sand through the harbor entrance; and prevailing winds and ocean currents altering the morphology of the sand spit. In Morro Bay, these natural processes have been accelerated by activities in the watershed that contribute additional sediment to the flow entering the estuary from creeks and stormwater runoff.

At the time of the 2001 CCMP, local studies and modeling efforts estimated that accelerated sedimentation would cause the estuary to fill in within a few hundred years (TetraTech Inc., 1998). Other observed changes, including rise of the bottom of Chorro Creek at South Bay Boulevard and the increase in salt marsh habitat at the confluence of Chorro and Los Osos creeks, provided additional evidence for accelerated sedimentation. Since the completion of these studies, a more nuanced and complex picture of sedimentation has emerged. It is now understood that the majority of sedimentation occurs during episodic storm events. The impact of these events varies greatly, depending on the storm intensity and how saturated the ground is prior to any particular storm. Annual rates of sediment accretion observed in the bay, although difficult to quantify over short time frames, appear to be relatively low. However, catastrophic storm events can contribute vast amounts of sediment to the bay in a very short period of time. This new knowledge is based in part on an ongoing effort by the Estuary Program to track the rate of sediment accretion at various locations in the bay. This data set, ongoing since 2004, shows a variable rate of accretion throughout the bay. Locations in the southern most portion of the bay, near Shark's Inlet, and areas of the salt marsh just south of the Morro Bay State Park marina, show greater accretion rates than other areas (MBNEP, 2011). Another monitoring effort uses suspended sediment concentrations in creek flow to model sediment loads delivered to the bay. Since this project began in 2008, the results have demonstrated the immense variability in sediment load from year to year (MBNEP, 2011). This variability is mainly due to fluctuations in the frequency and intensity of storm events.

Sediment deposits in the estuary from creeks and stormwater runoff occur through the natural process of erosion. However, a variety of land uses can exacerbate erosion. Urban development increases the amount of impervious surfaces in the watershed, reducing the ability of the ground to absorb rainfall and increasing stormwater volumes and velocities. Certain grazing and cultivation practices can reduce or eliminate ground cover, making hillsides and fields more vulnerable to soil loss. An especially significant issue has been wildfires, which leave barren hillsides prone to erosion when storm events occur. Alterations in the natural landscape and the spread of non-native vegetation can increase the intensity of wildfires. In the mid-1990s, the combination of an intense wildfire that scorched a significant portion of the upper watershed and strong El Nino rainstorms the following winter resulted in a tremendous amount of sediment flowing to the bay, with significant impacts on eelgrass beds, oyster farms, and the bay's form and volume (MBNEP, 2001).

In addition to inputs from creeks and stormwater runoff, ocean currents also add sediment to the estuary, primarily at the harbor mouth and in the main navigation channel. For this reason, the harbor entrance is maintained with regular dredging to ensure safety of navigation. Whether sand from the sand spit is contributing to sedimentation is not well understood. Considering this source is a natural process, the management issue of concern is to minimize erosion on the sand spit from plant removal and human use while maintaining healthy native habitats on the spit.

Due to the conditions described, Morro Bay, Los Osos, and Chorro creeks are listed as impaired waters under the federal Clean Water Act Section 303(d) for sediment. The Central Coast Regional Water Quality Control Board (Water Board) has established total maximum daily loads (TMDLs). (See Chapter 3, action plan MON-1 for further detail on TMDLs.) Estimates of the relative contributions of the two major sub-watersheds suggest that about 80 percent of the stream-borne sediment comes from the Chorro Valley (Tetra Tech Inc., 1998).

Impacts on Beneficial Uses: Sedimentation affects the habitat value of the estuary. As the bay fills, rare coastal wetlands are lost to terrestrial habitats. Shallow water results in increased temperatures and reduces circulation, adversely affecting water quality

and habitat richness. Sediment can impact eelgrass through depth changes, reduction of light penetration, and direct siltation on top of eelgrass. Sediment also degrades habitat for freshwater species, including the red-legged frog and southwestern pond turtle.

The potential loss of bay volume affects commercial and recreational boating navigation. The main channels must be dredged regularly due to sediment accumulation. The State Park Marina has become inaccessible during low tides in the past.

Reduced open water area could also affect the recreational values of the bay, limiting such activities as fishing and boating. Reduction in the estuary's recreational potential may adversely affect bay-related tourism. Sediment can also interfere with the commercial cultivation of oysters.

Upstream from the bay, erosion adversely impacts agricultural land by reducing acreage suitable for cultivation and through the loss of topsoil essential to intensive farming. In streams, silt reduces the quality of spawning habitat for steelhead and can impede steelhead migration during high flow events. Biodiversity and general habitat quality can also be reduced by excessive sediment.

To address sedimentation, the Estuary Program and its partners work to control erosion and capture sediment upstream of the bay.

Actions and Trends: Much effort has been directed to addressing the problem of sedimentation.

One approach often discussed would be to dredge the bay or to alter the channels to facilitate improved tidal flushing. The Estuary Program and the U.S. Army Corps of Engineers (ACOE) conducted a large-scale analysis of these in-bay solutions, including assessing the possibility of opening the south end of the sand spit to the ocean or restoring the bay's natural communication with the sea near Morro Rock (U.S. Army Corps of Engineers (ACOE), 2007). Another specific option was to re-route the mouth of Chorro Creek that had shifted southward in the 1990s from its previous course nearer to the State Park Marina. All of these options were deemed infeasible due their extremely high cost, significant environmental impacts, regulatory impediments, and other concerns.

A variety of best management practices and restoration techniques can be implemented to reduce erosion. The Estuary Program and its partners concluded that the most feasible ways to address sedimentation is by reducing erosion in the watershed and by capturing sediment upstream of the bay through various methods, including the restoration of floodplains. These methods have been the focus of the Estuary Program and its partners. The Coastal San Luis Resource Conservation District (CSLRCD) spearheaded "Project Clearwater", funded in part through the Estuary Program, which improved land management practices on private farms and ranches to reduce erosion. The CSLRCD estimated that these efforts prevented thousands of tons of sediment from reaching the bay (Coastal San Luis Resource Conservation District (CSLRCD), 2009). Examples of other projects undertaken during the last 10 years include: riparian corridor restoration along Walters and Chumash creeks; over 11 miles of riparian fencing; riparian re-vegetation; remediation of mines that are out of commission; and rural road improvement projects. (See Best Management Practices and Ecosystem Conservation and Restoration Riparian sections in Chapter 3 for further details on these methods.)

Another important project was the Chorro Flats Enhancement Project that opened levees along Chorro Creek, allowing the stream to access its natural floodplain. The CSLRCD estimates that approximately 198,000 cubic yards of sediment had been captured by this project as of January 2001, with the site expected to reach its capacity 35 years from that time (CSLRCD, 2002). Another floodplain restoration project is managed by the CSLRCD on Los Osos Creek.

New Issues and Perspectives: The experiences of the last 20 years suggest several important considerations as the Estuary Program moves forward on addressing sedimentation.

Many aspects of sedimentation need further exploration to guide effective conservation work. One important topic is how the intensity and timing of severe storm events influences the transport of sediment, especially

in light of predicted changes in precipitation patterns due to climate change. Determining what transported sediment does once it reaches the bay requires a better understanding of the hydrodynamics and bathymetry of the bay. This type of knowledge about how sediment moves through the watershed and estuary will inform what best management practices and restoration projects are implemented in the future. An important step in implementing projects is evaluating the effectiveness of the approach used. This is an area that the Estuary Program will continue to refine its expertise to bring about the strongest and longest lasting results possible.

A tool available to facilitate implementation of best management practices in the watershed is Ranch Water Quality Plans. Ranch Water Quality Plans are developed by individual landowners, with support from the University of California Cooperative Extension and the Natural Resources Conservation Service. These plans help landowners address nonpoint source pollution, identify potential water quality threats and relevant BMPs on their property, and are written in line with local and regional water quality guidelines.

Bacterial Contamination

In Morro Bay, elevated levels of bacteria in the water present potential health threats to those who use the bay for recreational purposes and economic threats to those who depend upon the resources of the bay for their livelihood. Elevated concentrations of bacteria can also adversely affect marine mammals that inhabit the estuary. The Morro Bay estuary, Chorro Creek, Los Osos Creek, Dairy Creek, and Warden Creek are listed as impaired water bodies under the federal Clean Water Act, Section 303(d) for pathogens. All except Dairy Creek have approved TMDLs from the Water Board and USEPA.

Contributors to bacteria levels in Morro Bay include both point and non-points sources: urban runoff, runoff from rangeland and grazing operations, inadequate waste disposal from boats in the bay, domestic and wild animal waste, and failing or overloaded septic systems (Central Coast Regional Water Quality Control Board (Water Board), 2002). When in compliance with existing permits, wastewater treatment plants do not appear to contribute to elevated bacteria levels. A study of E. coli strains in the estuary indicated that four sources contribute the majority of this particular bacteria type: birds (22%), humans (17%), bovine (14%) and dogs (9%) (Kitts et al., 2002).

Bacteria levels originating from urban runoff, grazing operations and domestic animals enter the creeks and bay primarily during storm events. The amount of bacteria actually transported to waterways may vary based on the intensity and frequency of precipitation. Bacteria contributions also vary by sub-watershed, with Chorro Creek generally contributing significantly more bacteria than Los Osos Creek (Tetra Tech Inc., 1999). Chorro Creek averages higher flows and drains more of the watershed than Los Osos does.

Impacts on Beneficial Uses: In Morro Bay, oysters have been harvested since the 1930s and 1940s. The first oyster lease was established in 1932, and there now exist two active aquaculture operations in the bay. Oysters are filter feeders and thus bacteria and other pathogens in the water can be temporarily concentrated in the shellfish, making them unsafe to eat. While the bay's water is generally clean enough to support commercial oyster farms, certain parts of the bay are currently closed to harvesting. In other areas, harvesting may be suspended if bacteria levels become elevated. Furthermore, as demand has driven market changes and brought about a focus on young, small oysters, water quality is even more critical to oyster farmers.

Recreation and tourism play a large part in this area's economy and water sports are increasingly popular. The water in the bay must be safe for swimming and human contact for these activities to be enjoyed. Water is tested regularly in the bay and creeks for the presence of E. coli and enterococcus, the presence of which can indicate fecal contamination from warm-blooded sources. After rainstorms, the water in the bay may becomes unsafe for human contact. Most popular recreational sites generally test at levels safe for swimming; however, sites in the southern portion of the bay around Los Osos and Baywood Parks may exceed recommended bacteria levels in as many as 20 percent of samples taken (MBNEP, 2010). Bacteria levels in the creeks tend to exceed standards at even higher rates than in the bay itself.

Elevated bacteria and pathogen levels can also adversely impact marine mammals that inhabit the estuary, such as sea otters and sea lions (Jessup et al., 2004).

Actions and Trends: Several programs and major projects have been completed to address pathogenic pollution. One approach is the upgrade and installation of wastewater treatment plants to minimize spill risks. The California Men's Colony (CMC) treatment plant was upgraded in 2007 to tertiary treatment and more recently to replace chlorine disinfection with UV light treatment. (see BMP-11).

A number of best management practices and projects have been implemented throughout the watershed, in partnership with public and private landowners, to reduce bacteria concentrations in stormwater runoff. These practices include riparian fencing, installation of off-creek water sources for grazing operations, and pasture management (such as rotational grazing). Over 11 miles of stream have been protected with riparian fencing in the last ten years. Education and outreach about disposal of pet waste and the installation of Mutt Mitt dog waste bag dispensers have also helped reduce bacterial contamination. Over 200,000 Mutt Mitt bags are distributed each year in the watershed.

Other outreach efforts have focused on educating the boating community about proper waste disposal and use of pump-out facilities and the removing of illegal moorings and abandoned vessels. These projects have been undertaken in partnership with California Department of Fish and Wildlife (DFW), State Parks, and the City of Morro Bay Harbor Department.

New Issues and Perspectives: Future efforts to address elevated bacteria levels will include effective best management practices, such as the ones described above and explored in further detail in the Best Management Practices section of Chapter 3. In addition, project effectiveness monitoring will continue to be improved to demonstrate the capacity of particular approaches to bring about desired changes. Effectiveness monitoring is needed not just on a

project-by-project basis, but also on a cumulative basis over many projects.

The Estuary Program recognizes the need to better understand how the bay's bathymetry and hydrodynamics influence the movement and residence time of bacterial pollution. How the bathymetry of the bay and inputs of freshwater from the watershed influence tidal flushing and bacteria concentrations is not well understood.

In general, a more complete understanding of how pathogens move through the ecosystem is needed. Other bacterial pathogens, such as taxoplasma, have been shown to detrimentally affect marine life. Other types of pathogens may also be affecting marine and riparian organisms and may need further study to determine sources and solutions.

Elevated Nutrient Levels

Nutrient enrichment, primarily from nitrates, can detrimentally impact the bay and watershed. Excess nutrients increase the growth of algae blooms. Algae take up oxygen when they are not photosynthesizing and can consume large amounts of oxygen dissolved in the water column. Dissolved oxygen (DO) is also reduced when algae blooms die off and decompose. Thus, high nutrient levels and low DO are usually linked. Appropriate levels of DO are critical to supporting aquatic life such as fish and invertebrates. Objectives for DO concentrations are outlined in the Water Board's Central Coast Basin Plan (Water Board, 2011).

Algae blooms and low levels of DO have been regularly observed in Morro Bay, especially in the southern portion of the bay during the dry seasons of summer and fall. Elevated levels of nutrients, along with warmer water temperature and poor circulation conditions, contribute to this seemingly recurring problem. Chorro Creek, Los Osos Creek, Warden Creek, and Warden Lake are all listed as impaired waters for nutrients and dissolved oxygen under Section 303(d) of the Clean Water Act and are subject to TMDLs adopted by the Water Board. Dairy Creek (a tributary of Chorro Creek) is also listed for dissolved oxygen.

Contributors to elevated nutrient levels in the Morro Bay area include wastewater treatment effluent from CMC, cropland runoff, rangeland runoff and natural background concentrations from biological activity (Water Board, 2005; Water Board, 2007). Nutrients in runoff can come from fertilizers, animal waste, and heightened water temperatures due to a lack of shading. When creeks do not have adequate vegetative cover, surface water temperatures increase and reduce circulation. Adequate circulation helps maintain high levels of DO.

Impacts on Beneficial Uses: When excessive nutrients lead to algae growth, the water column is robbed of DO essential to many fish and invertebrates. Thus, elevated nutrients can damage the habitat value of the creeks and bay, threatening the ability of the estuary to function as a nursery for fish and to sustain productive commercial oyster beds. High nutrients and low DO also reduce insects and other macro-invertebrates that live in the creeks that are essential food sources for steelhead and many other species. In extreme cases, low DO can promote fish kills.

Elevated nutrient levels also impair water for municipal and domestic water supplies, including drinking water.

Actions and Trends: To address elevated nutrients in the effluent discharge from CMC wastewater treatment, the plan was upgraded in 2007 to full tertiary treatment (see BMP-11). Under normal operating conditions, the plant now meets its permit requirements for levels of nitrate in its effluent. While these levels are protective of human health, they are not low enough to be protective of aquatic life.

Other actions have focused on addressing nitrates in stormwater runoff. MBNEP and its partners have undertaken programs to encourage proper use of fertilizers at both the commercial farming and household levels. Other educational programs encourage residents to keep pollutants from entering the storm drains.

Projects to increase riparian vegetation along Chorro Creek and its tributaries are aimed at increasing water circulation and dissolved oxygen. These projects include riparian fencing, re-vegetation of riparian corridors, and restoration of highly impacted stream sites. Descriptions of these approaches are presented in the riparian section of the Ecosystem Conservation and Restoration section of Chapter 3.

New Issues and Perspectives: MBNEP and its partners will continue efforts to address nitrate concentration in stormwater runoff and work toward continued improvement in riparian vegetation and canopy cover throughout the watershed.

Toxic Pollutants

Toxic pollutants include pesticides, organic compounds, heavy metals, and a variety of chemical compounds. The upper Chorro Creek watershed was historically mined for chromium and nickel, naturally occurring metals that can be toxic in high concentrations. When the 2001 CCMP was approved, Chorro Creek was listed as impaired due to heavy metals under Section 303(d) of the Clean Water Act. Subsequent analysis, however, showed that observed levels of these elements in the creek water and sediments did not pose a threat to people or wildlife and Chorro Creek was de-listed for heavy metals.

Other non-natural sources of toxics continue to impact water quality and wildlife in the bay and watershed. Toxics enter the bay and creeks primarily through non-point source pollution from stormwater runoff. Sources of toxics include household and agricultural pesticides, detergents and soaps, oils and lubricants from street drainage, and household or commercial cleaning products. Other potential sources are non-fouling paints and other chemicals used for boat maintenance, as well as fuel spills and illegal dumping. Recent studies have raised concerns about emerging contaminants, which are toxics not regulated with regard to water quality and have environmental impacts that are not well understood. Such contaminants represent a growing area of water quality research that may provide insights and new perspectives in the future.

Toxic pollutants can accumulate in sediments and cause future environmental issues when sediments are disturbed and the compounds are released into the water column. The extent of this issue in Morro Bay is not well understood. Another possible environmental impact of toxics is bioaccumulation – when chemicals accumulate in the tissues of organisms at higher concentrations than what is found in the water column or sediments.

Impacts on Beneficial Uses: Both contact and non-contact water recreation can be adversely affected by concentrations of these pollutants due to potential impacts on human health. Marine wildlife, shellfish harvesting, fish migration, spawning habitat, and rare, threatened, and endangered species habitat can all be damaged by toxic pollutants. Certain aquatic organisms are acutely affected even by very low concentrations of toxic pollutants. Oyster farming can be impacted by oil spills and release of other hazardous substances because oysters are unable to purge these toxins efficiently and may become contaminated.

Actions and Trends: The California Department of Public Health (CDPH) does not currently test for toxics and heavy metals in shellfish. Results in prior years from the NOAA and state Mussel Watch programs indicated that metal and toxic concentrations are not present in Morro Bay's shellfish populations at levels that would be of concern for environmental and human health (National Oceanic and Atmospheric Administration, n.d.). Further study is needed to determine the current status of toxics and heavy metals in both the sediment and shellfish populations of Morro Bay. Limited research results have documented the possibility of elevated heavy metal concentrations in sediment in Morro Bay (Pehaim, 2004).

State law and County regulations closely control the application of agricultural pesticides. Municipalities and other dischargers of stormwater and wastewater must comply with National Pollutant Discharge Elimination System (NPDES) permits from the Water Board. Construction projects require a Stormwater Pollution Prevention Plan (SWPPP) detailing how stormwater runoff will be minimized and monitored. The Estuary Program has shared data and technical knowledge to support local partners in meeting NPDES and SWPPP requirements.

Efforts to reduce toxic pollutants from urban runoff and the boating community have centered on education and outreach projects. The Estuary Program has disseminated information about proper use and disposal of toxic materials. The City of Morro Bay has also installed additional hazardous waste disposal facilities for boaters.

The Estuary Program, City of Morro Bay Harbor Department, State Parks, and DFW have completed a number of cooperative efforts to remove illegal moorings and abandoned vessels in the bay. These

efforts reduced potential pollution sources and also provided aesthetic and safety benefits.

New Issues and Perspectives: The Estuary Program and its partners will continue work to educate the local community about proper use and disposal of hazardous materials. Stricter regulations regarding stormwater management at the municipal level are being implemented by state and federal agencies.

Facilities are needed for boat owners to conduct repairs and maintenance while minimizing pollution to the bay. The Estuary Program supports the city of Morro Bay in its efforts to make such facilities available.

Emerging contaminants are likely to be a growing issue in the future, as the scientific and regulatory communities gain greater understanding of their sources and effects. The Estuary Program will continue its involvement in efforts to better understand emerging contaminants and learn about ways to reduce their effects.

Competition for Scarce Freshwater Resources

Freshwater is critical to the health of the estuary. Estuarine habitats such as saltwater marshes require regular inflows of freshwater to function properly. Creeks must have adequate flows to provide habitat for a variety of water-dependent plants and animals and to accommodate steelhead passage. Freshwater is also critical for the wide variety of land uses in the watershed, including farming, ranching, and urban communities. Competition among domestic, agricultural, and environmental uses for scarce freshwater resources is a priority issue in the Morro Bay watershed.

The watershed's Mediterranean climate and variable precipitation patterns (both seasonally and from year to year) limit the amount of freshwater that enters the system. Creek flow naturally diminishes in the summer and autumn due to low rainfall during these times and shallow wells drawn for agriculture and domestic use can directly affect creek flow (particularly in the Chorro Creek watershed). Parts of Chorro Creek are fully appropriated (as regulated by the State Water Resources Control Board (The California State Water Board), indicating strong competition for scarce freshwater resources in this area. Groundwater resources are also impacted in the watershed. The Los Osos upper aquifer is impacted by nitrates and the lower aquifer is exhibiting signs of saltwater intrusion. Morro Bay's municipal groundwater wells are also contaminated with nitrates. More information on freshwater resource uses in the Morro Bay watershed is presented in the Freshwater Flow section of Chapter 3.

Additional freshwater is contributed to the system from treated effluent discharged to Chorro Creek from the CMC wastewater treatment plant. CMC is required, by their NPDES permit, to discharge at a minimum continuous flow of 0.75 cfs (cubic feet per second) for the benefit of aquatic resources, such as steelhead. (See BMP-11 in the Best Management Practices section of Chapter 3 for more information on CMC discharge requirements.)

Impacts on Beneficial Uses: Reductions to freshwater flows in the watershed have a direct impact on a wide variety of beneficial uses. As noted above, freshwater is a critical element of several rare habitat types. In addition, reduced flows can impede the migration and spawning of steelhead; low flows that contribute to higher water temperatures can directly affect the viability of steelhead. Freshwater is essential to other special status species found in the watershed, including the red-legged frog and southwestern pond turtle.

Groundwater provides domestic water to users throughout the watershed, but it is especially essential to Los Osos and Baywood as a sole source of drinking water. The City of Morro Bay also uses wells in the lower Chorro Valley when its primary source, imported state water, is unavailable. In both watersheds, groundwater is used for crop irrigation and to provide water for cattle.

Actions and Trends: The California State Water Board regulates surface water rights and issues permits for allowable withdrawals in the watershed. The groundwater basins in the watershed have been studied at various times and one basin, Los Osos area, is categorized as high priority under California's Susutainable Groundwater Management Act (SGMA). The Los Osos groundwater basin is managed by the Los Osos Basin Management Committee, which was formed under a court ruling that required all water purveyors in Los Osos to manage withdrawals to recover the

basin from salwater intrusion and contamination in the upper aquifer. The community of Morro Bay has also developed a One Water Plan to address water, sewer, and stormwater management through 2040. The plan recommends discontinuing the use of well fields in Chorro Valley, eliminating municipal use of that groundwater basin. The remaining users would be agricultural and private landowners. The County Master Water Plan addresses water resource issues in the county and specifies management approaches. The Estuary Program has focused its efforts on encouraging water conservation practices in the watershed with a wide variety of partners and supporting integrated water management approaches.

New Issues and Perspectives: New issues to address with regard to freshwater flow include:

- Addressing impacts of climate change to freshwater resources
- Improving water conservation practices
- Increasing infiltration of runoff to groundwater aquifers
- Improving the understanding of freshwater needs for public trust resources

Many action plans in Chapter 3 capture these new issues, particularly FWR-1 through FWR-6, CLIM-1, USE-5, and many of the best management practices (BMP) actions. Additional background information is provided in those sections. Significant efforts have been made in some of these areas already, including water conservation and infiltration of runoff.

Enhancing Biodiversity to Maintain Habitat and Ecosystem Functions

Biodiversity is "the variety of life and its processes; and it includes the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur." (Keystone Center, 1991; California Biodiversity Council, 2008) The rich biodiversity found in the Morro Bay watershed and estuary is critical to the ecosystem's ability to continue providing important functions, such as habitat for critical species, flood protection, and water filtration. Rich biodiversity strengthens the environment's resilience in the face of future change, including altered precipitation patterns and temperature gradients due to climate change. Citizens and scientists alike have expressed concern over species and habitat loss in the watershed over the last twenty years (both recognized as priority issues in the 2001 CCMP), and preserving biodiversity can address both of these concerns. By taking the more holistic approach of emphasizing biodiversity, the Estuary Program anticipates more effective and long-lasting conservation results. The core conservation issues to be addressed in the Morro Bay watershed in order to preserve biodiversity include:

- Preventing habitat degradation
- Improving and preserving the ecosystem's ability to be resilient to and adapt to changing conditions
- Protecting and expanding migration corridors
- Maintaining ecological connections between habitats to protect important ecosystem functions

Biodiversity comprises many habitats, species, and ecosystem processes in the Morro Bay watershed – wetlands, marshes, mudflats, eelgrass beds, maritime chaparral, riparian canopies, oak woodlands, 15 federally listed species, many endemic species, and the numerous ecosystem processes that support these habitats, species, and important human uses.

Habitat loss, degradation, and fragmentation all can negatively impact diversity. Most of these causes occur through land uses that alter the natural landscape, such as urban development and agriculture. Invasive species can also decrease biodiversity by outcompeting native species for habitat and resources. Climate change is likely to impact biodiversity and related ecosystem

Photo : Mike Baird

functions, but the exact consequences are difficult to predict. Poor water quality, pollution, and competition for natural resources also affect biodiversity.

Impacts on Beneficial Uses: Several habitat types that have survived in and around Morro Bay – brackish wetlands, salt marsh, mud flats, eelgrass beds, coastal dunes complexes, and maritime chaparral – are quite rare in southern and central California. They constitute remnants of a natural world that has been lost in more populated and developed areas. Numerous special status species are dependent on these habitats. Special status species include those listed as endanged or threatened at the state or federal level, as well as species that are considered rare under California's Environmental Quality Act Guidelines. These special status species are listed by DFW here: https://www.dfg.ca.gov/wildlife/nongame/list.html. Healthy habitats are also critical to shellfish farming and to recreational and commercial fishing.

Morro Bay is renowned for its natural beauty, including its abundance of fish, waterfowl, and marine mammals. These factors form the base of the local recreation and tourist economy and are at risk when biodiversity is threatened.

Action and Trends: Land use planning and other policy strategies have provided some buffer to increased development pressure on biodiversity in the watershed. The entire estuary and large portions of the watershed fall under the jurisdiction of the California Coastal Commission, and both the City of Morro Bay and County of San Luis Obispo have Local Coastal Plans and other planning regulations that stipulate protections for native habitats and species.

Photo : Dean Sullivan

Habitat preservation through land acquisition and conservation easements has also helped protect biodiversity. In many cases, acquisitions resulted in the protection of special habitats or species. In other cases, acquisitions helped form greenbelts around the developed communities of Los Osos and Morro Bay to provide clear boundaries between urban growth and open space. Since the adoption of the 2001 CCMP, thousands of acres of land around the bay and in the watershed have been acquired or placed in conservation easements.

In addition to preservation, the Estuary Program and its partners have restored many areas of previously degraded habitat. Several miles of riparian corridors and hundreds of acres of land have been enhanced through these efforts. The implementation of best management practices to improve land stewardship has also supported the conservation of biodiversity (see the Best Management Practices section of Chapter 3 for more information). Work to improve water quality, such as what is described in previous sections of this chapter, benefits biodiversity. Finally, many education and outreach efforts in the watershed have increased awareness of important habitats and species and how to reduce impacts to them when people are recreating or engaging in other uses in the watershed.

New Issues and Perspectives: Ongoing efforts to preserve and restore habitats, promote best management practices, improve water quality, and educate citizens about biodiversity in the watershed will continue. This wide array of activities encompasses nearly all of the action plans outlined in Chapter 3.

Future efforts to preserve biodiversity and ecosystem functions are likely to include more strategic approaches to land acquisition and easements, with a goal of preserving a diverse and robust set of habitats to promote migration of species between habitats and adaptation to climate change. Best management practices will focus on the most effective approaches, as demonstrated by monitoring and evaluation efforts. Future efforts will also include work to limit the impact and spread of invasive species in the watershed, as outlined in the Estuary Program's Invasive Species Action Plan (Hall, 2010).

Climate change is expected to significantly impact habitats, species, and ecosystem functions. The Estuary

Program will work toward helping the watershed's habitats be resilient and adapt to climate change by encouraging scientific work to better understand local impacts of climate change. The Estuary Program will also support efforts to develop and implement Climate Action Plans to address climate predictions and adapt to change. Outreach and education will also be a part of the Estuary Program's response to climate change. (See the Climate Change section of Chapter 3 for further details.)

Environmentally Balanced Uses

Many uses in the watershed and estuary depend on local natural resources – shellfish farming, commercial fishing, farming, ranching, tourism, and water-based recreational activities are just some examples. Although many of these uses were discussed in the 2001 CCMP, the Estuary Program now recognizes the priority issue inherent in the challenge of balancing important economic and social uses with the needs of the ecosystem.

Many important human uses necessarily have some impact on natural resources. Agriculture, ranching, and urban development require changes to the natural landscape and produce stormwater runoff. Recreational activities in the bay may scare wildlife or impact habitats. All of these uses are also integral to the economy and quality of life people experience in the watershed. The challenge facing the local community is how to balance these uses with the needs of the ecosystem in a manner that preserves those important economic and social qualities.

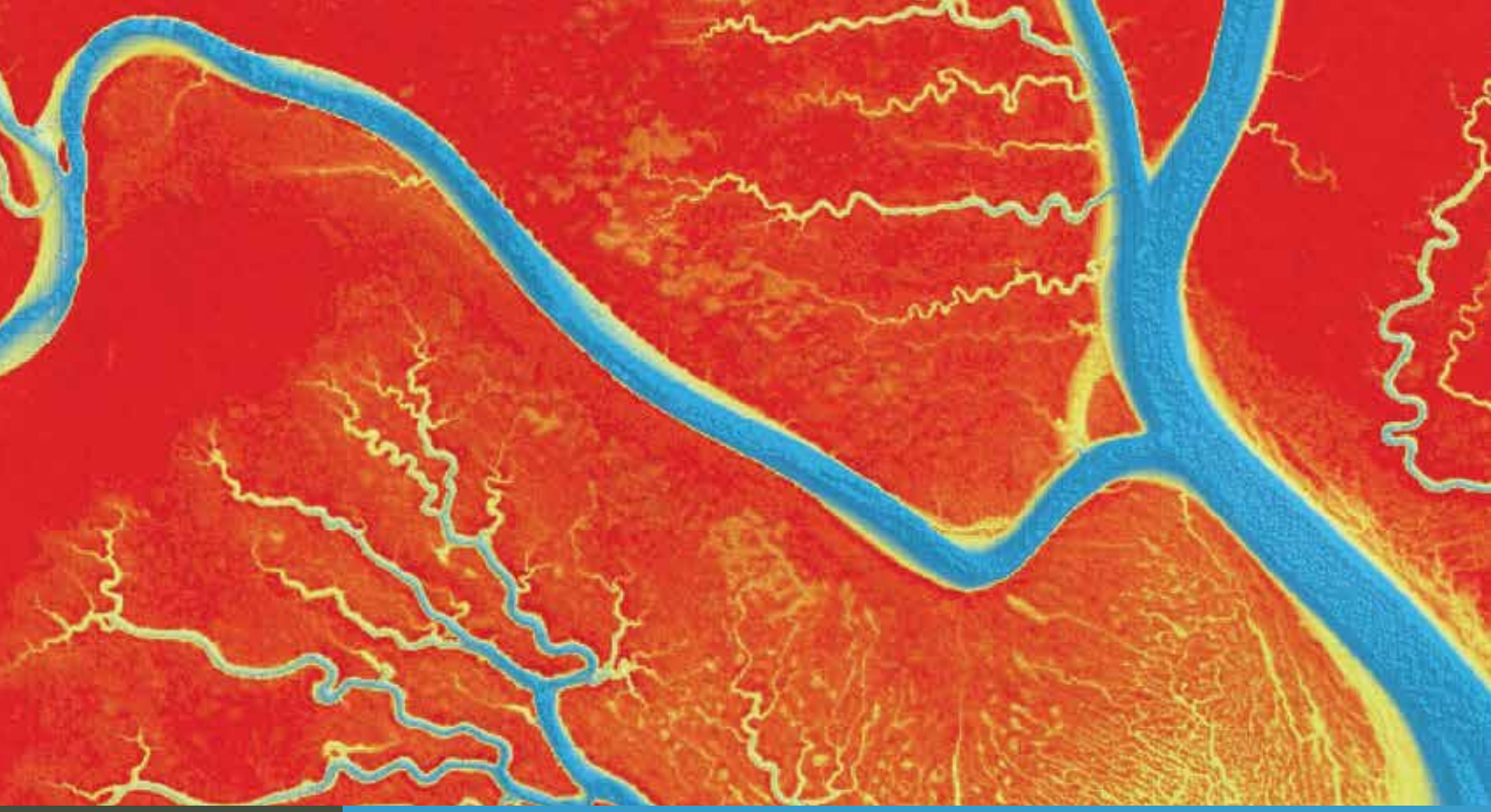
Impacts on Beneficial Uses: Each of these activities is itself a beneficial use. They can be the cause of impacts to other beneficial uses if they adversely affect important environmental values. Urban development, for example, has occurred on a number of important habitat types, such as coastal dune scrub and marshes. Current development plans and regulations at the state, county, and municipal level now require mitigation of the loss of important habitats. Boating, while central to both recreation and fisheries, can have impacts on water quality and habitat quality. Improper dumping of boat waste and discharge of toxics through

Photo : Lynda Roeller

spills or boat maintenance can affect bay health. The city of Morro Bay, the California Department of Fish and Wildlife, and private marina owners must work together to educate the boating community and ensure that convenient and workable facilities are available to support the infrastructure needed to protect water quality. More information is provided in Chapter 3, under the Action Plan BMP-8.

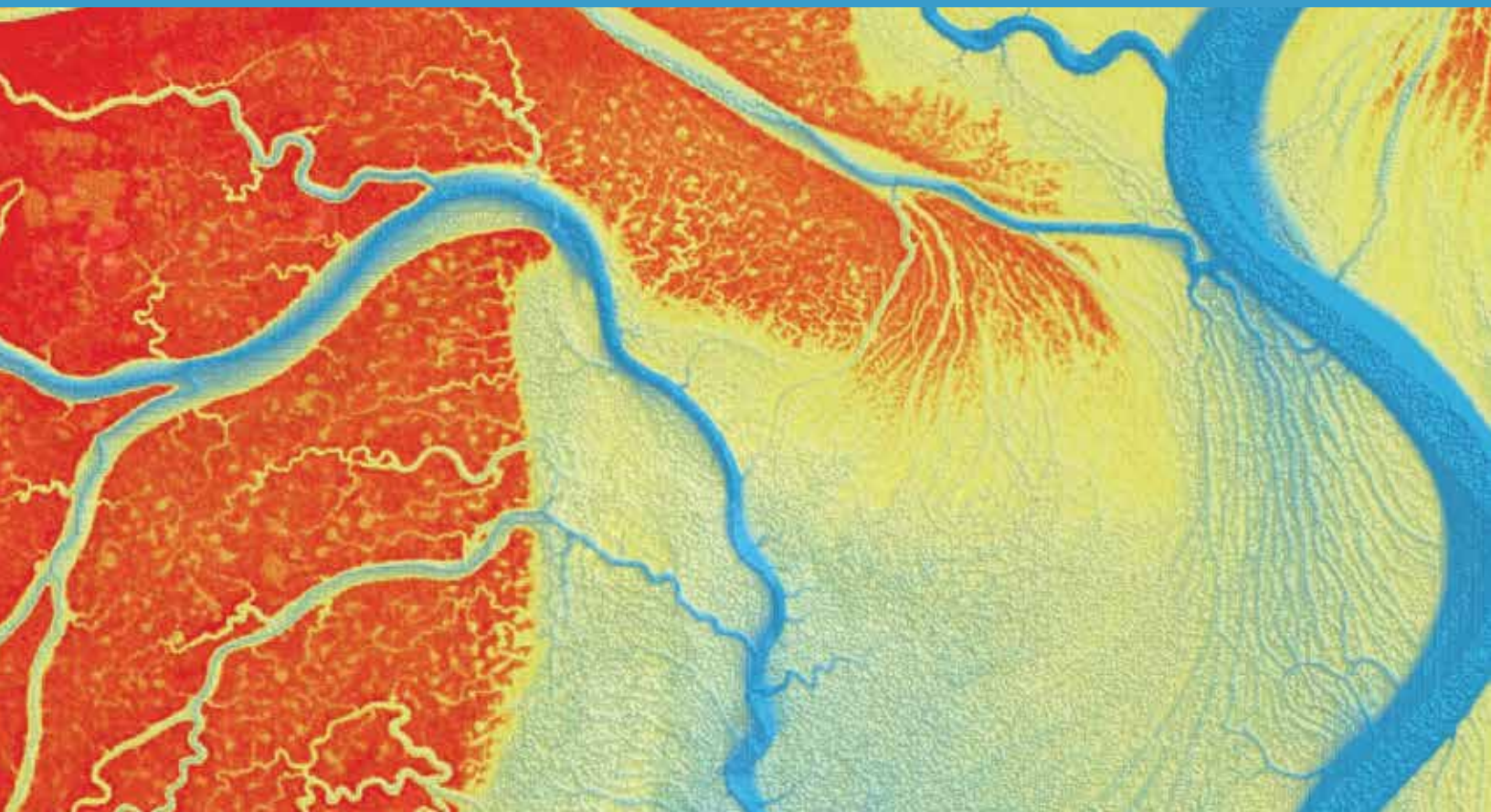
Not only can certain uses result in environmental impacts, but they can also impact each other. Stormwater runoff from a variety of land uses can degrade water quality that is essential for shellfish farming operations and recreational activities. Recreational activities such as kayaking and paddleboarding can scare wildlife away that bird watchers enjoy.

New Issues and Perspectives: The Estuary Program's work to address this priority issue will focus on supporting local partners in striking a balance between uses and the needs of the environment. A first step will be to determine the key areas of concern under this priority issue and developing approaches to address those concerns with partners. Action plans that address this priority issue include those presented in the Environmentally Sound Estuarine Resource Use section of Chapter 3.



Chapter 3

Action Plans



The heart of the CCMP is the **ACTION PLANS** that the Estuary Program will undertake to support the conservation and sound management of the estuary and watershed. These actions were developed through the dedication and hard work of numerous community members and partners over the past fifteen years. Many of the newly revised action plans are deeply rooted in the first CCMP; others address new issues and approaches that have risen over the past decade.

The action plans are now organized by categories of similar actions, rather than by priority issue. This new approach is the basis for an entirely new framework for the action plans, which is illustrated in Figure 1 and detailed in Table 1. Now each action plan clearly addresses multiple priority issues, something which was difficult to track in the first version of the CCMP. Leveraging each action for the greatest impact will allow the Estuary Program and its partners to effect greater change in a more strategic fashion. The new categories of action plans are: Land Protection, Water Quality Standards and Monitoring, Best Management Practices, Ecosystem Conservation and Restoration, Freshwater Flow, Climate Change, Environmentally Sound Estuarine Resource Use, and Education and Outreach. Each section of this chapter summarizes issues and approaches encompassed by these categories.

Each action plan includes a short discussion followed by a list of potential partners, timeframe, cost estimates, and ways that the implementation of the action plan can be tracked. The priority issues addressed by each action plan are shown in Table 1.

Partners refers to those public agencies, nonprofit groups, or other organizations that will likely be involved in the implementation of the action plan due to the nature of the work involved and the mission and goals of each partner organization. Listing in the partners section does not commit any organization or individual to any specific activity; rather, it is recognition of that entity's previous work and engagement relevant to the action plan in the watershed and an expectation of continued interest and involvement. (See Chapter 4 for a full list of acronyms used to represent partner organizations.)

Timeframe refers to when important milestones are expected to be reached. At this stage of the program, many of the action plans have been initiated and their implementation is simply ongoing. In most cases, the timing of specific projects is contingent on a number of factors, particularly funding availability.

Cost refers to the estimated funding needed to implement the action plan. A simple code is used to signify the total cost of the action plan, or in the case of ongoing ones, the typical annual cost:

$	**$25,000 or less**
$$	**$25,001 - $100,000**
$$$	**$100,001 - $500,000**
$$$$	**More than $500,000**

In many cases, different elements of an action plan may have widely disparate costs; for those action plans, a short note on the range of likely costs is included. The Estuary Program is also aware that cost estimates, even ones as broad as are shown, are likely to change over time as cost categories fluctuate and new approaches are realized.

Implementation tracking refers to how the program, partners, and the public can determine whether or not an action plan has been implemented and how the progress of implementation may be measured. Many of the measures presented are general in nature, recognizing that more specific measures will be developed for individual activities and projects under each action plan.

The Estuary Program recognizes that in a complex and interrelated system such as the Morro Bay watershed, many actions will relate to or complement other actions. Thus, there are frequent cross references among the action plans to highlight these connections.

This updated CCMP is strongly rooted in the first CCMP, which proved so successful in guiding the Estuary Program's first decade of work. Most of the

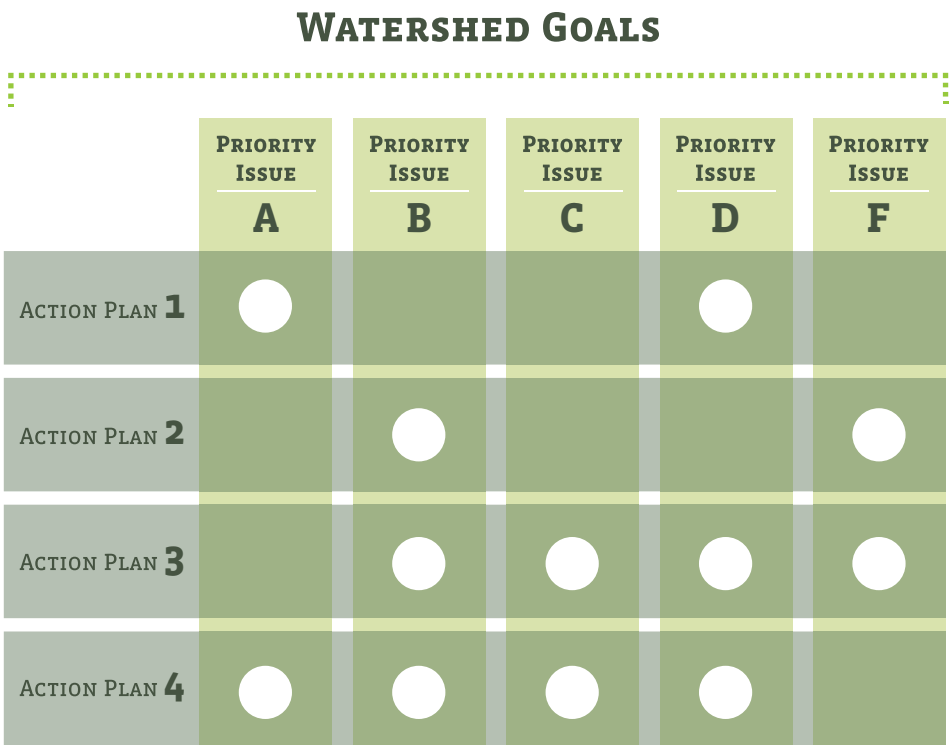
new action plans are updates or refinements to earlier ones; modifications to an action plan may reflect new conditions, a better understanding of underlying issues, more current technology or data, or simply a change in the status of a successful action plan from its initiation stage to ongoing implementation.

Where new action plans are closely linked to earlier ones, the former action plans are referenced. The first version of the CCMP, as well as a list of the action plans in that version, is available by visiting the Estuary Program offices.[1]

One critical issue impacting the Morro Bay estuary and watershed today, which was not addressed in the first CCMP, is climate change. The causes and impacts of climate change are complex and difficult to predict. A specific category of action plans addresses this issue and aims to increase the understanding of local impacts from climate change and appropriate actions to address those impacts. However, climate change must also be considered in many of the other action plans because future climate scenarios may impact the outcomes of those actions. Throughout the CCMP, action plans that are likely to be strongly impacted by climate change when they are implemented are marked with a ◉.

Lastly, although there is a section of action plans specific to education and outreach, many of the other action plans also contain educational elements. To highlight this fact, action plans in which education and outreach are core components are noted with a ★.

FIGURE 1: *Conceptual framework of the CCMP. Action plans, organized by type of action, address multiple priority issues. Watershed goals guide all of the work of the Estuary Program.*



1 The Morro Bay National Estuary Program website (as of August 2012) is www.mbnep.org. The offices are currently located at 601 Embarcadero, Suite 11, Morro Bay CA 93442.

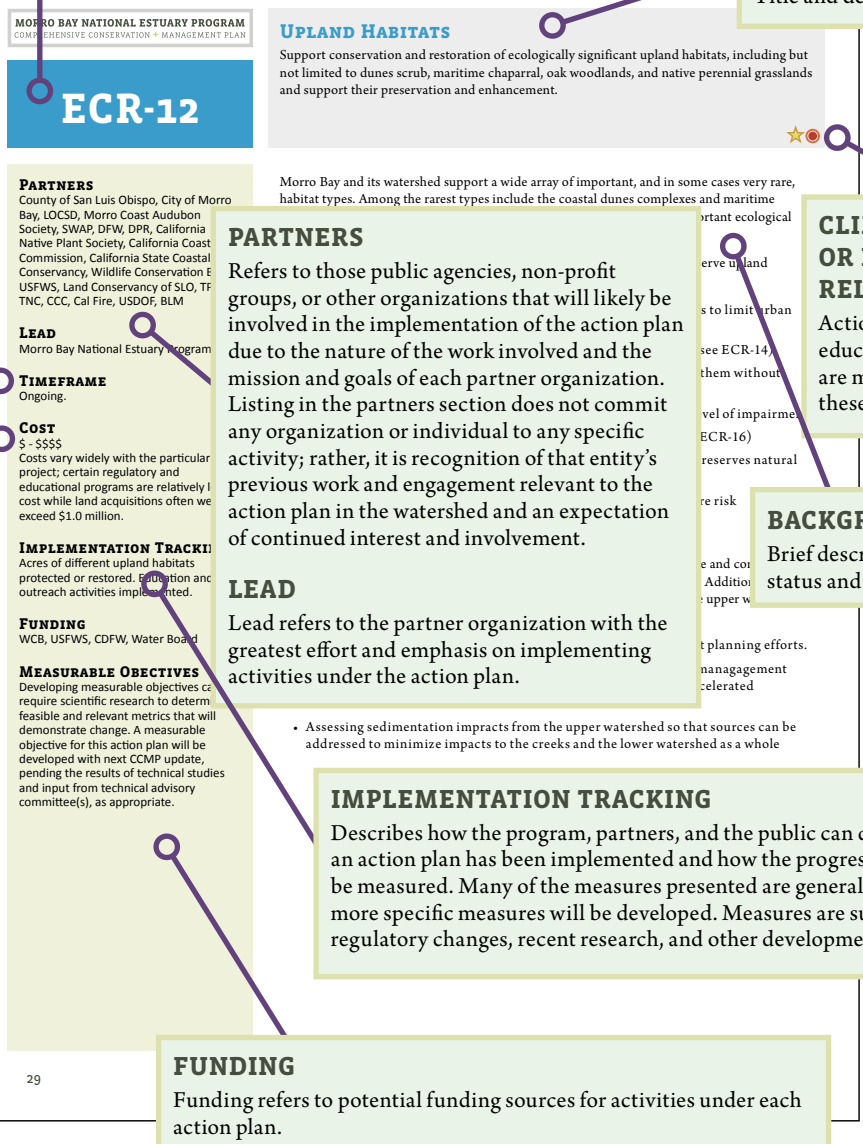
TABLE 1: *A matrix documenting which priority issues are addressed by each action plan.*

Categorized Action Plans		CCMP Priority Issues									Refer to Page
		Bacteria (B)	Nutrients (N)	Toxics (T)	Sediment (S)	Bio-diversity (BIO)	Fresh-water Flows (F)	Balanced Uses (BU)	Climate Change	Education	
LAND PROTECTION		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
LP-1	Protect Special Habitats/ Species					x			x		38
LP-2	*Restore Floodplains*	*REMOVED ACTION PLAN, COMBINED WITH LP-1*							x		*39*
LP-3	Direct Urban Development	x	x	x	x	x	x	x	x		40
LP-4	*Reduce Water Demand*	*REMOVED ACTION PLAN, COMBINED WITH LP-3*							x		*41*
LP-5	*Enhance Public Recreation*	*REMOVED ACTION PLAN AS NO LONGER RELEVANT*								x	*42*
WATER QUALITY STANDARDS AND MONITORING		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
TMDLs											
MON-1	Support Development of TMDLs	x	x	x	x			x	x		44
Monitoring Approaches											
MON-2	Monitor Environmental Indicators	x	x	x	x	x	x	x	x		45
MON-3	Monitor Project Effectiveness	x	x	x	x	x	x	x	x		46
Volunteer Monitoring Program (VMP)											
MON-4	Maintain VMP	x	x	x	x	x	x	x		x	47
Monitoring Partners											
MON-5	Support Partners	x	x	x	x	x	x	x			48
MON-6	Support Research Activities	x	x	x	x	x	x	x			49
BEST MANAGEMENT PRACTICES		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
Agricultural and Grazing											
BMP-1	Agricultural and Grazing BMPs	x	x		x	x	x	x	x	x	52
Rural Lands											
BMP-2	Rural Roads Erosion		x		x	x			x		54
BMP-3	*Fire Management Plan*	*REMOVED ACTION PLAN, COMBINED WITH ECR-12*							x		*55*
BMP-4	*Mine Remediation*	*REMOVED ACTION PLAN AS NO LONGER RELEVANT*									*56*
Urban											
BMP-5	BMPs by Private Landowners and Municipalities	x	x	x	x			x	x	x	58
BMP-6	Reduce Pet Waste	x							x	x	59
BMP-7	Support Stormwater BMPs	x	x	x	x			x	x	x	60
Boating											
BMP-8	Harbor Operations BMPs	x		x		x		x		x	62
BMP-9	Boating BMPs	x		x		x		x		x	63
Municipal Wastewater Plants											
BMP-10	*Los Osos Wastewater*	*REMOVED ACTION PLAN, COMBINED WITH MON-2, MON-3, FWR-5*									*65*
BMP-11	CMC Wastewater	x	x			x	x		x		66
BMP-12	MB Wastewater	x	x						x		67

Categorized Action Plans		CCMP Priority Issues									Refer to Page
		Bacteria (B)	Nutrients (N)	Toxics (T)	Sediment (S)	Bio-diversity (BIO)	Fresh-water Flows (F)	Balanced Uses (BU)	Climate Change	Education	
ECOSYSTEM CONSERVATION AND RESTORATION		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
Riparian											
ECR-1	In-stream Habitat	x	x			x	x		x		70
ECR-2	*Riparian Corridors*	*REMOVED ACTION PLAN, COMBINED WITH ECR-1*									*72*
Wetlands											
ECR-3	Wetlands Protection and Enhancement	x	x			x		x	x		74
ECR-4	Wetlands Habitat Assessment	x	x			x		x	x		75
Estuarine											
ECR-5	Sediment Traps				x	x			x		77
ECR-6	Hydrology and Bathymetry				x	x	x		x		78
ECR-7	Eelgrass Data and Research					x		x	x		79
ECR-8	Eelgrass Restoration					x		x	x		80
ECR-9	Regional and National Collaboration	x	x	x	x	x	x	x	x	x	81
ECR-10	Nutrient and Bacteria Dynamics	x	x						x		82
ECR-11	Conserve Ecosystem Functions	x	x	x	x	x		x	x	x	83
Upland											
ECR-12	Upland Habitats					x			x	x	85
Special Status Species and Recovery Plans											
ECR-13	Population Dynamics					x			x	x	87
ECR-14	Support Recovery Plans					x			x	x	88
ECR-15	Steelhead Barriers and Habitat					x	x		x		89
Invasive Species											
ECR-16	Invasive Species Action Plan				x	x	x	x	x	x	91
WATERSHED CREW		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
CREW-1	*Watershed Crew*	*REMOVED ACTION PLAN AS NO LONGER RELEVANT*									*92*
FRESHWATER FLOW		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
Resource Management											
FWR-1	Manage Freshwater Resources					x	x	x	x		95
FWR-2	*Scientific Information for Management*	*REMOVED ACTION PLAN, COMBINED WITH FWR-3*									*96*
FWR-3	Understand Flow for Public Trust Resources					x	x	x	x		97
FWR-4	Chorro Valley Water Users Group					x	x	x	x		98
Water Conservation and Re-Use											
FWR-5	Water Conservation					x	x	x	x		100
FWR-6	Groundwater Re-charge					x	x	x	x	x	101

Categorized Action Plans		CCMP Priority Issues									Refer to Page
		Bacteria (B)	Nutrients (N)	Toxics (T)	Sediment (S)	Bio-diversity (BIO)	Fresh-water Flows (F)	Balanced Uses (BU)	Climate Change	Education	
CLIMATE CHANGE		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
CLIM-1	Improve Understanding of Climate Change Impacts	x	x	x	x	x	x	x	x		**104**
CLIM-2	Assist in the Implementation of Local Government Climate Action Plans	x	x	x	x	x	x	x	x		**105**
CLIM-3	Climate and Adaptation Education	x	x	x	x	x	x	x	x	x	**106**
ENVIRONMENTALLY SOUND ESTUARINE RESOURCE USE		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
Recreational Uses											
USE-1	Recreational Uses					x		x		x	108
Shellfish Farming											
USE-2	Shellfish Farming	x				x		x	x		109
Commercial Fishing											
USE-3	Commercial Fishing Port Uses			x				x		x	110
Morro Bay Power Plant											
USE-4	Morro Bay Power Plant					x		x	x		111
Urban Development											
USE-5	*Urban Developement*	*REMOVED ACTION PLAN, COMBINED WITH BMP-7*							x	x	*113*
EDUCATION AND OUTREACH		**B**	**N**	**T**	**S**	**BIO**	**F**	**BU**	●	☆	
Public Education and Outreach											
EO-1	Publice Education and Outreach	x	x	x	x	x	x	x	x	x	115
State of the Bay											
EO-2	State of the Bay	x	x	x	x	x	x	x	x	x	116
Nature Center and Related Displays											
EO-3	Nature Center	x	x	x	x	x	x	x	x	x	117
Formal Education Programs											
EO-4	Formal Education Programs	x	x	x	x	x	x	x	x	x	118

Anatomy of an Action Plan



Action Plan Number

Title
Title and description of the action plan.

Timeframe
Lays out when important milestones are expected to be reached. Many of the action plans have been initiated and their implementation is simply ongoing. In most cases, the timing of specific projects is contingent on a number of factors, particularly funding availability.

Climate Change or Education Related
Action plans related to education or climate change are marked with one or both of these symbols.

Partners
Refers to those public agencies, non-profit groups, or other organizations that will likely be involved in the implementation of the action plan due to the nature of the work involved and the mission and goals of each partner organization. Listing in the partners section does not commit any organization or individual to any specific activity; rather, it is recognition of that entity's previous work and engagement relevant to the action plan in the watershed and an expectation of continued interest and involvement.

Lead
Lead refers to the partner organization with the greatest effort and emphasis on implementing activities under the action plan.

Background
Brief description of need, current status and other relevant information.

Cost
Refers to the estimated funding needed to implement the action plan. A simple code is used to signify the total cost of the action plan, or in the case of ongoing ones, the typical annual cost:

$	$25,000 or less
$$	$25,000 - $100,000
$$$	$100,000 - $500,000
$$$$	More than $500,000

In many cases, different elements of an action plan may have widely disparate costs; for those action plans, a short note on the range of likely costs is included. The Estuary Program is also aware that cost estimates, even ones as broad as are shown, are likely to change over time as cost categories fluctuate and new approaches are realized.

Implementation Tracking
Describes how the program, partners, and the public can determine whether or not an action plan has been implemented and how the progress of implementation may be measured. Many of the measures presented are general in nature, recognizing that more specific measures will be developed. Measures are subject to change due to regulatory changes, recent research, and other developments.

Funding
Funding refers to potential funding sources for activities under each action plan.

Measurable Objectives
Many actions can be measured by a number of different metrics. We have included a numeric target when feasible for actions plans, and have also listed other tracking measures that may be helpful in documenting progress.

Maximizing Impact in the Next Five Years

The action plans presented in this chapter outline a universe of possible projects and activities that could not all be fully accomplished by the Estuary Program and its partners in the next five years. Therefore, the Estuary Program has developed an approach to narrow its efforts over this time period to maximize effectiveness and produce tangible conservation results. As described in Chapter 2, the Estuary Program has identified seven priority issues impacting the estuary and watershed. To have meaningful impact on these issues over the next five years, the Estuary Program will direct its work toward addressing a primary focus for each priority issue. Relevant action plans will then serve as tools to achieve results in this area.

Each spring, the Estuary Program develops an annual workplan outlining the tasks anticipated to be undertaken the following year. When developing the annual workplan, the Estuary Program will specify which action plans will be implemented to address each primary focus. While the primary focus areas will guide the majority of effort, they do not preclude the Estuary Program from working on other projects with the potential for effective conservation results, as opportunities and resources arise.

Some of the focus areas described below encompass broad environmental issues for which a solution may not be feasible in the next five years. Thus, rather than serving as concrete endpoints, these focus areas direct the Estuary Program's efforts toward some measurable results that address the priority issues outlined in Chapter 2. Figure 2 illustrates this approach.

Figure 2: *As with all of the Estuary Program's work, the four goals described in Chapter 1 overarch all the priority issues. Each priority issue has one primary focus, described below. A number of relevant action plans can be used to address each focus area over the 5-year time horizon. Sedimentation is used here as an example.*

Accelerated Sedimentation

Over the next five years, the Estuary Program will focus its efforts to address sedimentation on upland erosion sources. The upper watershed possesses a highly erodible geography and has been recognized as a significant source of sediment to the bay. The Estuary Program will continue its work to address erosion problems in the upper watershed, including improvements to rural roads and fire management, and will also aim to develop a better understanding of relative erosion from individual sub-watersheds. This understanding will help the Estuary Program and its partners prioritize upland implementation projects.

Goal Address erosion problems in the upper watershed, including improvements to rural roads and fire management, and develop a better understanding of relative erosion from individual sub-watersheds to help prioritize upland implementation projects.

Outcome Upgrade high priority eroding roads and reduce sediment delivery to Chorro Creek and its tributaries.

Measure Estimated sediment load reductions; miles of roads upgraded. Updated fire management plan for the watershed. Sediment load reductions are calculated for each BMP type based on area of road or bank that is treated and prevented from eroding.

Bacterial Contamination and Elevated Nutrient Levels

The priority issues of bacterial contamination and elevated nutrient levels often overlap in terms of both sources and solutions. One significant source of both of these pollutants to the estuary is stormwater runoff. Over the next five years, the Estuary Program will focus its efforts to reduce these two pollutants on stormwater management. Non-point source runoff during storm events transmits elevated concentrations of nutrients and bacteria to the creeks and estuary. To better address this source, a stronger understanding of the dynamics of stormwater as a mechanism for transporting pollutants is needed. More detailed information in this realm would help the Estuary Program better tailor best management practices and projects to achieve greater improvements in water quality. Over the next five years, the Estuary Program will focus on strengthening this understanding and continuing to implement best management practices and projects to address nutrient and bacteria sources.

Goal Strengthen the collective understanding of the dynamics of stormwater as a mechanism for transporting bacteria and nutrients and implement best management practices and projects to address pollutant sources.

Outcome Estuary Program supports partner efforts (including data sharing) to increase the understanding of stormwater dynamics. Estuary Program directly supports the implementation of best management practices to address nutrient and bacteria sources.

Measure Amount of stormwater volume subject to BMPs. Estimated reductions in pollutants due to BMPs implemented by the Estuary Program and partners.

One source of bacteria in the estuary is through improper disposal of human fecal matter from boats. Over the next five years, the Estuary Program will make additional efforts to address bacterial contamination from disposal of waste from boats in the estuary. The Estuary Program in the past has supported efforts to install new pump-out facilities, upgrade old ones, encourage alternative pump-out options, and educate the boating public about proper waste disposal. The Estuary Program will continue these efforts over the next five years. Education efforts under this focus area will overlap with those under the Toxic Pollutants focus area.

Goal Continue to support city efforts to maintain functioning and easily accessible pump-out facilities, encourage alternative pump-out options, and educate the boating public about proper waste disposal.

Outcome Estuary Program participates in city efforts to install or upgrade pump-out facilities and actively encourages alternative pump-out options. Estuary Program and partners complete at least two seasons of a boater education campaign that addresses bacteria and toxics, reaching a majority of slip and mooring renters. (See also the focus area for Toxic Pollutants).

Measure Amount of waste diverted by pump-out facilities. Number of education campaigns completed and number of boaters reached.

Toxic Pollutants

Over the next five years, the Estuary Program will prioritize its efforts to address toxic pollutants on marina and boat-related toxics. A variety of toxic chemicals may be used in activities related to marina and boat maintenance – oil, gasoline, cleaning compounds, paint, and paint remover. Boating and marina activities can also produce marine debris. The Estuary Program will continue its partnership with the Morro Bay Harbor Department and other entities to implement projects designed to reduce toxic inputs to the bay. Past efforts include removal of abandoned vessels and illegal moorings, purchasing supplies for oil spill preparedness, and providing proper disposal facilities.

Goal Implement projects designed to reduce toxic inputs to the bay from marina and boating activities, such as: removal of abandoned vessels and illegal moorings, purchasing supplies for oil spill preparedness, and facilitating access to disposal facilities. Implement education and outreach activities to increase awareness among the boating public about proper disposal of hazardous waste and use of bay-friendly alternatives.

Outcome Estuary Program continues strong partnership with city of Morro Bay to address derelict boats and illegal moorings as they occur. City of Morro Bay's capacity to address oil spill is maintained at existing levels. Estuary Program and partners complete at least two seasons of a boater education campaign that addresses bacteria and toxics, reaching a majority of slip and mooring renters.

Measure Estimated amount of toxics diverted, if applicable to projects completed. Capacity to address oil spills and number of incidents addressed by local responders. Number of education campaigns completed and number of boaters reached.

Competition for Scarce Freshwater Resources

Over the next five years, the Estuary Program will focus its efforts to address freshwater flows on water budgets and water conservation. One challenge in addressing limited freshwater flows in the watershed is a lack of understanding regarding the water budget of each sub-watershed (Chorro Valley and Los Osos Valley). A water budget includes the inputs (precipitation, irrigation, piped water, etc.) and outputs (evapotranspiration, runoff, infiltration, and human water use) of water in a specific region. The Estuary Program will participate in efforts to define these water budgets to better inform water conservation and freshwater flow management. An initial step in defining local water budgets may be to encourage the re-formation of the Chorro Valley Water Users Group, or similar cooperative (see FWR-4). This group can help coordinate discussions, decision-making, data collection, and data sharing.

Goal	Participate in efforts to define water budgets for Chorro Creek and Los Osos Valley watersheds to better inform water conservation and freshwater flow management.
Outcome	Estuary Program will support our partners in defining a water budget for Los Osos Valley and Chorro Creek watersheds. Water budgets are shared with relevant stakeholders and managers.
Measure	Completion of water budget for Los Osos Valley and Chorro Creek watersheds and dissemination of information to stakeholders.

One of the central tenets of good water management is water conservation, especially in the climate of the Morro Bay watershed. Local water supplies are limited; the City of Morro Bay, California Men's Colony, and Cuesta College depend on the State Water Project for a significant portion of their water resources due to the scarcity of local resources. The Estuary Program has completed some past outreach and education efforts concerning water conservation at the household level and will strengthen these efforts in the future. The Clean Water, Great Life campaign started in 2012 and focused on community members and visitors taking a Clean Water pledge to complete bay-friendly actions in their daily life. The pledge was actively promoted through 2017 and a total of 762 individuals participated. All participants received follow-up outreach materials (including our weekly blog, if selected) and a subset voluntarily participated in post-pledge surveys to determine if actions were taken as pledged. Of those that responded to the post-pledge survey, the steps taken to reduce water use were: 94% of people turn off the tap, 69% use drought-tolerant landscaping, and 20% use graywater. Active promotion of the pledge has ended, but it is still available online at https://www.mbnep.org/kids/#pledge. The Estuary Program will also support local agencies in improving water conservation at a broader scale.

Goal	Engage in outreach and education efforts concerning water conservation and support local agencies and partners in improving water conservation at a broader scale.
Outcome	Estuary Program continues implementation of the "Clean Water, Great Life" campaign and creates at least three new outreach tools based on the campaign. Estuary Program actively supports local agencies and partners in improving water conservation within the watershed.
Measure	Number of projects that Estuary Program collaborates with local agencies and partners. Estimated water use reduction at the household/landowner level.

Enhancing Biodiversity to Maintain Habitat and Ecosystem Functions

Over the next five years, the Estuary Program will prioritize its efforts to preserve biodiversity by informing effective restoration. With uncertain future environmental and ecological changes driven by climate change, classical approaches to restoration in many cases are no longer viable. Conservation objectives that once focused on preserving biodiversity as it is, or restoring it to some prior condition, now must be consistent with a dynamic biodiversity and some amount of uncertainty. The Estuary Program's conservation objectives will focus on environmental and habitat heterogeneity, including the presence of refuges; habitat connectivity to allow species migration and buffering against climate change impacts; and ecological processes that give rise to the adaptability and persistence of biodiversity in landscapes.

Goal Identify a network of interconnected lands to focus conservation efforts that provide critical habitat for sensitive species; high biodiversity patterns; essential ecosystem services and functions; and provide the greatest opportunity for biodiversity to adapt naturally in a changing and variable environment.

Outcome Estuary Program completes a conservation planning effort that identifies areas of focus for conservation and restoration efforts based on the following criteria: critical habitat for sensitive species; high biodiversity patterns; essential ecosystem services and functions; and providing opportunity for adaptation and preserving resilience in a changing and variable environment.

Measure Completed conservation plan as described, with implementation goals for next five years.

Environmentally Balanced Uses

This priority issue focuses on the role the Estuary Program can play in encouraging economic and recreational uses on the bay that support a clean and healthy bay. Most activities on the bay, from kayaking to fishing and waterfront dining, have some requirements to comply with environmental regulations. However, environmental impacts may still occur and use conflicts may exacerbate those impacts. In addition, education and outreach can support public understanding of existing regulations, particularly when it comes to recreation. The Estuary Program will take this opportunity to gather input from local stakeholders, including resource managers, the general public, and specific user groups, to determine their top areas of concern regarding environmental impacts and use conflicts. Entities in other regions that deal with similar issues will also be consulted for their expertise. This knowledge-gathering phase will also act as an opportunity to educate different users about the Estuary Program and learn what role the organization can play in addressing this priority issue. At the end of this time period, the Estuary Program will updates action plans in the CCMP that can be taken to fulfill that role. Implementation goals for this area are being developed and will be complete by 2025.

Goal Over the next five years, the Estuary Program will focus its efforts to address environmentally balanced uses on determining the key areas of concern under this priority issue and developing approaches to address those concerns.

Outcome Estuary Program engages partners and stakeholders in developing a plan for implementing actions that address environmentally balanced uses.

Measure Updated action plans within CCMP to address the priority issue that engages partners and outlines specific actions, with implementation goals for next five years.

CCMP ACTION PLANS

Land Protection

The most direct and effective way to protect certain watershed and estuarine resources is to purchase land or conservation easements. The Estuary Program has partnered with several public agencies and nonprofits in land and easement purchases since 2000. Generally, the Estuary Program provides funds that leverage much larger amounts of money from other sources. This funding can be especially effective in meeting costs not usually covered by other funding sources, such as title reports, appraisals, and resource assessment studies. Besides contributing money, the Estuary Program may also provide technical expertise or supporting educational materials to help attract support for a project.

Outright purchase is the most expensive approach and makes sense when ownership is important to implement extensive restoration or other conservation approaches. An example is the Chorro Creek Ecological Reserve, the purchase of which discontinued specific water-intensive agricultural uses and paved the way for future modifications of levees and floodplains. These types of actions would be extremely difficult to achieve through land easement agreements.

In other cases, easements can be an excellent tool for reducing threats from specific land uses and promoting land practices that preserve natural resources and local heritage. Conservation easements are agreements in which the landowner sells some or all development or other rights associated with the land but retains the fee ownership of the land. For example, the Maino Ranch Conservation Easement limits development and protects on-site riparian resources while also extending a greenbelt around the city of Morro Bay. The Maino family maintains fee ownership of the land and its ranching operation.

The Estuary Program takes a strategic approach to land protection, often focusing on target properties that are important for achieving specific resource goals. However, acquisition and easements must also be opportunistic and take advantage of unexpected developments in market conditions, funding availability, and initiatives by partners. In considering whether or not to participate in a land conservation project, one key factor is the assurance of appropriate and reliable ongoing stewardship of the property after purchase. The Estuary Program often works with the owner of protected properties to encourage good stewardship and develop land management plans when needed.

The following discusses land protection for specific purposes, keeping in mind that many such acquisitions can achieve multiple objectives. In all cases, the Estuary Program only participates in acquisitions involving willing landowners.

Photo : Lynda Roeller

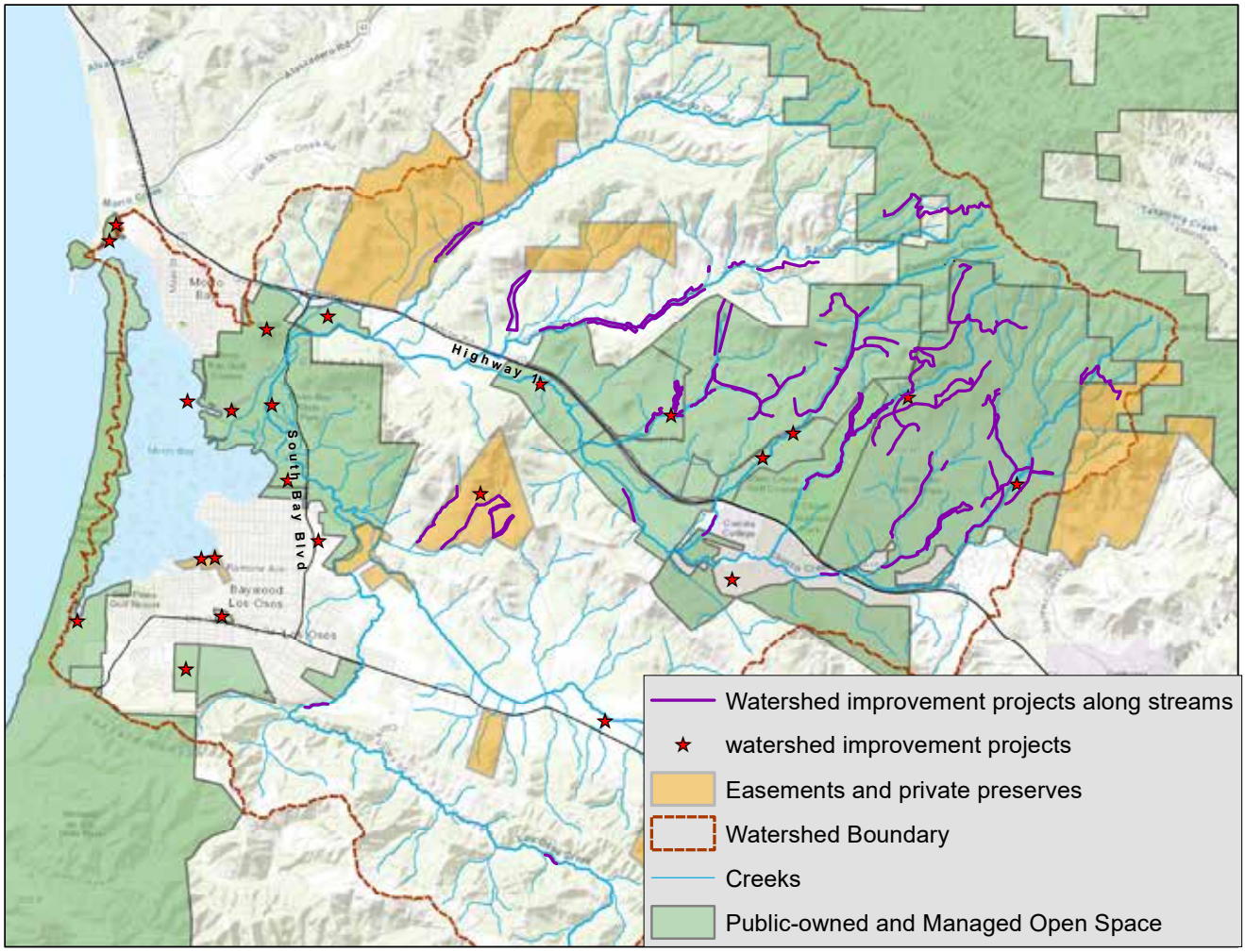


FIGURE 3: *Map of areas protected, restored, and enhanced in the Morro Bay watershed as of 2011.*

LP-1

Protect Special Habitats/Species

Participate in the purchase of land or easements to protect or enhance critical species and sensitive habitat, that provide connections and transitions between habitats, restore floodplain, and locate areas that are suitable for sediment capture. *(Related 2012 action: LP-2)*

Partners
Organizations that provide technical expertise and funding for these types of acquisitions include TNC, TPL, Land Conservancy of SLO, California State Coastal Conservancy, DFW and WCB, DPR, USFWS and the Bay Foundation. Those that have been involved in holding or managing land and easements include DFW, DPR, CSLRCD, Land Conservancy of SLO, County of San Luis Obispo, Morro Coast Audubon Society, SWAP, and the Bay Foundation. (See Chapter 4 for a full list of acronyms used in this document.)

Lead
The Land Conservancy of San Luis Obispo County

Timeframe
Ongoing; purchases are contingent on willing landowners, funding availability, market conditions, and the conservation goals of partners.

Cost
$$$ - $$$$ Cost varies greatly with market conditions and location. In-fee acquisitions of shoreline properties have cost as much as several hundred thousand dollars per acre, while other inland conservation easements have cost nearer to $1000 per acre. In all cases, the Estuary Program aims to leverage much larger funding amounts with its financial participation.

Implementation Tracking
Acres purchased or placed in conservation easements. Acres acquired for floodplain restoration. BMPs implemented by acreage. Ratio of funding provided vs. funding leveraged to complete a purchase.

Funding
SCC, WCB, CDFW, USFWS

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Morro Bay estuary and its surrounding watershed contain unique and rare habitats, including the coastal dunes complex and maritime chaparral, which are home to numerous special status plants and animals. Land protection, by fee title or easement, has been and will continue to be an important method for protecting these resources from a variety of threats, among them development, habitat fragmentation and degradation, and floodplain alterations. An additional consideration in the strategic purchase of land or easements is identifying restorable floodplain and areas suitable for sediment capture. Accelerated sedimentation, one of the priority issues for the Estuary Program, threatens the habitat and socio-economic values of the Morro Bay estuary (see Chapter 2 for a further discussion on sedimentation). An important strategy to reduce the amount of sediment reaching the bay is the restoration of floodplains that naturally capture sediment upstream. Much of the historical floodplain area, particularly in the Chorro Valley, has been modified by levees for development or farming. Opportunities to restore floodplains to a more natural state or to construct sediment capture basins have been identified, and others may exist. Because floodplain restoration and sediment basins typically require modification of the existing conditions, in-fee acquisition is usually required to achieve this goal. Acquisitions and easements can also aid in the successful implementation of sediment-reducing Best Management Practices (BMPs). Purchasing a property with significant erosion issues can make implementation of BMPs quicker, easier, and more effective. Such BMPs are discussed in more detail in the Best Management Practices section of this chapter.

In all cases, the Estuary Program only participates in acquisitions and easements involving willing landowners.

LP-2

Restore Floodplains

Participate in the purchase of restorable floodplains and areas suitable for sediment capture.

Current Status

Analysis determined that the implementation tracking actions for this Action Plan were similar to those for LP-1. The two action plans also address overlapping priority issues. Thus, LP-2 was eliminated and combined with LP-1.

LP-3

Direct Urban Development

Participate with public and nonprofit partners in the purchase of land or easements in strategic locations that help guide development toward existing and strategically planned communities and conserve critical resources. *(Related 2012 action: LP-4)*

Partners
Organizations that provide technical expertise and funding for these types of acquisitions include TNC, TPL, Land Conservancy of SLO, California State Coastal Conservancy, DFW and WCB, DPR, USFWS and the Bay Foundation. Those that have been involved in holding or managing land and easements include DFW, DPR, CSLRCD, Land Conservancy of SLO, County of San Luis Obispo, Morro Coast Audubon Society, SWAP, and the Bay Foundation.

Lead
The Land Conservancy of San Luis Obispo County

Timeframe
Ongoing; purchases must be contingent on willing landowners, funding availability, market conditions and the goals of other partners.

Cost
$$$ - $$$$ Cost varies with location; refer to cost explanation for LP-1.

Implementation Tracking
Acres purchased or placed in conservation easements. Extent and continuity of greenbelts. Ratio of funding provided vs. funding leveraged to complete a purchase. Water rights altered, if any, by land acquisition or easement. Projected reductions in water use due to acquisition or easement. Ratio of funding provided vs. funding leveraged to complete a purchase.

Funding
SCC, WCB, CDFW, USFWS

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Activities in the watershed strongly influence the ongoing ecological health of the estuary. Urban development in the watershed can contribute a wide range of pollutants to stormwater and freshwater flow, impact populations and habitats of special status species, and compete directly with non-urban uses for land and water resources. California's approach to coastal development attempts to balance development needs with environmental integrity, ecosystem services (including flood protection provided by certain coastal habitats), and the local sense of place. Local governments and the California Coastal Commission specify the areas in which urban development and other land uses can occur through land use plans and development codes. Nonetheless, continued population growth and development needs may increase pressure to adjust those boundaries and alter land use planning guidance that currently benefits the estuary.

Purchasing land or easements can also help to alleviate pressure on critical, local surface water resources from processes such as intensive agriculture and urban development. The estuary's principal freshwater sources, Chorro and Los Osos Creeks and their tributaries, often experience extremely low flows and become seasonally intermittent in certain places, potentially harming significant ecological resources in the process. The Mediterranean climate of California's central coast generates extreme and unpredictable seasonal fluctuations in precipitation, which drives such patterns of irregular flow. Climate change is likely to exacerbate seasonal low flows (Koopman, Meis, & Corbett, 2010). Withdrawals from shallow aquifers that are closely associated with streams can exacerbate low-flow or dry creek bed conditions and contribute to detrimental environmental impacts, such as loss of aquatic organisms and riparian vegetation. For example, hundreds of acres of the Chorro Creek Ecological Reserve were cultivated with orchards and row crops. Purchase of the property allowed for the removal of the orchards and irrigation system, and the discontinuation of water-intensive farming. The Maino Ranch easement is another example where the terms of the easement explicitly limit the acreage that can be used for irrigated farming

However, the most effective, long-term method for limiting the impacts of urban development on the estuary and watershed is to develop "greenbelts" around existing developed areas, primarily Los Osos/Baywood Park and the City of Morro Bay, and to a lesser extent, county and state facilities (such as California Polytechnic University) on the San Luis Obispo side of the watershed. Greenbelts are stretches of undeveloped land surrounding existing communities, serving the purpose of encouraging future development within existing communities rather than developing sprawl on the outskirts of urban areas.

Significant progress has been made in establishing greenbelts in the watershed. A necklace of publicly held open space parcels largely surrounds Los Osos, although some urban development has occurred beyond that greenbelt. Expansion of the City of Morro Bay into the Chorro Valley has been effectively controlled by largely contiguous public lands and conservation easements. The largest single contribution to this greenbelt is the 1,860-acre Maino Ranch easement held by the Bay Foundation. The City of San Luis Obispo has also assembled several parcels into a greenbelt, which may help control encroachment into the watershed from inland.

Impacts from development can also be limited by acquiring parcels planned for intensive urban uses. One example is the urban development proposed on large parcels in the Chorro Valley near Hollister Peak. Although the necessary permits were not approved, the threat of large-scale development was permanently extinguished only with the acquisition of what is now the Chorro Creek Ecological Reserve.

Additional opportunities for preventing the conversion of the estuary's relatively undeveloped watershed into urban sprawl are likely to arise in the future.

LP-4

Reduce Water Demand

Participate with public and nonprofit partners in the purchase of land or easements to reduce the use of water resources for intensive agriculture or urban development.

Current Status

Analysis determined that the implementation tracking actions for this Action Plan were similar to those for LP-3. Thus, LP-4 was eliminated and combined with LP-3.

LP-5

Enhance Public Recreaction

Participate with public and nonprofit partners in the purchase of land or easements to allow for enhanced public access or recreational opportunities with minimal environmental impact.

Current Status

Analysis determined that this Action Plan was no longer relevant due to changing priorities of our partners. Entities such as California State Parks, the Resource Conservation Districts, and the California Department of Fish & Wildlife as less able to accept land and manage access. Thus, LP-5 was eliminated.

Water Quality Standards and Monitoring

Congress created the National Estuary Program under the federal Clean Water Act Section 320 (Federal Water Pollution Prevention and Control Act (Clean Water Act), 1987), recognizing that protecting water quality preserves the unique biological significance of estuaries and many associated human activities. To protect water quality and the important uses that occur within estuaries and their watersheds, the National Estuary Program strives to achieve two foundational goals – support the establishment of appropriate water quality standards and monitor progress toward meeting those standards.

The Central Coast Regional Water Quality Control Board (Water Board) is the state agency that sets water quality standards in the Morro Bay area. The Water Board establishes Total Maximum Daily Loads (TMDLs) for impaired waterbodies in Morro Bay pursuant to Section 303 of the Clean Water Act (CWA) (Clean Water Act, 1987). Impaired waterbodies are first identified through data analysis and then classified as "listed" pursuant to CWA 303. Waterbodies can be "de-listed" when water quality improves. If water quality does not improve, the Water Board develops a TMDL and allocates loads to the various pollutant sources. When developing TMDLs, the Water Board takes into account all pollution sources, including point sources, nonpoint sources, and natural background loading. Waterbodies that achieve their TMDLs are considered acceptably clean to support the biological values and human activities that depend on them.

The Water Board also issues permits to persons and agencies that discharge water into the ocean, estuary, and creeks. Such permits include conditions to protect water quality and minimize environmental impacts.

Other agencies set water quality standards for specific pollutants related to specific uses. For example, the California Department of Public Health (CDPH) closely regulates pathogen indicators and biotoxins in waters open for commercial oyster farming and where shellfish is sport-harvested. Oyster harvesting is suspended when bacteria levels exceed acceptable limits. Similarly, the San Luis Obispo County Environmental Health Services ensures that water quality in the county is sufficiently safe for human contact during recreational activities such as swimming, fishing, and boating. The California Coastal Commission addresses water quality in the coastal zone through its permitting process. Projects in the coastal zone must meet the Coastal Act's requirements for protecting water quality and the Coastal Commission considers these requirements when issuing permits.

The Estuary Program has played a major role for more than a decade in monitoring water quality and related measures of environmental health. To a large extent, the program relies on specially trained volunteers that participate in the Volunteer Monitoring Program (VMP). VMP-collected data has been used by the Water Board, CDPH, and other agencies to track a wide variety of pollutants and other environmental indicators in the watershed. VMP activities are managed by the Estuary Program staff and are carried out pursuant to a Quality Assurance Project Plan (QAPP) approved by the USEPA and Water Board.

Certain parameters require monitoring expertise or techniques that are not appropriate for volunteers. In such cases, the Estuary Program may utilize its professional staff or contractors to undertake the work. In addition, the Estuary Program has partnered with other organizations, notably the San Luis Obispo Science and Ecosystem Alliance (SLOSEA), to augment the monitoring conducted by the VMP.

Besides monitoring changes to the estuary's environmental health, the Estuary Program also measures the effects of projects that are undertaken to improve water quality. For example, the Estuary Program tests the water quality upstream and downstream of projects that implement best management practices to assess the effectiveness of the projects on stream water quality.

It is worth noting that the two types of monitoring – project effectiveness versus long-term datasets – have very different time scales and geographic scopes. In allocating its resources (staffing, volunteers or funding), the Estuary Program recognizes these differences and strives to balance the needs for both types in developing a fuller picture of the estuary's health.

MON-1

Support Development of Total Maximum Daily Loads (TMDLS)

Support Central Coast Regional Water Quality Control Board in monitoring progress and reporting on TMDLs, or similar standards for pollutants, relevant to the estuary and its water bodies. Participate in any future TMDL reviews and revisions.

Partners
Water Board, California State Water Board, USEPA

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$ To a large extent, this action plan occurs within the usual scope of the Estuary Program functions, including the VMP (see MON-5), and costs are likely to overlap with other action plans in this section.

Implementation Tracking
Regular reports on the status of TMDL compliance in impaired water bodies, in conjunction with the Water Board's triennial review of each TMDL.

Funding
Water Board, EPA, Private Foundations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Estuary Program participates in monitoring and reporting on TMDLs in the Morro Bay watershed to aid regulators in better understanding progress being made toward TMDL requirements. The data collected by Estuary Program volunteers and staff is provided to the Water Board for updates to the TMDLs and 303(d) listings. Without the Estuary Program data, the Water Board would be relying on extremely limited data in the watershed to measure progress. The Estuary Program will continue to collect and share data to help motivate progress toward improving water quality and demonstrate change.

The following TMDLs apply to water bodies in the Morro Bay watershed[1]

- Dissolved Oxygen – Chorro Creek
- Sediment – Chorro Creek, Los Osos Creek, and the Morro Bay estuary
- Pathogens – Morro Bay estuary, Chorro Creek, Los Osos Creek, and Warden Creek
- Nutrients – Chorro Creek, Los Osos Creek, and Warden Creek and Lake Wetland

At one time, Chorro Creek was considered impaired by the presence of certain heavy metals that were historically mined in the upper watershed. During the past decade, the creek was de-listed for those constituents as information about natural background levels was better understood.

The current sediment TMDLs for all three water bodies (Chorro Creek, Los Osos Creek, and the Morro Bay estuary) relies on tracking implementation projects to achieve its goals. Loading reduction estimates are used to predict progress as implementation projects are completed. Although loading is the most direct measure of progress, it requires an extraordinary amount of data to calculate and does not fully capture variability due to weather, seasons, and flow volumes. The Estuary Program will support efforts to explore alternative measures of progress besides loading for sediment TMDLs, such as bay bathymetric changes, marsh and mudflat elevation changes, and estimations of sediment captured by floodplains. Activities that the Estuary Program may undertake to support TMDL monitoring and reporting include

- Monitoring in creeks and estuary for constituents listed in TMDLs, as monitoring capabilities allow
- Analyzing monitoring data in formats usable for the TMDL process
- Monitoring of implementation projects to demonstrate effectiveness in meeting TMDL benchmarks

1 All current and proposed TMDLs for the Morro Bay watershed can be found online at the Central Coast Regional Water Quality Control Board's website: http://www.swrcb.ca.gov/rwqcb3/water_issues/programs/tmdl/303d_and_tmdl_projects.shtml. A copy of all current TMDLs is also kept at the Estuary Program office and can be accessed by request.

MON-2

Monitoring Environmental Indicators

Monitor a suite of environmental indicators that track changes to the estuary and watershed and that are supportive of state water quality and biological objectives; the selection of appropriate indicators should consider factors such as how well the indicator demonstrates the health of the environment, priority issues of the Estuary Program, reliability of methodology, and costs (time, staff, funding). *(Related 2012 action: BMP-10)*

Partners
Water Board, California State Water Board, USEPA, DPR, NOAA NMFS, Cal Poly including SLOSEA, California Coastal Commission, CDPH, ACOE, SLO County, City of MB, LOCSD, Aquaculture operators

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$
Costs for this action are partially encompassed within the scope of the VMP (See MON-5) but includes other efforts such as evaluating sediment levels and eelgrass surveys.

Implementation Tracking
A current suite of variables being monitored. Tracking of use of Estuary Program data by partners and regulatory agencies. Entry of the Estuary Program data into California-wide water quality database(s) used by stakeholders and regulatory agencies.

Funding
Water Board, EPA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The estuary and its watershed compose a complex system with many influences from both the land and ocean. Measuring the health of such a dynamic environment is a difficult task, but it is one of the Estuary Program's most crucial roles. Numerous partners rely on Estuary Program monitoring data to inform management decisions and demonstrate improving conditions from various projects. In addition, the Estuary Program provides water quality data for the public to learn more about their local environment.

In this dynamic system, many variables can demonstrate environmental change. It is impossible, and inefficient, to monitor all potential measures, so the Estuary Program focuses on a specific suite of water quality, biological, and related environmental indicators. Ideal indicators are relatively easy and cheap to monitor, and are strongly linked to the wider environmental health of the system. The Estuary Program also chooses indicators that support the data needs of partners (such as the Water Board). This collaborative approach reduces costs and paints a more complete picture of how the estuary and watershed are changing.

As technology and scientific understanding change, new pollutants, standards, and protocols will emerge. At the time this plan was written, some potential pollutants not currently regulated, called "emerging contaminants", were being investigated for water quality and biological impacts in Morro Bay. The Estuary Program endeavors to balance adapting to such developments with maintaining long-term datasets.

Many typical water quality measures analyze the concentration of one or more chemical variables. Biological objectives instead measure changes in aquatic biota of a water body. These objectives provide insight on the net impact of pollutants on aquatic life, and are therefore becoming increasingly important. The Estuary Program has already begun incorporating biological objectives into its monitoring program and will continue to adapt as water quality regulations move toward this approach. The Monitoring Plan includes relevant indicators, measures, and types of data collected for assessment. See the Monitoring Plan for more information.

Activities to support this action plan may include:

- Continued monitoring of environmental indicators known to be useful in tracking environmental change and informing regulatory partners
- Supporting advancement of biological objectives to determine impacts of water quality on aquatic life
- Sharing of relevant water quality data with project and regulatory partners
- Supporting agencies in any information needs related to estuary and creek impacts from project upgrades
- Tracking of scientific progress in determining emerging contaminants of concern and monitoring those contaminants if water quality impacts are suspected and analysis is not cost or labor prohibitive

MON-3

Monitoring Project Effectiveness

Develop environmental indicators and engage in monitoring to contribute to project evaluation in the Morro Bay estuary and watershed; the development of indicators and methodologies should consider factors such as the needs/requirements of funders and partner agencies; meaningfulness and potential for reliable replication over time; and costs (time, staff, funding). *(Related 2012 action: BMP-10)*

Partners
USEPA, DFW, CSLRCD, NOAA NMFS, Cal Poly, Water Board, university and research institutions

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing (specific timeframes set for each project being evaluated).

Cost
$$

Implementation Tracking
The number and scale of project performance monitoring efforts and evaluation results. Reporting the use of monitoring data to demonstrate impacts and adapt future projects.

Funding
Grant funding by project

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Estuary Program is not only concerned about how the entire estuarine system is changing over time, but also how specific projects aimed at improving water quality and other environmental conditions are performing. Evaluating the effectiveness of projects helps adapt current efforts and refine future practices to most efficiently generate positive changes. The nature of each specific project determines the methods required to monitor effectiveness. For example, a riparian fencing project might necessitate bacteria monitoring while a floodplain restoration project may require monitoring changes in sediment transport. Sewer system upgrades and retrofits might necessitate bacteria or nutrient water quality monitoring. Other considerations for project evaluation include cost, ease of replication, and the requirements of partner and funding agencies. Beyond water quality, monitoring under this action also addresses habitat restoration measures of success, such as vegetative cover, use of restored site by certain species, and restoration of specific ecosystem functions. The Monitoring Plan includes relevant indicators, measures, and types of data collected for assessment. See the Monitoring Plan for more information.

Activities to support this action plan may include

- Development and execution of monitoring plans for restoration projects implemented by the Estuary Program and partners
- Analysis of project-specific monitoring data to demonstrate impacts on water quality objectives and habitat restoration measures
- Supporting agencies in any information needs related to estuary and creek impacts from project upgrades
- Providing technical expertise for any planned monitoring efforts related to new retrofit and project upgrade measures

MON-4

Maintain Volunteer Monitoring Program (VMP)

Maintain a high quality Volunteer Monitoring Program to track environmental variables appropriate for volunteer involvement and meaningful to the program and its partners.

Partners
Water Board, California State Water Board, USEPA, CCAMP

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$$
The current VMP operates on a budget of approximately $200,000 per year for management, training, supplies, data entry, quality control, and data analysis. This budget can vary drastically depending on the variables being monitored and the amount, and level of sophistication, of lab analysis.

Implementation Tracking
Number and types of variables monitored; number and frequency of sites monitored; annual QAPP approval; number of volunteer hours. Number of data reports created that use volunteer-collected data (as well as how those reports are used).

Funding
EPA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Morro Bay's Volunteer Monitoring Program (VMP) is a model of citizen-based science emulated by groups nationwide. During the last decade, hundreds of volunteers have contributed thousands of hours to the program. Volunteers have collected data related to a wide variety of variables, including water pollutants, physical parameters of water quality, geomorphic and hydrodynamic changes in creeks and the bay, sedimentation, the distribution and abundance of species and habitats, biological productivity, and project effectiveness. This data informs the Estuary Program's decisions about implementing restoration projects and is also used by a number of partner agencies. The Water Board, CDPH, City of Morro Bay, County of SLO, LOCSD, California Coastal Commission, DFW, NOAA NMFS, and DPR all use VMP data to inform management and regulatory decisions within the Morro Bay watershed. VMP data contributes to the writing and revision of TMDLs, 303(d) listings, and warnings about recreational contact in certain waterbodies. Private landowners also use VMP data to manage a variety of land uses. All monitoring activities are conducted pursuant to a Quality Assurance Project Plan (QAPP) approved by the Water Board and USEPA. Volunteers undergo extensive training to meet those approved protocols. Morro Bay's QAPP is frequently cited as a model for other monitoring programs.

Beyond collecting essential water quality data, the VMP serves another important function – connecting the community to the watershed and estuary. By enlisting the public directly in the work of the Estuary Program, the VMP increases awareness of the community's connection to the estuary and how human activities can impact this important place.

The size, scope and sophistication of the VMP necessitate a high-level professional support staff. Funding for staff, as well as equipment, testing, and data input, is essential to the program's success and requires assistance beyond the funds of the Estuary Program. Activities to continue the VMP and ensure the sustainability of the program well into the future include

- Management of the VMP to ensure high quality data that can be used by a variety of partners
- Continual volunteer oversight to maintain a well-trained and motivated volunteer corps
- Regular training, data sharing, and appreciation events to keep volunteers engaged in the program

MON-5

Support Partners

Continue to share data and collaborate with federal, state, regional, university, and local monitoring partners.

Partners
Water Board, CCAMP, CDPH, County of SLO, City of Morro Bay, LOCSD, CSLRCD, DFW, DPR, NOAA NMFS, SLOSEA

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$
To a large extent, this type of collaboration occurs within the usual scope of the Estuary Program functions and is embedded in overall program costs. However, future collaborations that involve collecting additional data will require additional funding for staff, equipment, testing, and analysis.

Implementation Tracking
The number of agencies with which the Estuary Program has collaborative monitoring relationships. The number and frequency of data sharing mechanisms the Estuary Program employs, including adding data to regional and state databases. Inclusion of Morro Bay in state and region-wide water quality studies.

Funding
EPA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Many agencies and organizations in the Morro Bay area need monitoring data regarding water quality and environmental conditions in order to do their work. One outstanding example of water quality monitoring is the Water Board's Central Coast Ambient Monitoring Program (CCAMP). CCAMP collects, analyzes, and disseminates data on water quality in creeks and rivers between Santa Cruz and Santa Barbara counties, including those in the Morro Bay watershed. The Estuary Program has participated with CCAMP on database support, determining data collection needs at specific sites, equipment and data sharing, and conducting staff professional development activities. Other agencies that monitor variables relevant to the Estuary Program include CDPH, County of SLO, City of Morro Bay, LOCSD, CSLRCD, DFW, DPR, NOAA NMFS, as well as nonprofit and university groups such as SWAP, the Land Conservancy of SLO, and SLOSEA. The Estuary Program will continue its efforts to regularly collaborate with all of these groups to share data and equipment and reduce duplicative efforts. Supporting activities may include

- Aligning constituents monitored, methods used, and analysis approaches with CCAMP, local partners, and state monitoring standards to ensure transferability of data
- Providing technical support and local planning assistance for monitoring efforts by partners
- Data sharing to support monitoring efforts of SLOSEA, CCAMP, and other partners

MON-6

Support Research Activities

Support scientific research and studies that contribute to a better understanding of complex estuary and watershed ecosystem dynamics. Encourage information exchange with research activities.

Partners
Water Board, DFW, NOAA NMFS, ACOE, California Coastal Commission, California Energy Commission, TNC, CSLRCD, Land Conservancy of SLO, Cuesta College, Cal Poly (especially Coastal Resources Institute and Escuela Ranch), SCCWRP, USF

Lead
Cal Poly

Timeframe
Ongoing.

Cost
$$ - $$$
Cost varies considerably; the majority of funding for research comes from outside sources. The Estuary Program has provided some direct research funding, but also regularly provides staff support and data from the VMP and related monitoring work for researchers and scientists.

Implementation Tracking
Number and scope of high quality research projects relevant to Morro Bay. Use of research results in management decisions (including restoration projects, monitoring, and regulatory decision making).

Funding
EPA, Water Board, Sea Grant

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Estuary Program is a science-based program that has greatly contributed to better scientific understanding of the estuary and watershed. Although the Estuary Program does not typically directly engage in research activities, it does collect monitoring data used by other entities in research endeavors and occasionally commissions studies to better understand particular environmental issues. The Estuary Program also relies on scientific studies and research results to design restoration projects and monitoring protocols. Partners including the Water Board, DFW, NOAA NMFS, ACOE, California Coastal Commission, the California Energy Commission, TNC, CSLRCD, and the Land Conservancy of SLO, have all contributed to research related to Morro Bay. Among the most important resources, however, is Cal Poly. Three important programs – the Coastal Resources Institute and the Escuela Ranch in the College of Agriculture and SLOSEA in the College of Science and Mathematics – have worked extensively in Morro Bay. Furthermore, individual faculty members across many of Cal Poly's colleges and departments have directed their research interests to the issues of the watershed and estuary. University students, at both the undergraduate and graduate levels, have undertaken useful research relevant to the Estuary Program and its partners. One of the Estuary Program's crucial roles is to encourage and support these entities in continuing to study the many complex environmental dynamics of the Morro Bay estuary.

Activities to support scientific research may include

- Sharing monitoring data and restoration project results to facilitate research efforts
- Providing technical and logistical support for partner research projects
- Guiding research efforts toward projects that will generate information useful to management efforts

Best Management Practices

A wide variety of human activities in the watershed and on the bay impact the health and productivity of the estuary. All such activities – whether farming or ranching in rural lands, living or doing business in local towns, or boating on the bay – can be carried out in ways that reduce impacts to natural resources. Effective approaches and tools that prevent or reduce pollution and other environmental impacts are collectively termed "Best Management Practices", or BMPs. BMPs are an important part of voluntary and regulatory programs to improve water quality, but they often require unique knowledge, skills, or tools to implement. The Estuary Program plays a critical role in the community by promoting the implementation of BMPs with programs that share knowledge and skills and leverage funding to support installation of BMP infrastructure.

The following actions support the promulgation and implementation of BMPs relevant to the broad range of land uses that occur in the Morro Bay watershed – agriculture, grazing, rural and urban development, boating and harbor management, and municipal wastewater treatment.

Figures 4 and 5: *Examples of Best Management Practices.*

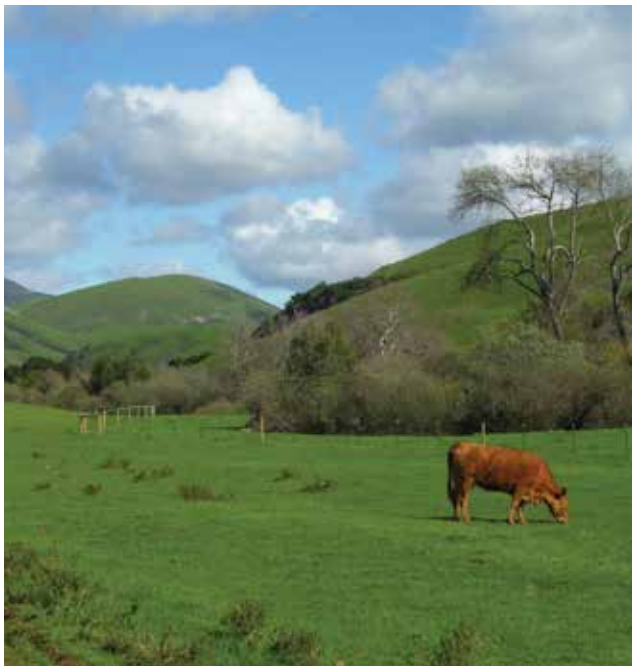


Figure 4 (left): *A common BMP that helps reduce bacteria pollution is riparian fencing. Riparian fencing restricts access by cattle and other grazers to creeks and streams on ranch lands, thus limiting the amount of animal waste that makes its way into waterways. The Estuary Program has helped install more than 11 miles of fencing in the watershed and has built strong working relationships with local ranch owners and managers to do so. Oftentimes, a riparian fencing project will include developing off-creek water sources to provide cattle with alternative water when they are prevented from accessing streams.*

Figure 5 (right): *Another effective BMP implemented in urban areas is Mutt Mitts – specially designed dispensers and bags to encourage pet owners to pick up after their pets in public areas. Waste from pets can be a source of bacteria to nearby water bodies and Mutt Mitts, when used regularly, can play an important role in reducing that source.*

Agriculture And Grazing

Farming and ranching are important land uses in the watershed, creating food for society, providing jobs and economic stability, and preserving the local agricultural heritage. These valuable activities can also impact water quality in creeks and the estuary. Certain farming and grazing activities tend to exacerbate natural erosion rates, accelerating the deposition of sediment in creeks and the bay. Grazing animals that have free access to creeks can be significant sources of bacteria and sediment to the estuary. Many of the fertilizers used in farming can contribute to high nutrient levels in the creeks and groundwater, and certain pesticides can adversely affect specific plants and animals.

Many landowners in the watershed, both public and private, have proactively implemented or supported BMPs to reduce impacts while allowing for continued, effective farming and ranching operations. Rangeland BMPs include riparian fencing and off-creek water sources, riparian re-vegetation, rotational grazing pastures, reduction in grazing intensity, and other pasture management activities. Agricultural BMPs range from the establishment of vegetated creek setbacks to cultivation practices that reduce the need for fertilizers and pesticides. In addition, erosion caused by unpaved ranch roads can be significantly reduced by proper design, and on-site retention ponds can capture sediment before it reaches creeks and the bay.

For over two decades, many organizations in San Luis Obispo County have helped landowners implement BMPs through both technical and financial assistance. The Estuary Program has strongly supported these efforts, partnering with the CSLRCD, the Natural Resources Conservation District (NRCS), the San Luis Obispo Farm Bureau, UC Cooperative Extension (UCCE), Cal Poly, and numerous private landowners. These partner efforts focus primarily on promoting farming and grazing management practices that reduce non-point source pollution. The Estuary Program has also funded educational materials to increase awareness of BMP options, including brochures, workshops, and demonstration programs.

The essential partners in all of these efforts are the landowners themselves, who have altered their practices to benefit the environment while sustaining successful agricultural and ranching practices. Several property owners moved beyond implementing BMPs on their land to actively promoting such practices to their neighbors in the watershed.

BMP-1

Agricultural and Grazing BMPs

Provide technical assistance, financial assistance, and other incentives, including educational outreach through various media, such as workshops and trainings to promote the implementation of Best Management Practices on agricultural and grazing lands in the watershed.

Partners
CSLRCD, UCCE, Farm Bureau, private and public landowners, CCC (including the Watershed Crew), DFW, DPR, Coastal Conservancy, Water Board

Lead
CSLRCD

Timeframe
Ongoing.

Cost
$-$$$
Cost depends on the number and scope of projects undertaken in any given timeframe; typical implementation projects can range from less than $10,000 to well over $100,000.

Implementation Tracking
Acres where BMPs are implemented. Number of each type of BMP implemented by sub-watershed. Acres of stream fenced and re-vegetated. Reduction in amounts of fertilizers, herbicides, and/or pesticides used (if data is collected during implementation projects by the Estuary Program and partners). Miles of dirt roads with BMPs implemented. Number of stream crossings and/or banks repaired and amount of sediment retained. Documentation of relevant outreach and education projects completed. Improved riparian habitat (changes in canopy, plant types, CRAM, etc.), and change in number of acres of riparian habitat.

Funding
Water Board, USFWS, NRCS

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

A variety of BMPs exist to reduce impacts from sedimentation, bacteria, and nutrients. These practices may be implemented voluntarily by willing landowners or may be part of regulatory requirements due to water quality issues. Choosing which BMP is appropriate for a particular landowner depends on the primary water quality issue, type of land use, site and funding constraints, ease of maintenance, proven effectiveness of the design, and regulatory requirements. In addition, water quality regulations may promote the use of specific BMPs for agriculture. BMPs that the Estuary Program may support or help implement include

- Riparian fencing projects coupled with off-creek water systems to keep grazing animals out of creeks and provide an alternative water source
- Re-vegetation of riparian corridors to reduce bank erosion
- Stabilization of failing banks and failing stream crossings
- Rotational grazing plans
- Reduction of grazing intensity, particularly at sites near creeks and streams
- Dirt road erosion prevention tactics, such as rolling dips, sloping, and cross ditches
- Planting of stream buffer zones with native vegetation
- Alternative fertilizer, herbicide, and pesticide application systems to reduce total usage and promote more direct application
- Educational materials and training programs to various partners in the agricultural community

Rural Lands

The Morro Bay watershed remains, in large part, undeveloped or rural lands. Rural lands support a wide range of important activities, including farming, grazing, education, recreation and military training. In the past, the upper watershed was also mined for valuable metals (notably nickel and chromium).

Coupled with important human benefits, these land uses can also exacerbate natural erosion processes by increasing the amount of sediment entering creeks and accelerating transport of sediment to the estuary. The following action plans address three strategic approaches to reduce sediment and heavy metal impacts from the activities mentioned.

Photo : Lynda Roeller

BMP-2

Rural Roads Erosion

Encourage and assist in the implementation of BMPs to reduce erosion from rural roads. *(Related Actions ECR-8)*

Partners
Partners: CSLRCD, UCCE, Farm Bureau, CCC (including the Watershed Crew), Water Board, private and public landowners, AmeriCorps (Watershed Stewards Program)

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$-$$
Educational materials are relatively inexpensive; actual implementation projects can vary widely in cost depending on their nature and scale.

Implementation Tracking
Miles of rural roads upgraded to current BMP standards. Number of crossings and/or banks repaired and amount of sediment retained. Miles of rural roads decommissioned. Miles of road relocated to protect resources and reduce erosion.

Funding
Water Board, USFWS, NRCS

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Unpaved roads, both abandoned and still in operation, lace most of the rural portions of the watershed. These roads constitute a recognized contributor to sediment loading; an assessment done in 2008 documented rural roads as the largest contributors of sediment to fish bearing streams (Pacific Watershed Associates, Inc., 2009). BMPs have been implemented by both public and private landowners to greatly reduce erosion and increase the functional lifespan of the roads. The Estuary Program facilitates the implementation of these BMPs by funding them, wholly or in part, as well as by supporting the distribution of educational materials and related trainings. The Estuary Program will continue to encourage BMPs on rural roads through activities such as:

- Technical and leveraged funding support for rural road improvement by private landowners and public agencies
- Road evaluation and planning assistance to facilitate implementation of BMPs
- Technical support in developing methods to demonstrate success in reducing sediment runoff

BMP-3

Fire Management Plan

Periodically review, update, and help implement a fire management plan for the watershed to reduce erosion following wildfires. *(Related 2012 action: BMP-3)*

Current Status

Analysis determined that the implementation tracking actions for this Action Plan were similar to those for ECR-12 and that the Action Plans were duplicate. Thus, BMP-3 was eliminated and combined with ECR-12.

BMP-4

Mine Remediation

Support the remediation of mines in the upper Chorro Creek watershed to reduce downstream sediment and toxic/heavy metals loads.

Current Status

Analysis determined that no further action is planned by any partners on this issue and that the landowner and regulatory agency consider the issue to be resolved. Thus, the Action Plan is no longer relevant and BMP-4 was eliminated.

Urban

The Morro Bay watershed has a relatively small urbanized area, with approximately 25,000 residents in about 13 square miles adjacent to the estuary. Urbanization has brought many economic and social benefits to the area, including increased tourism capacity, and has resulted in vibrant, livable communities. Urban development has also impacted the surrounding environment, particularly by increasing stormwater runoff volume, velocity, and pollutant loadings. The impervious surfaces associated with development reduce the ability of the land to absorb and filter rainwater. Activities in urbanized areas also contribute non-point source pollutants: fertilizers and pesticides used on lawns and gardens; pet waste; silt and sediment from construction projects; and compounds that accumulate on streets and parking lots from automobiles and trucks, such as chemicals, hydrocarbons, soaps, detergents, and metals.

Urbanization also increases water use from the local aquifer and streams. The Los Osos community uses water from the groundwater basin's lower aquifer and is facing saltwater intrusion issues (ISJ Working Group, 2010). The upper aquifer contains elevated nitrate concentrations that limit its potable use (Cleath and Associates, 2006). Morro Bay relies mainly on imported state water but does pump water from city owned wells in adjacent Morro Creek when state water is not available. As these two urban areas grow in population, water demand will also increase. Conserving local freshwater sources is important to the estuary and the health of local streams that depend on certain minimal flows to support riparian communities. Diminished freshwater inputs to the estuary can increase salinity and detrimentally impact a variety of estuarine species that are adapted to brackish waters.

The introduction and spread of invasive species also increases with urbanization. Many invasive species are initially introduced as landscape plants and thereafter spread to natural areas through rigorous seed dispersal mechanisms. Disturbance of natural landscapes from urban activities, including road construction and recreational trails, can also help spread invasive species, which are generally well-adapted to colonize disturbed areas. Both Morro Bay and Los Osos have a strong history of landscaping with native plants, and awareness of invasive species has increased with outreach and education efforts by the local native plant society, master gardeners, and nurseries. Development and urban landscapes also cause habitat fragmentation, which may limit the ability of species to utilize their full habitat range and lead to further habitat degradation.

The diversity of stormwater, water use, and invasive species impacts in urbanized areas necessitates a comprehensive strategy that combines regulation with community-wide education and outreach, as well as incentive-based and volunteer programs. Practical and cost-effective BMPs are essential to any strategy to control, prevent, and reduce impacts from urbanization while maintaining the social benefits of urban areas.

The Estuary Program has worked with local governments to provide educational materials to residents, property owners and business operators to encourage stewardship and the use of BMPs. One example is the Bayside Living Guide, with more than 20,000 copies distributed. Most of the Estuary Program's literature encourages the use of stormwater BMPs.

Photo : Lynda Roeller

BMP-5

BMPs by Private Landowners and Municipalities

Promote Best Management Practices by property owners, residents, visitors, and businesses in urban areas to reduce impacts to the estuary from stormwater runoff, water use, and the spread of invasive species. *(Related Actions ECR-8)*

Partners
City of Morro Bay, County of SLO, LOCSD, Water Board, and local residents, property owners and business operators

Lead
CSLRCD

Timeframe
Ongoing.

Cost
$-$$

Implementation Tracking
BMP educational materials – number distributed and/or persons reached through different media. Number of BMP projects implemented in each municipality. Reduced amounts of various pollutants in tested stormwater samples. Reductions in domestic water use, as relevant to municipal partner efforts.

Funding
Water Board, USFWS, NRCS

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

All community members play an integral role in sustaining environmental well-being and maintaining the livability and unique connections to the local environment that Morro Bay and Los Osos enjoy. A variety of BMPs can be implemented to address urban impacts from stormwater runoff, water use, and the spread of invasive species. Some examples of appropriate BMPs include

- Education and outreach campaigns to teach practices that reduce stormwater pollutants (e.g., reducing fertilizer and pesticide use, lawn watering, and car washing)
- Support of municipal programs to encourage residents, visitors, and businesses to reduce stormwater runoff and conserve water, in alignment with the County Master Water Plan
- Partnerships with local nurseries to educate the public about invasive species and promote the use of native plants that are drought tolerant and adapted to the local water regime
- Education and outreach programs to encourage reduced water use in the home
- Support of municipal, county, and state efforts to incentivize low impact development and other stormwater management measures taken by individual property owners and businesses
- Development and support of demonstration projects that implement low impact development techniques, such as rainwater gardens, green streets, and other on-site infiltration practices

See also action plans FWR-5 and FWR-6 in the Freshwater Resources section. These action plans also address water conservation.

BMP-6

Reduce Pet Waste

Reduce pet waste entering creeks and the bay through storm runoff.

Partners
City of Morro Bay, County of SLO and LOCSD

Lead
Morro Bay National Estuary Program

Timeframe
Mutt mitts and education are ongoing; dog parks are contingent on local government action.

Cost
$

Implementation Tracking
Number of mutt mitts dispensed and dispensers maintained. Number of educational materials distributed and/or persons reached. Amount of volunteer time and funding donated to support Mutt Mitt program.

Funding
Private Foundations, County of SLO, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The population of household pets is generally much higher in urban areas. The American Veterinary Medical Association estimates that nearly 70% of households nationwide have either a dog or cat as a pet, and many households have more than one pet (American Veterinary Medical Association, 2007). While pets enhance our lives and communities, their waste contributes bacterial contamination to the estuary. The Estuary Program has taken steps to reduce pet waste, principally by coordinating and helping fund the placement of "Mutt Mitt" dispensers at locations popular with dog walkers. The Mutt Mitt program is extremely popular in the community and offers an opportunity to volunteer with or donate to the Estuary Program. The Estuary Program also supports appropriately located and maintained off-leash dog parks. The Estuary Program has partnered with other groups to educate pet owners about the deleterious effects of pet waste and ways to better control and dispose of such waste. Activities that may be undertaken to support this action plan include

- Continuation of the Mutt Mitts program and management of volunteers to support it
- Outreach materials and partnership efforts to educate pet owners about proper waste disposal
- Support for additional off-leash dog parks appropriately located and maintained

BMP-7

Support Stormwater BMPs

Promote Best Management Practices by local governments related to stormwater pollution prevention. *(Related Actions ECR-8)*

Partners
Water Board , City of Morro Bay, County of San Luis Obispo, Local Agency Formation Committee, California Coastal Commission, California State Coastal Conservancy, WCB, DFW, DPR, LOCSD, Los Osos Community Advisory Council (LOCAC), SWAP, Morro Coast Audubon Society, among other public agencies, as well as private landowners.

Lead
Local municipalities

Timeframe
Ongoing.

Cost
$ - $$$
Costs will vary with the nature of particular projects.

Implementation Tracking
Number and type of SWPPP programs put into effect. Estimates of stormwater pollution reduction. Number of training or other efforts to increase local knowledge of evolving practices and technology.

Funding
Water Board, County of SLO, City of Morro Bay

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Pursuant the Clean Water Act and National Pollution Discharge Elimination System (NPDES) requirements, local governments must prepare Stormwater Pollution Prevention Plans (SWPPPs). This applies to the City of Morro Bay, and the County of San Luis Obispo in conjunction with the LOCSD. SWPPPs typically include provisions to limit stormwater pollution from construction and maintenance activities; educational programs to encourage pollution reduction measures by the agency employees and area residents; and upgrades to stormwater collection systems, among other measures. In addition to the SWPPP requirement, local municipalities have emphasized the need for ongoing training so that stormwater managers, as well as consulting engineers, remain current with evolving practices and technology. Trainings and a resource library that consolidates water quality data, implementation effectiveness studies, and up-to-date practices may be important tools for this effort.

The development of regional priorities among stormwater pollution reduction programs is needed. All regional priorities should be informed by SWPPPs, current regulatory requirements, and stormwater environmental issues of greatest concern.

The Estuary Program supports local efforts to strategically plan development, minimize environmental impact, and maximize livability for citizens. A central tenet of such an approach is to encourage development in existing communities (rather than in undeveloped areas). Another tool is to use development practices that minimize impacts. Practices such as low impact development (LID) preserve a site's natural hydrology and landscape and minimize stormwater runoff. A more subtle approach is to infuse within land-use plannings a strong desire to preserve the natural sense of place and encourage development that increases walkability and other livable characteristics of a community. The Estuary Program has hosted trainings for local planners about applying strategic growth principles. The Estuary Program has also worked to limit urban sprawl by preserving greenbelts along the urban limits of Morro Bay and Los Osos (see LP-3).

Activities to help implement this action plan may include:

- Promote training events and programs to increase the technical capacity of local agencies in meeting stormwater permit requirements
- Support for municipalities in meeting education and outreach requirements in stormwater permits, including social-based marketing
- Develop regional stormwater priorities that support local pollution reduction programs and regulations
- Support for increasing access to reports and methodologies explaining successful BMP approaches to pollution reduction

Climate Resilience Considerations
More frequent and intense storms as a result of climate change will increase inputs of stormwater pollution into the estuary and watershed. The Estuary Program has been, and continues to be, involved in the implementation of monitoring of stormwater BMPs. Monitoring stormwater BMPs, such as floodplain restoration and installation of riparian fencing, to effectively manage and mitigate climate change driven stormwater pollution will be promoted and completed by the Program. Reduction in stormwater pollutants will reduce the risk of algal blooms and impacts on sensitive speciies and mitigate these effects to levels below significance. Additional future activities in this area include, support for (1) training events & programs, (2) access to reports & methodologies for pollution reduction, specific to climate resilience, and (3) monitoring stormwater best management practices such as floodplain restoration and installation of riparian fencing in order to effectively manage and mitigate climate change driven stormwater pollution.

Boating And Harbor Management

Commercial and recreational boating activities are the historic essence of the Morro Bay harbor and are critical components of the local economy. Commercial fishing brings jobs and infrastructure, and is a source of local fish for restaurants and residents. Recreational fishing supports local businesses that provide charter trips, boat rentals, and bait and tackle. People who come to fish in Morro Bay often spend money at other local businesses. However, the operation and maintenance of vessels can generate pollution in the bay. Examples of potential pollutants include toxic cleaners and solvents, marine varnishes and anti-fouling paints, batteries, fuels, and lubricants. Furthermore, when boat operators fail to use appropriate waste disposal facilities, human waste and toxic substances often end up in the water. Pollutants, toxic substances, and waste impact water quality, marine life, and commercial enterprises such as oyster farming. Marina and boating-related BMPs can reduce or prevent pollution associated with boats. Many BMPs can be conveniently carried out by boat owners and operators and are currently in use, but some BMPs require more infrastructure (such as convenient waste disposal and vessel maintenance facilities).

A related problem in Morro Bay has been illegal moorings and abandoned boats. A major effort undertaken by DFW, OSPR, and DPR, with the support of the Estuary Program and local agencies, has largely eliminated illegal moorings. In addition, many neglected boats that had sunk or were in danger of doing so have been removed by the City of Morro Bay with funding assistance from the Estuary Program. Nonetheless, in poor economic times and as the commercial fishing industry adapts to new environmental and regulatory situations, the potential for abandoned boats and illegal moorings remains. Abandoned vessels are not only potential pollution sources but can be hazards to safe navigation. The City of Morro Bay and the Estuary Program have created a strong partnership to address the numerous consequences of abandoned boats.

The boating community of the Morro Bay area is a diverse group consisting of recreational and commercial boaters who enjoy one of the most pristine bays on the California Coast. The wide variety of concerns, challenges, and viewpoints of this community must be considered when implementing BMPs and generating education materials.

Photo : Lynda Roeller

BMP-8

Harbor Operations BMPs

Support the implementation of Best Management Practices related to harbor operations.

Partners
City of Morro Bay, DPR, DFW, OSPR

Lead
City of Morro Bay

Timeframe
Ongoing.

The timing of specific projects related to additional facilities is largely contingent on funding.

Cost
$ - $$$
Certain educational projects are relatively low cost; however, major facility upgrades and developing a boat haul-out facility are expensive undertakings and will likely proceed only with additional state or federal grant/loan support.

Implementation Tracking
Use rates of existing facilities. Facilities added or upgraded. Numbers of derelict boats removed and/or illegal moorings removed.

Funding
City of Morro Bay, DBW, Coast Guard

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The City of Morro Bay and its Harbor Department have been strong partners of the Estuary Program and work diligently for efficient, effective, and environmentally protective harbor operations. Three pumpout stations are provided by the City of Morro Bay Harbor Department as waste disposal services to any boat in the bay. The Harbor Department also operated an oil recycling facility, an oil/water separator, and vessel rinse station. Boaters turn in used oil absorbant materials and recieve free replacements through the Harbor Department as well. Derelict and sinking vessels are removed from the bay in partnership with the local Coast Guard station, although these efforts are dependent on available funding. Past partnership efforts include derelict boat removal, illegal mooring removal, and spill prevention and remediation. A variety of BMPs can be implemented at the municipal level to reduce environmental impacts from boat-related activities, and many have already been put in place. Specific activities that may be implemented or continued in the future include:

- Establishing additional and maintaining existing hazardous waste disposal sites, including bayside locations near other marina facilities
- Establishing additional and maintaining existing marine sanitation pump-out stations
- Educating the boating community to encourage the use of hazardous waste and pump-out facilities
- Developing a boat haul-out and maintenance center in Morro Bay, as well as other infrastructure or equipment that support marina BMPs (see also BMP-9)
- Continuing to support the City of Morro Bay in removing, when necessary, illegal moorings and derelict and abandoned boats
- Maintaining plans, equipment, and training for spill prevention and disaster preparedness

BMP-9

Boating BMPs

Support the implementation of Best Management Practices related to commercial and recreational boating.

Partners
City of Morro Bay, DPR, and boat owners

Lead
City of Morro Bay

Timeframe
Ongoing.

Cost
$
Outreach efforts have typically been relatively low cost; maintenance of public facilities and enforcement are much more costly for municipalities to implement.

Implementation Tracking
Outreach projects and the numbers of materials distributed and/or persons reached by various media. Use rates of existing and new facilities related to BMP implementation.

Funding
DBW, City of Morro Bay

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Estuary Program participates in outreach programs to the boating community about best practices to reduce pollution in the bay. These BMPs focus on actions that individual boat owners can take to reduce the environmental impact of boating activities, including sailing, motor boating, fishing, and living aboard a vessel. Outreach and education efforts are most successful when coupled with available adequate facilities for the boating community, as well as enforcement of existing regulations (see also BMP-8). Activities under this action plan may include training community volunteers and educating boaters about:

- Proper waste disposal methods and locations
- How to address an oil or waste spill
- Conducting common maintenance activities (such as paint and hull scraping and the use of toxic paints) in environmentally sensitive ways
- Avoiding the introduction of invasive species
- Observing marine mammals and birds safely and legally while recreating on the bay
- Reducing marine debris from recreational boating activities and protecting eel grass beds

Municipal Wastewater Treatment

The variety of urban and public land uses in the Morro Bay watershed necessitate some centralized wastewater treatment to maintain estuarine, coastal, and stream water quality. Wastewater treatment plants reduce nutrients and bacteria in wastewater, as well as providing recycled water for reuse. Three wastewater treatment plants currently operate within the Morro Bay watershed – the joint City of Morro Bay/Cayucos CSDplant, the Los Osos Water Reclamation Facility, and the California Men's Colony (CMC) plant. The Morro Bay treatment plant is currently in the planning process for a substantial upgrade to meet its existing NPDES permit requirements. The CMC plant was last upgraded in 2007 and is planning an additional upgrade to address chlorine in discharged effluent. The Los Osos facility came online in 2016.

BMP-10

Los Osos Wastewater

Continue to support the implementation of a wastewater treatment facility in Los Osos consistent with permits and plans approved by the County of San Luis Obispo, Water Board, California Coastal Commission, and other relevant agencies.

Current Status

Analysis determined that the Action Plan has been completed. Relevant elements of this Action Plan, specifically implemenmtation activities and tracking metrics, were added to MON-2, MON-3, and FWR-5.

BMP-11

California Men's Colony Wastewater

Continue to support compliance by the California Men's Colony (CMC) wastewater treatment facility with permit standards required by the Central Coast Regional Water Quality Control Board.

Partners
CMC, Water Board

Lead
CMC

Timeframe
Data collection is ongoing.

Cost
$-$$$$
Water quality monitoring and other support efforts can be very affordable.

Implementation Tracking
Demonstrated water quality changes over time.

Funding
CMC, Water Board

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Originally constructed in 1940 by the Department of the Army Corps of Engineers, CMC wastewater treatment plant is now owned and operated by the California Department of Corrections. The plant treats effluent from CMC, Cuesta College, nearby county facilities, and the Camp San Luis Obispo National Guard base. After several upgrades, the plant was rebuilt in 2007 to increase capacity, improve infrastructure, and add oxidation ditches. It is currently designed to handle 1.3 million gallons per day (mgd) of wastewater (San Luis Obispo County, 2008). Treated effluent is used by the County to irrigate Dairy Creek Golf Course, Cal Poly to irrigate fodder crops, and is also discharged to Chorro Creek at a minimum continuous flow rate of 0.75 cubic feet per second. This facility is subject to NPDES permitting through the Water Board. Subsequent regulations added a requirement to maintain 1.4 cfs minimum creek flow (measured at the well fields at Chorro Road) and 0.75 cfs release requirement from Chorro Reservoir.

Wastewater entering the plant is first screened to remove large debris and processed to remove grit and sands. Wastewater then receives oxidation treatment and goes through a secondary clarifier, finally receiving tertiary treatment through a sand filter. Nitrified effluent is then treated with UV light prior to being discharged into Chorro Creek. The discharge to Chorro Creek is beneficial when it meets water quality standards because it increases flow in Chorro Creek and provides significant summertime flow, thus maintaining and enhancing fishery, wildlife, recreational, and other in-stream beneficial uses. Levels of emerging contaminants, such as pharmaceuticals, in the effluent are largely unknown at this time.

CMC works to maintain compliance with permit standards and meet all water quality requirements from the Water Board, especially in regards to the discharge of effluent to Chorro Creek. MBNEP also works to contribute to the monitoring and protect water quality within Chorro Creek through the following actions (See MON, ECR, & FWR Action Plans for more types of projects):

- Water quality monitoring below and above the discharge site on Chorro Creek to determine water quality impacts according to the suite of indicators the Estuary Program monitors
- Data sharing to provide CMC and the Water Board with water quality information
- Implementation of projects to help improve water quality and quantity throughout Chorro Creek, including any supplemental environmental projects proposed in conjunction with CMC. Example of past project are floodplain restoration, rainwater harvesting, stormwater management at the landscape scale to reduce runoff, and irrigation audits.

BMP-12

Morro Bay Wastewater

Provide information, data, and relevant technical expertise to the Central Coast Regional Water Quality Control Board, California Coastal Commission and the City of Morro Bay, during the process to upgrade the Morro Bay wastewater treatment facility.

Partners
City of Morro Bay, California Coastal Commission, Water Board

Lead
City of Morro Bay

Timeframe
Ongoing.

Cost
$-$$$$
Plant upgrades can be costly, but water quality monitoring and other support efforts can be very affordable.

Implementation Tracking
Estuary Program actions to support the installation of a wastewater treatment plant, including data sharing, local water quality monitoring, research support, and facilitating the transfer of relevant knowledge between experts and implementers.

Funding
City of Morro Bay

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

After the California Coastal Commission denied a Coastal Development Permit (CDP) for construction to upgrade the wastewater treatment plant at its existing location in 2013, the City of Morro Bay, formerly in collaboration with the community of Cayucos (as a Joint Powers Authority, or JPA), began planning a new Water Reclamation Facility (WRF). From 2014 through 2016, the City evaluated many potential locations for the new WRF, before choosing the South Bay Boulevard site near Highway 1, based on detailed technical analysis and community-wide input. The site design of the upgraded plant is subject to the results of the currently ongoing (as of December 2012) California Coastal Commission, Water Board, and City of Morro Bay permitting processes. The existing plant has a capacity of 0.97 mgd when treating wastewater to full secondary treatment. Flows above 0.97 mgd receive primary treatment only. The total average dry weather flow capacity of the plant is 2.06 mgd. Primary treated effluent is mixed with secondary treated effluent before being discharged, under an NPDES permit issued by the Water Board, into the ocean through an outfall located 2,900 feet offshore (ESA Associates, 2010). Although the bay does not directly receive effluent, it is possible that the diluted treated wastewater does occasionally enter the bay through the harbor mouth. Furthermore, the effluent may have impacts on the nearshore ocean environment and, thus, could have secondary impacts to flora and fauna in the estuary. Increasing the treatment level of the effluent could have beneficial effects to the estuary. As the plant upgrade will incorporate recycled water distribution into the Morro Valley groundwater basin, the estuary may benefit by eventual elimination of the use of wells adjacent to Chorro Creek. MBNEP also works to contribute to the monitoring and protect water quality of nearby waterbodies through the following actions:

- Provide Estuary Program environmental and water quality monitoring data when requested by the city or regulatory agencies.
- Participate as an active stakeholder in the public process to complete the approvals and implementation of the new wastewater treatment facility.
- Continue to monitor flow in Chorro Creek to inform agencies about possible effects from reduced well usage by the city (see FWR-1 for more information on managing freshwater resources).

Ecosystem Conservation and Restoration

Morro Bay and its relatively undeveloped watershed comprise a remarkable array of habitats, including those of several rare and threatened plant and animal species. These interrelated habitats constitute an ecologically important network that supports rich biodiversity and important ecosystem functions. However, as the local population grows and land uses evolve, the watershed has experienced habitat loss and degradation and loss of critically important species. This loss in biodiversity is a priority issue for the Estuary Program. Human activities and development patterns can cause increased rates of sedimentation and pollution, as well as reduced freshwater flows, all of which impact habitats. By supporting a robust economy and high quality of life, the variety of human uses in the watershed also have great value. Some uses, like recreational activities, may help increase awareness of the value of local habitats and species. This awareness of and connection to the local environment is essential to the efforts of the Estuary Program and its partners to protect and restore habitat.

Impacts to the ecosystem of the estuary and watershed are likely to also come from predicted climate change outcomes. Altered precipitation patterns and more extreme storms events, sea level rise, increased flooding risk, and increased likelihood of fires are all predicted impacts for San Luis Obispo County (Koopman et al., 2010). These changes can have cascading effects throughout the ecosystem, which are described in more detail in the Climate Change section of this chapter.

The wide variety of habitat types found in the Morro Bay watershed are associated with the major landscape features of the estuary and the mountainous ridges of Chorro and Los Osos Valleys. These habitats include those found in freshwater and brackish wetlands, creeks and riparian corridors, and upland areas. Some habitats in Morro Bay, such as estuarine wetlands, native bunchgrass grasslands, and maritime chaparral, have largely vanished from southern and central California, or have been highly altered. The Morro Bay estuary is a rare remnant of these once abundant coastal ecosystems. To protect and restore these rare and imperiled habitats, the Estuary Program uses an ecosystem-based approach that prioritizes preserving ecosystem functions, connectivity between habitats, and the quality and sensitivity of habitat present. Although conservation work, like land acquisitions, is necessarily opportunistic, the Estuary Program strives over time to protect connected and highly functioning habitats across the watershed.

Connectivity is important to reduce population isolation, extinction, and related stresses (such as inbreeding, increased predation, and disease) and preserve biodiversity. Many species in the Morro Bay watershed require large spaces to adequately hunt and breed. When one continuous large space cannot be preserved, the best alternative is preserving wildlife corridors and transition habitats to encourage connectivity. It is also important to prioritize the protection of habitats that provide highly valued ecosystem functions, such as floodplains that help manage flooding and sedimentation to the estuary. These types of functions protect other habitats that benefit from those services, as well as provide human-related benefits (such as reduced flooding).

Identifying and mapping the presence of specific habitats and critical species (especially special status species that are listed as threatened, endangered, or species of concern) is often the first step in protecting these resources. Past Estuary Program efforts include: a detailed wetlands mapping program in cooperation with the California Coastal Commission; upland habitat surveys conducted in the Los Osos area by the Land Conservancy of SLO; and steelhead inventories in various creeks by partner organizations. The Estuary Program supports the continued maintenance and refinement of these data sets and mapping efforts.

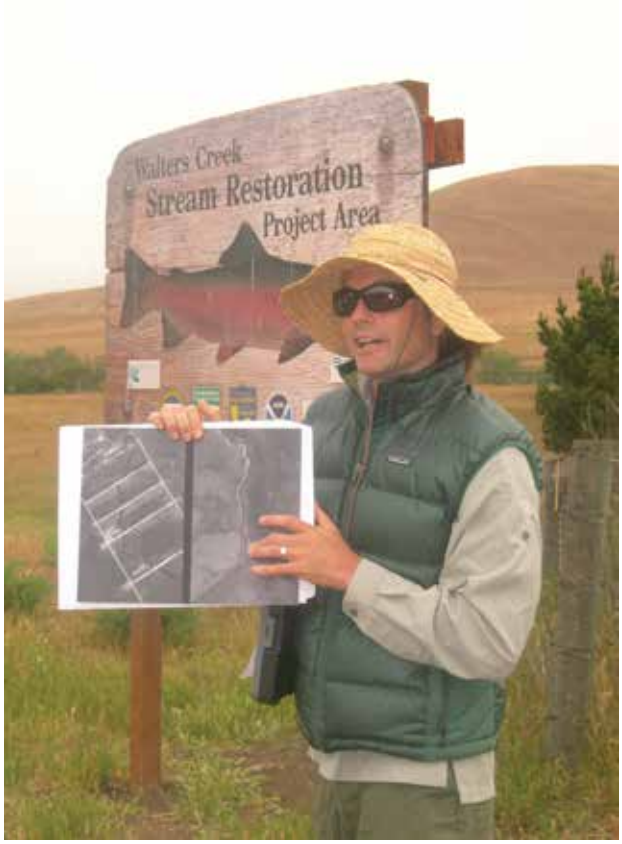
Once habitats and species are known, perhaps the most effective ways of protecting them is through the purchase of critical lands and the purchase of conservation easements (see LP-1). Whether or not habitat is in public ownership, there remains a need for restoration and ongoing maintenance. Thus, the Estuary Program has been involved in a wide variety of restoration programs on both public and private lands, including creek bank repair and erosion control, riparian fencing and re-vegetation, the elimination of barriers to migrating steelhead, and dunes re-vegetation. Frequently, the Estuary Program has partnered with agencies and organizations and has provided technical expertise, funding, and in some cases, grant

management. All of these restoration approaches aim to protect essential habitat, increase connectivity, and preserve or restore critical ecological functions. The action plans in this section broaden the set of restoration tools that the Estuary Program will use beyond those used in the past and incorporate the need for research and data to understand certain complex environmental processes before restoration can achieve the most desirable results.

Riparian

Riparian habitats are comprised of the vegetation and physical features of stream channels, beds, banks, and floodplains. These habitats provide cover and connectivity for in-stream organisms, such as fish and invertebrates, and a variety of birds, mammals and reptiles that use the riparian corridor. Without these corridors, many animals would be unable to migrate between habitats used for grazing, hunting, and breeding.

The Estuary Program and other partners in the watershed place particular emphasis on preserving riparian habitats to help restore healthy steelhead populations in Chorro and Los Osos creeks. Steelhead are an important indicator species of a creek's health because they require low sediment loads, healthy riparian habitat, no migration barriers, high water quality, and adequate freshwater flow. The steelhead in the Morro Bay watershed is the South-Central California Coast distinct population segment and is listed as threatened under the Endangered Species Act. In past efforts, the Estuary Program has contributed technical and funding support for habitat restoration and other implementation projects, and has assisted with grant applications and management and ongoing monitoring of results.



ECR-1

In-stream Habitat

Maintain and enhance in-stream habitat for freshwater aquatic species, including but not limited to streambed composition, riparian corridors and native riparian vegetation, stream geomorphology, water quality, and water temperature. *(Related 2012 action: ECR-2)*

Partners
USFWS, NOAA NMFS, DFW, CSLRCD, Cal Poly, Land Conservancy of SLO, the County of SLO, Fish America Foundation, California Conversation Corps (Watershed Crew), California State Coastal Conservancy, NRCS, UCCE, Water Board, and private property owners.

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$-$$$$

Implementation Tracking
Stream miles restored by specific projects (e.g., re-vegetation, fenced, natural streambed restored, etc.). Miles of riparian corridors enhanced and/or restored. Miles of exclusionary fencing installed. The number of steelhead barriers removed. Number of landownders involved in riparian enhancement projects. Monitoring status of specific projects.

Funding
USFWS, CDFW, NOAA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

High quality in-stream habitat is critical to sustaining native aquatic species, including special status species such as steelhead and California red-legged frogs. Sedimentation, erosion, removal of riparian vegetation, reduced freshwater flow, and increased pollution loads (including toxics and nutrient inputs) can all negatively impact in-stream habitats. The Estuary Program supports and implements projects to eliminate or reduce these impacts and restore natural geomorphology and ecological processes. The Estuary Program also supports activity to maintain and enhance riparian corridors to further achieve these goals. Well vegetated and complex riparian corridors are an important component in the healthy habitat of steelhead and other riparian species. Vegetated riparian corridors maintain bank stability, provide shade for the creek channel, and provide a food base for diverse insect fauna. They also are an extremely important resource for terrestrial animals and birds that use this type of habitat for migration corridors, breeding habitat, and foraging grounds. Activities and projects described in this section are conducted in close partnership with CCC, CSLRCD, Trout Unlimited, Creeklands, NRCS, private landowners, and more. Depending on the project type and expertise availalbe in each organization, different entities may be lead on different projects.

One area of particular concern for steelhead specifically, is the presence of barriers that prevent passage to upstream habitats. A steelhead's ability to migrate upstream is critical to spawning success. Barriers to passage can be in the form of culverts, bridges, waterfalls, or debris jams. The Estuary Program has supported an assessment of existing barriers in the watershed, projects to modify some barriers, and the development of plans for additional barrier removal. Support from the Estuary Program has included direct funding, technical assistance, and grant management. An important issue for further barrier removal has been the presence of the invasive Sacramento pikeminnow that preys on young steelhead and can compete with steelhead for habitat and resources. The Estuary Program has supported research to determine whether or not barrier removal would facilitate the spread of this invasive species. Preliminary results indicate that the pikeminnow's preferred habitat is the warmer waters of the main creek stems, rather than the fast flowing, cold waters of the upper tributaries that the steelhead prefers. These results demonstrate the low risk of an increase in the pikeminnow population and range when removing barriers to steelhead habitat.

Estuary Program activities to implement this action plan may include:

- Implementing riparian restoration projects, such as re-vegetation, bank stabilization, riparian fencing, and off-creek water development
- Reduction of erosion and prevention of other habitat impacts through riparian fencing to deter grazing animals from entering streams
- Reduction of nutrient inputs through BMPs on agricultural fields
- Removal or modification of migration barriers
- Restoration of natural stream geomorphologic patterns
- Using restoration techniques to promote natural opportunities to enhance habitat (e.g., natural sources of woody debris for riparian corridors)
- Implementation of water conservation projects to help maintain flow in streams (see also FWR-5)
- Mapping and removal of invasive species in riparian habitats (see also ECR-16)
- Providing technical assistance and/or funding to support similar projects by private landowners or other partners
- Supporting partners in securing and managing outside funds to complete restoration projects

Climate Resilience Considerations
In stream habitat maintanence and restoration support resiliency in light of future climate projections. For example, floodplain restoration provides benefits to water quality, ecosystem restoration, and water conservation. Riparian fencing installation may help to mitigate the effects of large and intense rainfall events that carry pollutants and erode landscapes. Additional activities for climate resilience may include:

- Continued implementation for restoration projects such as re-vegetation, bank stabilization, riparian fencing, and off creek water development to allow for increased groundwater recharge, filtration of pollutants, important habitat area, refuge during intense droughts, and reduce the risk of food impacts, all in response to climate change

ECR-2

Riparian Corridors

Support the maintenance and enhancement of riparian corridors and native riparian vegetation and the implementation of projects to advance bank stabilization, floodplain restoration, and stream geomorphology restoration.

Current Status

Analysis determined that the implementation tracking actions for this Action Plan were similar to those for ECR-1. Thus, ECR-2 was eliminated and combined with ECR-1.

Wetlands

Wetland habitats are increasingly rare around the world, and particularly so in coastal California. More than 90 percent of California's historic coastal wetlands have been lost or highly altered. Morro Bay represents one of the largest, relatively pristine and intact coastal wetlands complexes in the southern portion of the state. The wide variety of wetland habitat types found in the estuary provides critical feeding, resting, and breeding grounds for resident shorebird species and migratory birds that travel the Pacific Flyway each year.

The Pacific Flyway is one of four major migratory routes in North America and Morro Bay is an important stop for birds traveling south along the west coast. The protected wetlands of Morro Bay are used by nearly two hundred different bird species every winter, some of them threatened or endangered (National Audubon Society, 2010). Some sensitive species that use Morro Bay include the Brown Pelican, American Peregrine Falcon, Black Brant, Western Snowy Plover, and Marbled Murrelet (Sims, 2010).

Tidal mudflats, tidal marshes, seasonal wetlands, and freshwater marshes compose the diverse wetland habitats in Morro Bay. These habitats are characterized by unique salinity and tidal influences and their vegetation communities vary widely as a result. Some sensitive plant species inhabit the Morro Bay wetlands, including Marsh Sandwort, California Seablite, and Salt Marsh Bird's-Beak. In addition to providing bird habitat, wetlands (mudflats and tidal marshes in particular) serve as nursery and foraging grounds for steelhead, tidewater gobies, and a variety of small mammals and estuarine fishes.

In additional to providing indispensable habitat, wetlands serve important ecological functions by filtering nitrogen, phosphorous, and other pollutants out of water entering the estuary from streams, and providing flood protection. Wetlands also store carbon in plant mass (reducing carbon dioxide in the atmosphere) and protect shorelines from erosion. These functions can be reduced or eliminated entirely when wetlands are significantly altered by development, hydrologic changes, increased sedimentation, and high pollutant levels.

ECR-3

Wetlands Protection and Enhancement

Promote wetlands protection and enhancement by encouraging effective management.

Partners
California Coastal Commission, California State Coastal Conservancy, TPL, DPR, DFW, USFWS, County of SLO, City of Morro Bay, Morro Coast Audubon Society, and NMFS.

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$ - $$$$
Certain protection actions, such as the acquisition of shoreline wetlands, are very expensive (see LP-1).

Implementation Tracking
Acres of different wetlands habitat protected or enhanced. Monitoring data shared to support enforcement of regulations. Reductions achieved in pollutant and sediment inputs to wetland areas. Quantification of pollutant loads captured in constructed wetlands for water treatment, if applicable to project.

Funding
California Coastal Conservancy, USFWS, CDFW, NOAA

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The important ecological functions of wetlands, and the high rate of its loss across California, have driven protection and restoration efforts in Morro Bay. Many local organizations have worked toward wetland protection since the 1970s. Past restoration efforts addressed a wide variety of impacts, including increased sedimentation due to altered floodplain regimes, invasive species, and pollution sources. In the future, climate change impacts may transform wetland habitats and reduce ecological functioning. In San Luis Obispo County, sedimentation may increase in coastal estuaries, bird diversity may decrease, estuarine salinity balances may be altered, species composition of specific habitats may change, precipitation patterns will be altered, and sea level rise will occur (Koopman et al., 2010). Without diverse plant community composition and resilient hydrologic cycling, wetlands will be less effective at filtering pollutants, providing flood protection, and reducing erosion. Increased sedimentation may reduce tidal mudflats and other low-lying wetland habitats that provide important feeding and resting grounds for many species. These future conditions are hard to predict, however, as the interplay between climate change and other impacts is largely unknown.

Support for wetlands protection comes from local, regional, state, and national organizations and public agencies. The Estuary Program has worked with this broad array of partners to protect and restore wetland habitats of all types and sizes through land acquisition and restoration efforts that improve water quality and reduce sedimentation. The Estuary Program's future actions must also consider climate change impacts and adaptation approaches. As the Estuary Program continues to work with many partners to protect wetlands, activities may include:

- Appropriate land acquisitions that increase wetland protection in a comprehensive manner (see LP-1)
- Floodplain restoration and other sediment diversion tactics
- Implementation of agricultural, ranching, and urban BMPs to reduce impacts to existing wetlands
- Removal of invasive species in wetland areas
- Restoration projects to return wetland habitats to sustainable hydrologic functioning and a balanced native plant and animal community
- Restoration efforts to enhance active filtration in wetlands by increasing the presence of decomposers (fungi, algae, and invertebrates) that break down pollutants
- Sharing of existing data, as relevant, to regulatory agencies for wetland protection efforts. Data may include water quality monitoring, bioassessment, and CRAM assessments.
- Encourage research efforts to improve active filtration of pollutants in wetlands

Climate Resilience Considerations:
As Morro Bay contains some of the least disturbed wetland systems in California, climate change impacts to wetland areas will present a new suite of stressors to these unique environments that must be considered in order to adaptively manage them. These specific stressors may include, but are not limited to, wetland inundation and saltwater intrustion due to increased storminess and sea level rise, and loss of specialized wetland species due to increased drought conditions and subsequent change in salinity levels. Additional activities and management actions to increase wetland resilience to climate change include:

- Continued collaboration with partners in the implementation of restoration projects to serve as buffers to sea level rise impacts
- Sharing of existing data and providing support, as relevant, to regulatory agencies for wetland protection efforts
- Sharing of existing data and providing support, as relevant, to research partners for understanding of climate change impacts to wetland areas

ECR-4

Wetlands Habitat Assessment

Identify the most valuable shoreline areas to provide sea level rise buffer areas and transition habitats and to create functional connections between ecologically important areas.

Partners
California Coastal Commission, County of SLO, DPR, DFW, SCCWRP, and NMFS.

Lead
Morro Bay National Estuary Program

Timeframe
A map of shoreline buffer areas could be completed by 2025.

Cost
$$
Cost will depend largely on how much of the existing data can be utilized for these expanded purposes.

Implementation Tracking
Defined methodology to asses buffer areas and transition habitats. Map of buffers, transitions and connections.

Funding
California Coastal Conservancy, USFWS, CDFW, NOAA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Transition habitats are dynamic zones that allow migration of organisms and movement of nutrients and energy between established habitats. These zones connect habitats that provide integrated ecosystem functions (Wall, Palmer, & Snelgrove, 2001). Sea level rise will alter tidal habitat areas and cause migration and shifts in habitat. Buffer areas are transitional habitats established between protected areas (such as wetlands) and other land uses, like agriculture or development. Buffers help protect important habitats by slowing or stopping the input of sediment and polluted runoff from nearby land uses. As land uses evolve in the Morro Bay watershed and wetland habitats become even more important in providing essential functions, conservation must evolve as well. Incorporating transition habitats and buffer areas into conservation plans will allow the Estuary Program and its partners to more strategically protect existing wetlands and have greater success in restoring altered wetland habitats.

A preliminary step in this more strategic conservation approach will be to identify areas that provide shoreline buffers and transition habitats. In a related prior effort, the Estuary Program was a partner with the California Coastal Commission and others to comprehensively map wetlands in Morro Bay and to assemble associated data into a Geographic Information System (GIS). This action plan will expand on that work by defining appropriate buffers and transitional habitats that protect and enhance functional connections between these important habitat areas. Activities under this action plan may include:

- Development of an assessment method to define buffer areas and transition habitats specific to the shoreline habitats of Morro Bay
- Mapping of buffer areas and transition habitats determined to support ecological functioning of shoreline areas
- Partnership activities to share information and help increase the amount of buffer and transitional areas protected in and around the estuary

Estuarine

The Morro Bay estuary is a classic estuary, heavily influenced by stream inputs and tidal and wave energy (Gleason et al., 2011). This mix of hydrologic factors supports a diverse range of habitats, including the wetland habitats discussed in the previous section. Other habitats include open water, tidal channels, intertidal sand and mud flats, sand dunes, and coastal dune scrub. As some of the most productive ecosystems in the world, estuaries are extremely valuable for their biodiversity, range of habitats, and diverse ecological functions. Estuaries protect nearby lands from storm surge impacts and sea level rise, and provide water filtration and erosion buffers. Along with these functions, the Morro Bay estuary also support vital commercial and recreation activities, such as fishing, shellfish harvesting, diving, kayaking, and boating.

Land uses and water-based activities can alter some of the functions the Morro Bay estuary provides. Elevated levels of nutrients and bacteria entering streams and the estuary degrade water quality and can cause cascading ecological impacts. Nutrient inputs may come from fertilizers, pet and livestock waste, or nearby septic systems. Increased sedimentation can result from altered landscapes and reduced vegetative cover and cause the estuary to fill in at an unnatural rate. While it is a natural process for estuaries to eventually fill due to sedimentation, the concern in Morro Bay is that the natural processes may be accelerating due to watershed disturbances. Sedimentation can result in the loss of intertidal mudflat and open water subtidal habitat and reduce light penetration to underwater habitats. Accumulated sediment also reduces the tidal volume of the estuary, impacting the ability of water to circulate in and out the estuary at a natural rate. This flushing process is important for maintaining ecosystem functions in the estuary.

These impacts from land uses may be exacerbated by climate change in the coming decades. In San Luis Obispo County, climate change will likely accelerate sea level rise, bring more severe storms, change precipitation patterns, increase sedimentation, and alter the distribution of plants and animals (Koopman et al., 2010). All of these changes have the potential to detrimentally impact the habitats and ecological functions of the estuary. Conservation actions should consider climate change impacts and strive to increase the resilience and adaptability of the estuary to these developments.

Photo : Lynda Roeller

Photo : Dean Sullivan

ECR-5

Sediment Traps

Promote the installation of new and help maintain existing sediment traps to reduce sediment delivery to Morro Bay. Support efforts to reduce erosion from sediment source areas, such as gullies and bank failures.

Partners
DFW, CSLRCD, CCC, California State Coastal Conservancy, NRCS, County of San Luis Obispo, Cal Poly, NMFS, and other property owners in the watershed.

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$ - $$$$
Small-scale projects can be inexpensive while major floodplain restoration may require many hundreds of thousands of dollars.

Implementation Tracking
Number of small-scale sedimentation projects implemented. Estimates of sediment trapped by floodplain restoration and other measurable projects. Monitoring support provided to demonstrate project effectiveness.

Funding
CDFW, Water Board, USFWS, EPA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Reducing sedimentation in the bay calls for an integrated approach that uses multiple methods. The most effective, but also least centralized, method is to control erosion at its source. This method involves implementing BMPs on individual parcels that prevent sediment from entering creeks and tributaries (see BMP-1, BMP-2, and BMP-3). Another tactic is to remove sediment when it reaches the bay by dredging tidal channels. This approach was extensively analyzed in a study, partially funded through the Estuary Program, conducted by the ACOE. The study concluded that most dredging projects would be infeasible due to environmental impacts, regulatory restrictions, adverse public sentiment, and costs (ACOE, 2007). Dredging will likely be limited for the foreseeable future to the ongoing maintenance of navigation channels and the State Park Marina.

A third method is to capture sediment prior to its deposition in creeks or the bay using sediment traps. Traps can be implemented in key locations, like floodplains, to accumulate sediment from large portions of the watershed. There are many other approaches to capturing sediment in the watershed, and every type has environmental and economic costs and benefits that need to be evaluated on a case-by-case basis to determine feasibility for a particular site. Examples of sediment traps include:

- Flood plain restoration
- Sediment capture ponds (including stock ponds)
- Buffer and/or filter strips
- Restoration of riparian vegetation
- Small traps associated with the road network at culvert inlets and along roadside ditches (see BMP-2)
- Road improvement and decommissioning work to keep sediment from moving downstream (see BMP-2)
- Re-vegetation of gullies

The Estuary Program will continue to support both small-scale sediment capture projects on private and public lands as well as the implementation of large scale floodplain restoration. For example, the Chorro Flats project, owned and managed by CSLRCD, restored a floodplain that has captured hundreds of thousands of cubic yards of sediment that would otherwise be deposited in the bay. The restoration of Walters Creek through streambed alterations, re-vegetation, and floodplain restoration was designed to decrease erosion on-site and reduce sedimentation moving downstream. On a smaller scale, the Estuary Program has funded gully repair and stock pond projects, including several through CSLRCD's Project Clearwater that worked with private landowners.

The Estuary Program will continue to support both small-scale sediment capture projects as well as the implementation of large scale floodplain restoration. Activities to implement this action plan may include:

- Landowner support and technical assistance to install sediment capture ponds, buffer or filter strips, road sediment control projects, and gully repair
- Data and technical assistance for large-scale floodplain restoration projects in the watershed
- Land acquisitions strategically located to support sediment control
- Technical and monitoring support for voluntary programs that assist landowners with sediment control

Climate Resilience Considerations
While the accumulation of sediment in estuaries is a process that naturally occurs over thousands of years, accelerated sedimentation has been identified as a climate change impact especially due to increased storminess. Larger storms tend to transport more sediment from the watershed, which could have significant impacts on eelgrass beds, oyster farms, and the bay's circuation and volume. Actions taken to help to further increase climate resilence and mitigate the effects of accelerated sedimentation include:

- Continued support for large-scale floodplain restoration projects in the watershed to reduce the effects of sedimentation while creating and improving habitat in the area

ECR-6

Hydrology and Bathymetry

Support better understanding of the hydrology and bathymetry of the bay, especially accretion patterns and backbay circulation patterns, in order to foster projects that could protect and enhance the ecological functions of the bay.

Partners
DPR, State Lands Commission, Cal Poly, NOAA NMFS, SCCWRP, US Fish & Wildlife Service

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$ - $$$

Implementation Tracking
Mechanisms used to share monitoring data and collect additional data as needed; amount and type of data used. Support (through technical skills or funding) of necessary studies.

Funding
CDFW, Water Board, USFWS, EPA, NOAA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Hydrology and bathymetry play critical roles in maintaining the diversity of habitats, species, and ecological functions of the bay, yet are still not fully understood. As a classic estuary, the basic hydrologic dynamics of riverine and tidal input to the bay are well understood; however, there are still some questions about the relative magnitude of those inputs and how they fluctuate seasonally. Further, interactions between shallow groundwater aquifers and the estuary are only marginally understood. These freshwater-saltwater dynamics greatly affect the species composition and habitat distributions observed in the estuary, as well as the estuary's role in providing flood protection and water filtration.

The hydrology of the bay in turn carves out the bathymetry. Bathymetry measures the variation in depth of the estuary bottom. Although the major navigation channels in the bay are well-charted, many areas of the shallower, southern portion of the bay are less well documented. Furthermore, some areas have frequently changing depth, depending on sediment accretion and tidal scour and erosion.

Depth variation determines the types of habitats and organisms that can exist in different parts of the estuary. This variation is particularly relevant to eelgrass beds, which require specific light penetration and temperature ranges in order to grow. Eelgrass beds provide important food and habitat for a broad array of estuarine inhabitants and are therefore a habitat of particular interest in the bay.

There is an imperative need to better understand the hydrologic circulation and bathymetry of the estuary to accurately determine habitat and species distributions and predict future changes. High-level knowledge of hydrologic patterns and changes in bathymetry over time, due to both natural pressures and human activities, will require very sophisticated data collection and modeling. To support efforts to reach this advanced level of knowledge, the Estuary Program will engage in activities such as:

- Sharing and supporting the collection of monitoring data that demonstrates changes in the bay related to hydrology and bathymetry
- Supporting technical studies of the bay to better understand hydrology and map bathymetry

ECR-7

Eelgrass Data and Research

Provide data and support research efforts to help protect eelgrass and other bay habitats and continue mapping efforts to document changes in the extent and distribution of eelgrass habitat.

Partners
ACOE, City of Morro Bay, DPR, NOAA NMFS, California Coastal Commission, private consultants, SCCWRP, DFW, US Fish & Wildlife Service

Lead
Cal Poly

Timeframe
Ongoing.

Cost
$-$$

Implementation Tracking
Completed mapping efforts on regular basis. Implementation of monitoring efforts and data sharing mechanisms used.

Funding
NOAA, USFWS, EPA, Sea Grant, Private Foundations, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Eelgrass beds supply fundamental food sources and habitat for the diversity of life in the estuary – wading birds, brant, fishes, rays, invertebrates, and more. Fish species diversity and biomass in eelgrass beds significantly exceeds areas where eelgrass has been lost, demonstrating the vital importance of these habitats (Pihl et al., 2006). Eelgrass also stabilizes sediments on the bay floor, reducing erosion in areas with established beds. Morro Bay has previously supported the third largest eelgrass habitat in southern California (Bernstein, Merkel, Chesney, & Sutula, 2011).

Worldwide decline of eelgrass beds has spiked concern about protection and restoration of this essential estuarine habitat, and jumpstarted efforts to determine and mitigate causes of disturbance (Short and Wyllie-Echeverria, 1996). In Morro Bay, mapping efforts revealed a 96% decrease in eelgrass coverage from 2007 (a recent peak year) to 2017 (MBNEP, 2017). Eelgrass decline in Morro Bay likely stems from a confluence of factors, but known impacts include increased sedimentation (which reduces light availability to the submerged plant), elevated nutrient concentrations from runoff, shading from boat moorings or piers, disturbance from dredging activities, wasting disease, and scarring of eelgrass beds by boat propellers (MBNEP, 2011).

Climate change will also impact eelgrass, although specific changes in distribution are difficult to predict. Changes in sedimentation and precipitation patterns may stress existing beds and sea level rise will likely alter the areas that are suitable for eelgrass growth.

Dredging uniquely impacts eelgrass in Morro Bay because navigation channels are dredged on a regular cycle to maintain maritime safety and usability. Dredging beneficially maintains tidal flushing in the bay, but the movement of sediment during the process can smother eelgrass beds. Dredging can also impact eelgrass beds through direct removal or by causing beds to collapse from lack of stability of the substrate. The City of Morro Bay and the ACOE adhere to legal requirements for avoiding eelgrass and mitigating observed impacts. The Estuary Program provides data from regular mapping efforts to inform planning and supports monitoring efforts to track the health of beds throughout the bay. Maintaining vibrant eelgrass beds in Morro Bay is a high priority for the Estuary Program and data sharing is aimed at minimizing impacts to the maximum extent possible.

The Estuary Program will continue long-term efforts to track changes in the health of eelgrass and other bay habitats to determine the cause of eelgrass decline and to inform management and restoration decisions. Actions to protect eelgrass can also include:

- Acquiring multispectral aerial imagery of the bay during relevant tidal and seasonal conditions
- Maintaining current classification techniques to ensure accurate mapping
- Sharing mapping data through reports and other data exchange mechanisms
- Strengthening monitoring efforts of eelgrass beds and algal communities
- Monitoring health of eelgrass beds and supporting related research efforts

ECR-8

Eelgrass Restoration

Encourage and implement restoration to improve the quality and quantity of eelgrass habitat.
(See BMP-5, BMP-7, BMP-9, ECR-5, and ECR-6 Action Plans for more types of projects)

Partners
NOAA NMFS, Cal Poly including SLOSEA, City of Morro Bay, DPR, DFW, SCCWRP, Elkhorn Slough NERR

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$$-$$$

Implementation Tracking
Use of monitoring and mapping data to support restoration and research efforts. Regular reporting on eelgrass progress.

Funding
NOAA, USFWS, EPA, Sea Grant, Private Foundations, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The recent declines in eelgrass coverage in Morro Bay heightened concerns for the sustainability of this essential estuarine resource (see ECR-7). The precise causes of decline are difficult to pinpoint, especially considering the wide range of locations in which eelgrass beds are found in the estuary. More specific information is needed regarding causes of decline and successful restoration methods before restoration projects are undertaken. Still, the Estuary Program is committed to taking proactive steps to help protect and restore eelgrass habitat in the Morro Bay estuary, and will work toward developing a stronger understanding and a strategic approach to addressing this issue.

The Estuary Program has systematically mapped the location and evaluated the robustness of eelgrass beds on a regular basis. The Estuary Program has also supported research into how various environmental factors affect eelgrass productivity. Continued mapping and additional local studies are needed to understand causes of decline and the most effective restoration approaches to improve the quality and quantity of eelgrass beds. Some activities that the Estuary Program may engage in to support restoration efforts include:

- Analysis of long-term eelgrass mapping to inform restoration decisions
- Monitoring and technical support of restoration efforts
- Restoration pilot projects to determine most effective restoration methods

Climate Resilience Considerations
Several habitat types in Morro Bay—brackish wetlands, salt marsh, mud flats, eelgrass beds, coastal dunes complexes, and maritime chaparral—are quite rare in southern and central California. The expected impacts of climate change to these unique species and habitats, in particular eelgrass beds, range from accelerated sedimentation, warmer temperatures, and sea level rise. Increased sediment can impact eelgrass through depth changes, reduction of light penetration, and direct siltation on top of eelgrass. Warmer temperatures can favor pathogens and diseases in the estuary and impact oxygen concentrations, further contributing to eelgrass health declines in the bay. Sea level rise and increased water depth in the estuary may cause a shift in suitable habitat for eelgrass. Additional program actions to help increase climate resilence and mitigate the effects of climate change on eelgrass include:

- Continued monitoring, research, data sharing, and restoration efforts as climate science and understanding of effects to eelgrass health continues to improve. Implementation of adaptive management strategies and restoration projects to protect key eelgrass habitat areas and maintain ecosystem function as the understanding of climate science and effect of impacts on eelgrass continues to improve

ECR-9

Regional and National Collaboration

Support regional and national efforts to promote estuarine conservation and restoration.

Partners
ANEP, USEPA, NERRA, NOAA (including Fisheries, National Marine Sanctuaries, NERRs, and Coastal Zone Management), USFWS, California State Coastal Conservancy, California Coastal Commission, Ocean Protection Council, TNC, DPR, DFW, Land Conservancy of SLO, CSLRCD, Salmonid Restoration Federation, Tri-County Fish Team, San Luis Obispo Steelhead Initiative, San Luis Obispo County Weed Management Area,and other watershed organizations.

Lead
ANEP

Timeframe
Ongoing.

Cost
$

Implementation Tracking
Participation in regional and national programs.

Funding
EPA, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

As a member of the National Estuary Program, the Estuary Program has a unique opportunity to engage with estuary conservationists and policy makers around the nation. The 28 National Estuary Programs (NEPs) that exist across the country formed the Association of National Estuary Programs (ANEP) and meet annually to share lessons learned and develop partnership opportunities. This network allows the NEPs to advance and share scientific research, practical approaches to conservation, education and outreach strategies, and organizational capacity-building. Furthermore, as one organization, the NEPs can advance national efforts to conserve and restore estuaries more effectively than they each could alone. The Estuary Program will continue its active role in ANEP and the USEPA's National Estuary Program and strengthen its other national partnerships (with entities such as the Coastal and Estuarine Research Federation and NOAA's National Estuarine Research Reserves, National Marine Sanctuaries, Fisheries, and Coastal Zone Management programs).

In addition to national-level affiliations, the Estuary Program strives to support nearby partners to leverage local conservation efforts into regional collaborations. With scarce funding and reduced capacity in many organizations, regional cooperation can vastly elevate the success of conservation efforts. The Estuary Program supports regional efforts to better conserve coastal watersheds and small coastal estuaries and wetlands through information sharing, capacity building, and leveraging funding. The Estuary Program participates in regional entities such as San Luis Obispo Steelhead Initiative, Tri-County Fish Team, San Luis Obispo County Weed Management Area, and Salmonid Restoration Federation.Other strong partnerships include key state agencies, especially the California State Coastal Conservancy, California Coastal Commission, Ocean Protection Council, Department of Parks and Recreation, and Department of Fish and Wildlife.

Future efforts to continue national and regional collaborations may include:

- Membership in ANEP, Coastal and Estuarine Research Federation, and other organizations
- Attendance at national and regional meetings and conferences
- Continuation and improvement of established data sharing mechanisms between partners
- Collaborative funding applications and project implementation
- Participation on national and regional policy recommendation committees focusing on estuarine conservation and restoration priorities
- Collaboration on regional and national education and outreach efforts that are relevant to Morro Bay

ECR-10

Nutrient and Bacteria Dynamics

Better understand nutrient and bacteria dynamics of the estuary.

Partners
Cal Poly, CDPH, Water Board, California State Water Board, SCCWRP

Lead
Water Board

Timeframe
Ongoing.

Cost
$-$$

Implementation Tracking
Completion of bacteria sources studies. Continuation of monitoring with sharable results and spatial integration with hydrologic studies. Actions taken to support establishment of NNE criteria.

Funding
EPA, Water Board, Sea Grant

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Freshwater inputs to Morro Bay can contain elevated levels of pollutants, primarily nutrients and pathogens. Long-term monitoring by the Estuary Program and partners documents the elevated presence of these pollutants in municipal stormwater runoff, streams, and the estuary of Morro Bay. The precise dynamics of pollutants reaching the estuary are complex due to the variable environmental conditions that influence water delivery, retention, and circulation in the bay, as well as nutrient cycling. A stronger understanding of these dynamics – upland sources, transport rates, retention time in the bay, and relations to seasonal and weather changes – will inform more effective pollution reduction measures.

Climate change impacts to the circulation and hydrology of the bay, as well as precipitation patterns, will likely alter nutrient and bacteria dynamics in the future. Although the outcomes of such changes are unknown at such a small, detailed scale, continuing to develop clear climate change predictions will aid in planning for bacteria and nutrient impacts.

Particular efforts that may help implement this action and are in the Monitoring Plan include:

- Supporting bacteria source studies
- Continuing to support the development of numeric nutrient endpoint (NNE) criteria by the State Water Resources Control Board and the Southern California Coastal Water Research Project
- Maintaining monitoring of bacteria and nutrients in source waters and in the estuary to track changes over time
- Aligning monitoring and bacteria and nutrient studies with hydrologic studies of the bay (see ECR-6)
- Supporting climate change studies to better understand hydrological changes in the bay that may influence bacteria and nutrient dynamics

ECR-11

Conserve Ecosystem Functions

Implement activities to restore and conserve the balance of ecosystem functions of the estuary. *(Related Actions ECR-5, ECR-6, ECR-7, ECR-8)*

Partners
DPR, DFW, State Lands Commission, California Ocean Protection Council, California Coastal Commission, Land Conservancy of SLO, CSLRCD, TNC, California State Coastal Conservancy, CCC, NOAA, NOAA NMFS, Water Board, USEPA, USFWS, USGS, Cal Poly, Morro Coast Audubon Society, SWAP, CAPE, SLOSEA, City of Morro Bay, LOCSD, County of SLO

Lead
Morro Bay National Estuary Program

Timeframe
Contingent on the identification of particular projects, an evaluation of net benefits, and availability of funding.

Cost
$$-$$$$
The cost of project identification and assessment will likely run in the range of $100,000 and actual implementation of even small-scale projects would almost certainly exceed that.

Implementation Tracking
Status of identification of potential projects; status of implementation for specific projects undertaken. Use of monitoring data and analysis to inform restoration projects. Use of climate change modeling results to inform restoration projects.

Funding
California Coastal Conservancy, USFWS, CDFW, NOAA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Habitat restoration achieves limited results if it lacks a holistic, ecosystem-based approach. Only by striving for a well-balanced system can restoration and conservation succeed in bringing about stable and functioning habitats. The Estuary Program strives to implement such an approach in order to sustain the estuary's essential ecosystem functions. Ecosystem functions are physical, chemical, and biological processes that maintain the inherent stability of the ecosystem. These functions impart ecological benefits, such as suitable habitat, food sources, and nutrient cycling, but they also provide human advantages. For example, the estuary's ability to absorb tidal fluctuations and hydrologic changes protects the nearby shoreline from flooding and erosion. Nutrient cycling and water filtration in wetlands help maintain safe water quality for boating and fishing. Focusing on ecosystem functions helps direct conservation efforts toward balanced ecosystem goals. For instance, a project designed to improve specific wetlands habitat can also improve the estuary's resilience to sea level rise if the project is planned with that broader purpose.

Such an approach to conservation requires a wide range of reliable data, including water quality data, species distribution mapping, and community interaction information. The Estuary Program strives to collect data in a manner that is suitable to this integrative approach and encourages local partners to do the same.

Education and outreach activities support successful ecosystem-based restoration efforts. Community restoration projects improve habitat while increasing awareness of local ecosystem processes and issues. Outreach efforts help reduce impacts to publicly accessible restoration sites. Successful restoration projects can serve as important demonstrations about how to implement specific techniques.

Activities to support this action plan may include:

- Support of localized climate change modeling to predict impacts to estuary ecosystem functions
- Monitoring, data collection, and integrated analysis that inform strategic restoration activities
- Implementation of restoration activities to protect key habitats and maintain ecosystem functions
- Completion of community-based restoration projects
- Promotion of successful restoration projects to demonstrate how they have benefitted the area for local and regional partners

Climate Resilience Considerations
Climate change impacts will alter the ecosystem functions the estuary provides on a system wide scale. Rising sea level will change flooding and circulation patterns. Precipitation and temperature changes will influence species and habitat distributions, migration patterns, and flooding regimes. Freshwater availability may re-orient development and land uses in the watershed, changing the impacts of those human activities on the environment. Planning for these changes not only requires long-term data sets to indicate trends, but also localized modeling. Activities to support climate resiliency include:

- Implementation of ecosystem wide adaptive management strategies and projects to protect key habitats and maintain ecosystem function as the understanding of climate science continues to improve
- Work with partners to identify areas that are suitable for land preservation, or easements to increase ecosystem resiliency

Upland

Above the estuary and streams of the Morro Bay watershed, a myriad of Mediterranean coastal habitats exists – coastal dune scrub, maritime chaparral, oak woodlands, and perennial grasslands. These upland habitats mold the nature of the estuary itself. All the freshwater entering the estuary runs through parts of these habitats. The geologic nature of the upper watershed influences weather and precipitation patterns that in turn impact the estuary and the organisms depending upon it. Each of the upland habitats harbors a specific array of plant and animal species, and many of these species require a combination of habitats and are endemic to the region. This interrelation between upland habitats, and between the upper watershed and the estuary below, makes conservation in this region essential.

Sources of degradation in upland habitats can include introduction of invasive species, overgrazing on ranchlands, residential and agricultural development, and outdoor recreation. Erosion in this region contributes to sedimentation in the estuary (see Chapter 2, Sedimentation). This natural process is exacerbated by an altered fire regime, where natural fire cycles are suppressed to protect important land uses. The Morro Bay watershed also encompasses some unique land uses in upland habitat areas, including higher education facilities (Cal Poly and Cuesta College), a California state prison, and a California National Guard base. Each of these longstanding entities has afforded varying levels of protection to different habitats and maintains some open space. The unique conservation needs of lands under each of these uses necessitate individualized approaches. The Estuary Program has a long history of maintaining strong working relationships with each of these entities to advance conservation goals.

As is true for other habitats in the watershed, upland areas will also be significantly altered by climate change. Perhaps the biggest factor in this region will be changes in precipitation patterns. Current predictions indicate hotter, drier and longer summers, more severe winter storms, and declines in freshwater availability. Such developments will change species distributions and habitat compositions and may cause range reductions of some habitats. In addition, increased wildfires may occur. Predicting the consequences of such changes is exceedingly difficult, but increasing adaptability and resilience in natural systems may help mitigate the impacts.

ECR-12

Upland Habitats

Conserve and restore ecologically significant upland habitats, including but not limited to dunes scrub, maritime chaparral, oak woodlands, and native perennial grasslands and support their preservation and enhancement.

Partners
County of San Luis Obispo, City of Morro Bay, LOCSD, Morro Coast Audubon Society, SWAP, DFW, DPR, California Native Plant Society, California Coastal Commission, California State Coastal Conservancy, Wildlife Conservation Board, USFWS, Land Conservancy of SLO, TPL, TNC, CCC, Cal Fire, USDOF, BLM

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$ - $$$$
Costs vary widely with the particular project; certain regulatory and educational programs are relatively low cost while land acquisitions often well exceed $1.0 million.

Implementation Tracking
Acres of different upland habitats protected or restored. Education and outreach activities implemented.

Funding
WCB, USFWS, CDFW, Water Board

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Morro Bay and its watershed support a wide array of important, and sometimes very rare, habitat types. Among the rarest types include the coastal dunes complexes and maritime chaparral. These habitats support numerous special status species and important ecological functions.

The Estuary Program may engage in activities such as the following to conserve upland habitats:

- Targeted land acquisitions, conservation easements and other tools to limit urban development in the upper watershed (see LP-1)
- Assisting with implementation of relevant species recovery plans (see ECR-14)
- Educating the community about upland habitats and how to enjoy them without harming them
- Continue monitoring to identify significant habitats and their level of impairment
- Supporting the identification and removal of invasive species (see ECR-16)
- Supporting proactive measures to promote fire management that preserves natural processes and protects land uses.
- Implementation and evaluation of restoration projects to reduce fire risk
- Continued implementation of fire education and awareness efforts

Climate Resilience Considerations
Conservation of these lands and their ecological functions must incorporate and consider climate change impacts, fire management, and current and future land uses. Additional activities to support this action plan and promote climate resilience and the upper watershed include:

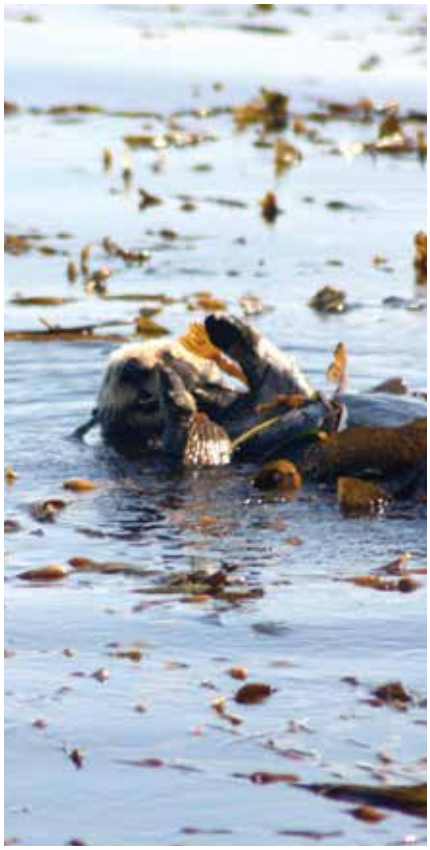
- Working with partners to provide information for fire management planning efforts.
- Providing technical assistance and support to farmers for grazing managagement practices in the upper watershed in order to reduce bacteria and accelerated sedimentation
- Assessing sedimentation impracts from the upper watershed so that sources can be addressed to minimize impacts to the creeks and the lower watershed as a whole

Special Status Species and Recovery Plans

State and federal regulations protect specific species due to concerns about the viability of their populations and habitats. These species may serve as indicators for the health of a habitat or ecosystem, or may even play the role of keystone species. Keystone species are essential to maintaining the balance of an ecosystem or habitats, and often impact their habitat in a manner that is disproportionate relative to their abundance. Special status species play an important role in conservation because requirements to preserve their habitat often facilitate broader conservation and restoration activities.

Federally listed species are covered by the Endangered Species Act, and can be listed as threatened or endangered. The federal Marine Mammal Protection Act also affords particular protections to marine mammals. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future. In California, species can also be listed as endangered or threatened under the California Endangered Species Act. California also lists "species of concern" and "taxa to watch"as well as "sensitive species" that require special protection. These designations stem from executive regulations, rather than legislation. Furthermore, many national and international conservation organizations, such as National Audubon Society, International Union for Conservation of Nature, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora, maintain lists of species at varying levels of concern. Designations on these lists are usually supported by scientific research and monitoring.

The Endangered Species Act requires the development and implementation of approved recovery plans for all listed species. These plans aim to protect and expand habitat and may include site-specific actions to improve the species' populations enough to be de-listed.



ECR-13

Population Dynamics

Develop a better shared understanding of population dynamics of special status species populations in the estuary and watershed.

Partners
California Coastal Commission, Land Conservancy of SLO, DFW, USFWS, NOAA NMFS, City of Morro Bay, County of San Luis Obispo, LOCSD, CSLRCD, California Native Plant Society, San Luis Obispo Steelhead Initiative Cal Poly (including SLOSEA and the Coastal Resources Institute).

Lead
USFWS

Timeframe
Ongoing.

Cost
$$

Implementation Tracking
Maintenance of special status species and habitat inventories and datasets. Research projects related to population dynamics. Participation or membership in collaborative groups related to special status species recovery. Participation in data sharing partnerships with regulatory and management agencies in support of special status species conservation.

Funding
USFWS, CDFW, NOAA

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Protecting special status species in the Morro Bay area depends on sound science, especially the specific understanding of how populations are affected by environmental and land use changes in the local context. Special status species include those listed as endangered or threatened at the state or federal level, as well as species that are considered rare under California's Environmental Quality Act Guidelines. Species recognized as sensitive or of special concern due to limited distribution or lack of adequate information are also recognized by DFW. This knowledge is essential to formulating viable protection and enhancement strategies and implementing recovery plans. A strong dataset of the locations and abundance of special status species is also valuable to local managers and regulators who need to meet requirements for the protection of these species, including mitigation of adverse impacts, when permitting or implementing various land uses.

An important step in developing a better shared understanding of these populations involves inventorying the distribution and numbers of special species and their habitats. The Estuary Program has helped implement extensive mapping and data collection efforts throughout the Morro Bay region. For example, staff and volunteers have mapped the location of eelgrass beds in the bay. The Estuary Program also helped fund upland habitat mapping around Los Osos. The Estuary Program funded an atlas of special status species in Morro Bay, developed in partnership with the San Luis Obispo Coast District of California State Parks. In addition, the Estuary Program implements and supports education and outreach projects that increase public awareness of special status species and how to best protect them. An example of such an effort is the Estuary Program's support of the Montaña de Oro State Park's monitoring and education effort to protect the threatened Western Snowy Plover.

Protecting special status species can drive larger efforts to conserve important ecological functions and habitats. Activities to strengthen a collective understanding of special status species populations and how they relate to broader conservation efforts may include:

- Refinement and improvement of existing special status species knowledge, including mapping datasets and determining population viability (See ECR-14 for species examples)
- Support for collaborative groups that share knowledge about special status species, such as the San Luis Obispo Steelhead Initiative or the Invasive Species Action Network (see ECR-16)
- Sharing of technical knowledge and data to support studies of special status species populations
- Conservation planning efforts to determine linkages between targeted special status species populations and critical ecological functions and habitats important to a wide variety of species
- Technical and data support for municipalities and regulators enforcing the protection of local special status species
- Education and outreach efforts to increase awareness of special status species on publicly accessible land and to encourage stewardship-oriented behaviors

ECR-14

Support Recovery Plans

Support the implementation of species recovery plans, including local steelhead.

Partners
Organizations responsible for the development and implementation of species recovery plans in the Morro Bay area include USFWS, NOAA NMFS, DFW, County of SLO, CCC, and the LOCSD.

Lead
NOAA

Timeframe
Ongoing; see table above regarding current status of different recovery plans.

Cost
$ - $$$$
Cost varies with each recovery plan; some implementation actions such as educational outreach are relatively low cost while others such as land acquisition are expensive.

Implementation Tracking
Implementation of recovery plan actions as are feasible for the Estuary Program to support. Technical and data support provided for plan development when available.

Funding
USFWS, CDFW, NOAA

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Morro Bay Estuary supports habitat for 15 federally listed species, some of them found nowhere else in the world. The federal Endangered Species Act directs the U.S. Fish and Wildlife Service (USFWS) and NOAA National Marine Fisheries Service (NMFS) to prepare recovery plans for all federally listed species under their jurisdiction. The following table shows the status of listed species present in the watershed.

Species	Federal Status	Recovery Plan Status
Morro Bay kangaroo rat	endangered*	Final, 1982; under revision, 1999
Morro shoulderband snail	endangered*	Final, 1998
California sea-blite	endangered*	Final, 2013
Morro manzanita	threatened*	Final, 1998
Indian Knob mountainbalm	endangered*	Final, 1998
Chorro Creek bog thistle	endangered*	Final, 1998
Least Bell's vireo	endangered	Draft, 1998
Western snowy plover	threatened	Final, 2007
California brown pelican	endangered - delisted	Final, 1983; Delisted November 17, 2009
American peregrine falcon	endangered - delisted	Final, 1983; Delisted August 25, 1999
Marbled murrelet	threatened	Final, 1997
Salt marsh bird's-beak	endangered	Final, 2013
Marsh sandwort	endangered	Final, 1998
Southern sea otter	threatened	Revised Final, 2003
California red-legged frog	threatened	Final, 2002
South-Central CA steelhead	threatened	Final, 2013
Southwestern willow flycatcher	endangered	Final, 2002
Tidewater goby	endangered	Final, 2005

*Endemic to the vicinity of the Morro Bay Watershed.

The Estuary Program has provided both technical and funding support for recovery plan design and implementation. For example, the Estuary Program provided funding and technical assistance for steelhead inventories and recovery work by CSLRCD, in cooperation with DFW and NOAA NMFS. The Estuary Program has also helped implement recovery plans for shoulderband snail and Morro manzanita through funding and partnership support for the purchase of properties essential to the ongoing survival of these species (see LP-1). The Estuary Program will continue efforts to support the implementation of recovery plans, with actions such as:

- Collaborative funding and technical assistance for species inventories and other efforts to inform recovery plans
- Implementation of recovery plan actions – some examples include:
  - Invasive species removal, such as Sacramento pikeminnow
  - Steelhead barrier removal and population assessment
  - Preservation of habitat through land conservation (see LP-1)
  - Technical support for the development of land use protections for specific species
  - Consideration of special status species when designing restoration or BMP projects
- Outreach and education efforts about the status of listed species and how to best protect them

ECR-15

Steelhead Barriers and Habitat

Remove barriers to steelhead migration and enhance and maintain in-stream habitat for steelhead and other aquatic species.

Partners
USFWS, NOAA NMFS, DFW, CSLRCD, Cal Poly, Land Conservancy of SLO, County of SLO, Fish America Foundation, Tri-County Fish Team, CCC, Creek Lands Conservation, , Trout Unlimited, California State Coastal Conservancy and private landowners.

Lead
Creeklands Conservation

Timeframe
Ongoing.

Cost
$$

Implementation Tracking
Miles of stream made accessible by barrier removal; status of specific projects. Miles of in-stream habitat restored or enhanced.

Funding
USFWS, CDFW, NOAA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

In the Morro Bay watershed, many obstructions to steelhead passage still exist, often related to abandoned agricultural diversions or aging road crossings. The Estuary Program uses the California Fish Passage Assessment Database, field observations, and surveys by the CCC and other partners to determine barriers. Steelhead swim up freshwater streams to spawn and their spawning habitat requirements are specific – consistent flow, high dissolved oxygen levels, gravel substrate with little fine sediment, and good general water quality. In-stream structures that prevent steelhead from swimming upstream limit available spawning habitat, thus limiting the population as a whole. The National Oceanic and Atmospheric Administration (NOAA) recognizes migration barriers as significant threats to the species' recovery from its threatened status under the Endangered Species Act (NOAA NMFS, 2007).

The Morro Bay watershed provides important habitat to steelhead, especially in the face of climate change. Access to a wide variety of coastal watersheds will provide steelhead with a range of adaptation opportunities as precipitation and temperatures patterns evolve. The South-Central California Coast steelhead that inhabit the Morro Bay watershed can live in warmer water with less than optimal dissolved oxygen levels, in comparison to other steelhead types. These unique characteristics may make the South-Central California Coast steelhead more capable of adapting to some climate change impacts. This adaptability highlights the importance of preserving this particular steelhead type. The Morro Bay estuary is also important to steelhead because it ensures year-round access for trout to swim upstream. In other locations along the southern coast, coastal bays become too dry in the summer to maintain connections to stream mouths.

The Estuary Program has supported several projects to remove barriers through direct funding, technical assistance, and grant management. An important issue has been the presence of the invasive Sacramento pikeminnow and the possibility that barrier removal would facilitate the spread of this invasive. Preliminary results indicate that the pikeminnow's preferred habitat is the warmer waters of the creek mainstems, rather than the fast flowing, cold waters of the upper tributaries that the steelhead prefer, so removing barriers would not cause significant pike minnow migration up stream (see also ECR-1).

Pikeminnow management efforts conducted since 2016 demonstrate that multiple methods can be used together to effectively reduce the pikeminnow population in Chorro Creek. Multi-pass electrofishing is used in reaches that have a high abundance of pikeminnow and are less than 4 ft deep. Some reaches are treated with single pass electrofishing and in deeper pools angling is used to capture large individuals. If funding and acess are available, gill nets can be deployed to capture pikeminnow from the Chorro Reservoir. The application of these methods is informed by snorkel surveys and NOAA guidance on appropriate use.

The Chorro Creek watershed has several factors that provide a higher potential for steelhead recovery and resiliency than in other watersheds within the Biogeographic Population Group (BPG). These factors include 1) perennial and continuous flows in the mainstem downstream of the Waste Water Treatment Plant, 2) year-round migratory connectivity to a productive estuary (Morro Bay), 3) dense riparian canopy, 4) moderate summer water temperatures, 5) suitable steelhead rearing habitat, and 6) a relatively small urban footprint. We know that pikeminnow pose a severe threat to steelhead in Chorro Creek, and we have seen steelhead abundance increase dramatically following pikeminnow suppression efforts. Therefore, we believe that there is strong evidence that continued pikeminnow management efforts in Chorro Creek is a critical action to support steelhead recovery in the BPG.

Activities to support this action plan may include:

- Technical assistance and leveraging funding for barrier removal and in-stream habitat improvements
- Implementation of barrier removal and in-stream habitat improvement projects
- Monitoring support for implemented projects and to help prioritize future projects
- Support for population studies to determine project placement and effectiveness

Invasive Species

Invasive species are non-native plants and animals that can deteriorate natural systems, reducing biodiversity and impacting ecological functions. Many introduced for specific purposes (such as windbreaks or pest controls) are now rapidly converting native habitats into less desirable systems. One example is the introduction of veldt grass as a forage crop and erosion control – the plant is now taking over unique coastal dune scrub habitat and reducing it to monoculture grasslands with little ecological value (Hall, 2010). The habitat provided to key species by dune scrub areas is badly impacted.

Invasive species also impact economic uses in the watershed. Noxious weeds such as yellow star thistle and purple star thistle reduce productivity of rangelands because cattle and other grazing animals will avoid eating them. Many invasive species, such as Arundo donax (giant reed) and blue gum eucalyptus, are much more flammable than native species and spread wildfires more quickly.

Climate change impacts in San Luis Obispo County, such as hotter, drier, and longer summers and altered precipitation patterns, may provide conditions that are more favorable to invasive species than native ones. In addition, exotic species that are not yet invasive may become so if climate change creates their preferred conditions. This is a serious threat because invasive species are extraordinarily difficult, and often practically impossible, to eradicate once they become established.

ECR-16

Invasive Species Action Plan

Develop, periodically update, and implement an invasive species action plan for the estuary and watershed.

Partners
DPR, Land Conservancy of SLO, SWAP, Camp San Luis, CCC, County Department of Agriculture, Morro Coast Audubon, California Native Plant Society, DFW, California Invasive Plant Council, California Invasive Species Council

Lead
Morro Bay National Estuary Program

Cost
$ - $$$
Certain action items, such as creating a list of local experts, are low cost, while others such as mapping "Red Alert" species and creating a rapid response network will cost considerably more.

Implementation Tracking
Status of implementation of the specific actions in the plan.

Funding
USFWS, CDFW, NOAA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

In 2010, the Estuary Program completed an Invasive Species Action Plan. Components of that plan include coordination, prevention, early detection, rapid response, control and management, and education and outreach. The plan calls for 26 specific actions related to the various components. The next steps will be the implementation of those specific actions.

Education and outreach is a particularly important component of the plan, as invasive species prevention requires knowledge of invasive species and how to control them. Because many invasive species originate as landscaping plants or for erosion control, it is important that local homeowners, not just landscapers and agriculturalists, understand the risks of planting an invasive species.

Hand in hand with the Invasive Species Action Plan is the Invasive Species Action Network. This network of land management and resource professionals works together to prevent, detect, and remove or control invasive species in the Morro Bay watershed and estuary. Meeting regularly, and sharing information electronically, the group has already prevented the colonization of one new invasive species. Algerian sea lavender is a landscaping plant that has invaded many estuaries in California. Its highly efficient seed dispersal mechanisms allow the plant to outcompete native sea lavender species, as well as other marsh plants. Luckily, the invasive plant was spotted early in Morro Bay State Park and steps were taken to remove it before it became established. The State Park and other members of the Invasive Species Action Network will continue to monitor the area for new specimens. This is just one example of the value of this collaborative network of dedicated professionals.

The Estuary Program will continue to implement the Invasive Species Action Plan. Activities may include:

- Development and distribution of education and outreach materials about invasive species
- Management of the Invasive Species Action Network
- Technical support for landowners wishing to remove invasive species
- Continuation of efforts to map the distribution of invasive species in the watershed

Climate Resilience Considerations
Invasive species have the potential to decrease biodiversity in the watershed by outcompeting native species for habitat and resources. For example, invasive plant species outcompete native species with an increase in hotter and drier conditions. As much of the watershed and bay are already influenced by invasive species, climate change impacts may make eradicating them much more difficult. Activites to minimize the impacts of invasive species to the watershed and bay in the face of climate change include:

- Working with partners to ensure that the Invasive Species Management Plan is updated as the understanding of invasive species dynamics in relation to clmate change as understanding continues to improve
- Working with partners to develop targeted and innovative invasive species BMPs
- Continue research and monitoring efforts to understand invasive species growth rates as climate science continues to improve
- Collaboration with partners to facilitate best management practices to control invasive species such as prescribed grazing and fire management
- Working with partners in the development of projects to remove specifically identified invasive species in the upper watershed and creeks

CREW-1

Watershed Crew

Continue to support a Watershed Crew with the California Conservation Corps and other partners to provide planning, labor, outreach, and other services in the watershed and to promote service and career learning in watershed management.

Current Status

Due to changes in funding, the Watershed Crew with the California Conservation Corps is no longer managed in the same way. While the CCC continue to be a strong partner in restoration, the Watershed Crew approach is no longer utilized, and thus this Action Plan has been eliminated.

Freshwater Resources

Estuaries are defined as places where freshwater meets the sea. In Morro Bay, two sub-watersheds (Chorro and Los Osos creeks) provide most of the freshwater mingling with the ebb and flow of ocean tides. Additional freshwater inputs include springs and groundwater seeps, as well as stormwater runoff that enters the bay directly from both the developed and undeveloped lands adjacent to the shore. The creeks are closely linked to underlying shallow groundwater aquifers; thus, groundwater withdrawals not only affect the subsurface resources, but may impact surface creek flows as well.

The Mediterranean climate of Morro Bay shapes the highly seasonal and variable nature of freshwater flow to the estuary. Winter rains usually bring full-flowing creeks and replenish groundwater; by late summer, much of the creek system is reduced to a trickle. Winter rains also account for what is sometimes called the "flashy" nature of Morro Bay's watershed: intense storms can cause huge amounts of water to flow into the bay with volumes quickly declining. Morro Bay's annual precipitation is also quite variable. Years when rainfall is well below long term averages, as well as those when rain volumes greatly exceed those averages, occur frequently in the historic record (Western Regional Climate Center, n.d.). Observations by wildlife professionals in this area suggest that many of the native species have adapted to these natural fluctuations in freshwater flow from year to year and from season to season.

The natural freshwater flow patterns have been highly altered in the Morro Bay region, both increasing and decreasing flows. The wastewater treatment plant operated by the California Men's Colony discharges treated effluent year round directly into Chorro Creek, and may account for a significant portion of dry season surface flows (Water Board, 2007). Local groundwater is withdrawn from the aquifer near Chorro Creek for private agricultural use. Los Osos and Baywood are entirely dependent on local wells. The Los Osos Water Reclamation Facility was designed to discharge water by percolation through leach fields. This water will replenish the upper aquifer and help abate saltwater intrusion. The interaction between groundwater withdrawals and discharges back into the systems has significant impacts on the natural hydrologic cycle.

The predictions for precipitation changes in San Luis Obispo County due to climate change complicate the hydrologic picture (Koopman et al., 2010). Hotter, drier, and longer summers, coupled with more extreme storm events, could exacerbate the flashy nature of the system. Flooding will likely be more prevalent, while groundwater infiltration may decrease with increasingly irregular winter rains. Erosion along stream banks may increase with higher velocity flows during extreme storm events. As water resources become scarcer throughout the state, use of local water resources may increase. Sea level rise may increase the likelihood of saltwater intrusion into groundwater aquifers (particularly in Los Osos), adding complexity to municipal water planning. Overall, these changes are likely to reduce freshwater flow into the estuary and make the timing of inputs more unpredictable.

The Morro Bay estuary ecosystem depends on freshwater mixing with the sea to create variable salinity levels that support the unique array of estuary wildlife and habitats. Thus, significant reductions in freshwater flow, and differences in seasonal patterns, threaten habitat and living resources. Reduced freshwater supplies also impact a wide variety of beneficial uses, including domestic water supply, irrigated farming, recreation, and fishing. The Estuary Program has supported efforts to reduce the demand for water for irrigated farming and domestic use and efforts to better manage water resources in the area. In general, the Estuary Program works closely with local agencies and landowners to encourage conservation of the watershed's freshwater to the benefit of users and public trust resources.

The Estuary Program has also promoted water conservation through a variety of educational projects, including its Bayside Living Guide (available on the Estuary Program's website, www.mbnep.org) and Estuary Nature Center, located adjacent to the Estuary Program offices in Morro Bay at 601 Embarcadero. The Estuary Program actively promotes practices that encourage groundwater recharge, including floodplain and riparian restoration projects and promoting the use of permeable surfaces in the design of new development.

Resource Management

Considering the complex influences on water resources in the watershed, managing those resources presents steep challenges. Municipal water managers must balance water demand in the community with maintaining a sustainable resource well into the future. Private landowners must avoid overdrawing their wells or extending beyond their legal water rights. Individual homeowners facing rising water prices may try to minimize costs by reducing water consumption. On top of all these specific needs for water, the California State Water Board and the Regional Water Board are tasked with protecting water quality and regulating water resources while balancing the many uses of water in the region.

These human water uses are essential to Morro Bay's coastal communities; however, they must be balanced with the needs of the environment to ensure viable communities well into the future. Only with healthy coastal habitats providing important ecological functions can the Morro Bay watershed maintain its unique heritage and way of life. Maintaining adequate freshwater flows for natural resources stretches current scientific knowledge to the limit of what is known. A better understanding of water needs for specific resources is necessary, as well as more sophisticated modeling showing the impact of changes to natural water regimes on habitats and species.

FWR-1

Manage Freshwater Resources

Support efforts by the State, local governments, and water purveyors to manage freshwater resources so as to provide for water users while protecting public trust resources.

Partners
California State Water Board, Water Board, County of SLO, LOCSD, City of Morro Bay, CMC, DFW, private water companies, and landowners and water users in the watershed.

Lead
CDFW

Timeframe
Ongoing.

Cost
$-$$$
Technical support can be low cost, but research studies and analyses of water use and environmental needs are often fairly expensive.

Implementation Tracking
Number of collaborative water conservation projects; amount of water conserved. Research and technical studies supported. Projects planned and developed by partners for water conservation planning and evaluation of water use. Monitoring data collected and shared. Number of flow monitoring sites.

Funding
Water Board, DWR

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Freshwater resources in the Morro Bay watershed are managed by many entities – state agencies, municipalities, private water purveyors, and landowners. In Los Osos, a groundwater basin management plan is currently being developed by the Interlocutory Stipulated Judgment (ISJ) partners (San Luis Obispo County, LOCSD, and private water companies) with input from state agencies (California State Water Board, Water Board, and DPR) (LaCaro, 2011). The groundwater basin is the primary source of freshwater for Los Osos. The court agreement (Interlocutory Stipulated Judgment, 2008) that directed the basin plan development requires that human uses be balanced with environmental water needs. Two major policy drivers intended to guide the effective management of freshwater resources on a regional scale include the Integrated Regional Water Management (IRWM) Plan and the Sustainable Groundwater Management Act (SMGA). Both are key in balancing needs of human uses and environmental water needs and are currently being finalized for implementation within the County of San Luis Obispo. These water resource planning and policy efforts, as well as those that are currently in development, will influence the coordination and management of water resources both in the watershed and on a regional scale. However, achieving this balance commands high quality data that demonstrate environmental water demand.

The California State Water Board issues permits and licenses to use surface waters for reasonable and beneficial uses. The Regional Water Board issues permits and enforces regulations related to water quality issues, including discharge to water bodies. California does not have a permit process for extracting groundwater, although in many basins court decrees have adjudicated rights to specific users. In the Chorro Valley, surface water permits and discharge permits are both in use. The City of Morro Bay holds a permit from the California State Water Board to extract water from wells in Chorro and Morro Valley and receives water from the California State Water Board Project (water piped in from outside the watershed). Morro Bay also runs a desalinization plant that may provide a more consistent source of freshwater in the future. Other water uses in Chorro Valley include Cal Poly, Camp SLO, Cuesta College, Dairy Creek Golf Course, and CMC. CMC and Cuesta College receive water from the State Water Project, which is supplemented by the Chorro Reservoir (located just above CMC on Camp SLO property). A water treatment plant provides potable water from the reservoir to CMC, Camp SLO, Cuesta College, and nearby county facilities. CMC provides recycled water from its wastewater treatment plant to the Dairy Creek Golf Course for irrigation. CMC is also required to discharge recycled water at a minimum continuous flow rate of 0.75 cfs (cubic feet per second) to Chorro Creek. Additional regulations include the maintenance of a 1.4 cfs minimum creek flow (measured at the well fields at Chorro Road) and a 0.75 cfs release requirement from Chorro Reservoir (see also BMP-11).

On September 1, 2020 the San Luis Obispo County Board of Supervisors adopted the 2019 Integrated Regional Water Management Plan. The Estuary Program is a member of the Regional Water Management Group and a signatory on the plan. The plan includes projects that address water infrastructure needs, water quality concerns, and climate change impacts. The Estuary Program supports these collaborative management efforts and encourages water management planning that provides for beneficial uses while maintaining adequate flow to riparian and estuarine ecosystems. Supporting activities might include:

- Facilitate collaborative planning that engages stakeholders on water conservation projects
- Support research to model and quantify water use in the watershed
- Support research and monitoring regarding environmental water demand
- Provide technical support for planning efforts
- Support for infrastructure installation and/or improvements for flow monitoring and management
- Support efforts to develop a County wide Integrated Regional Water Management Plan and maintain a current and robust Master Water Plan
- Support partners to implement the Integrated Regional Water Management Plan and Sustainable Groundwater Management Act, including data sharing and coordination of monitoring efforts

FWR-2

Scientific Information for Management

Improve the scientific information needed to better manage freshwater resources in the watershed in order to maintain adequate flows for public trust resources.

Current Status

Analysis determined that the implementation tracking actions for this Action Plan were similar to those for FWR-2. Thus, FWR-2 was eliminated and combined with FWR-3.

FWR-3

Understand Flow for Public Trust Resources

Support efforts to increase understanding of freshwater flow needs for public trust resources, including supporting the development and implementation of environmental demand and minimum flow requirements and supporting research projects to improve the quality and quantity of scientific information to best inform management efforts. *(Related 2012 action: FWR-2)*

Partners
California State Water Board, Water Board, County of San Luis Obispo, LOCSD, City of Morro Bay, Cal Poly, Creek Lands Conservation, Trout Unlimited, CCC, CMC, Camp SLO, SLO Farm Bureau, NRCS, NOAA NMFS

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$ - $$$
The cost of research projects will vary widely and certain large-scale studies are likely to be expensive. Funding from a variety of sources will be necessary.

Implementation Tracking
The number and scope of research and partner projects undertaken. Discharge monitoring data collected and shared. Additional weather station data or other scientific data sources becoming available for local landowners and resource managers. Completion of relevant data collection efforts.

Funding
Water Board, NOAA, Private Foundations, Private Donations

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The freshwater systems in the Morro Bay area are complex, with watersheds, sub-watersheds, aquifers with direct connections to surface waters, the presence of aquitards (layer of low permeability that interrupts the connection between surface and groundwater), and the pressure of sea water intrusion into Los Osos groundwater. High quality, freshwater flow sustains diverse wildlife in the estuary and the creeks that feed it. Steelhead rely on fast flowing waters as spawning habitat. Riparian vegetation, like willows and oaks, need a consistent water source. Estuarine species, such as tidewater gobies and salt marsh plants, require a variable mix of fresh and saline water. Despite understanding these needs, little information exists on the precise freshwater flow required to sustain these public trust resources. As such, effective management approaches that recognize the needs of public trust resources cannot be developed without more sophisticated hydrologic data. Public trust resources are natural and cultural resources that are held in trust for all people and are protected under the law so they will be present for future generations. In Morro Bay, wildlife, essential habitats, commercially important species (such as steelhead), and navigable waters may all be considered public trust resources. This special distinction emphasizes the importance of ensuring that these resources have the freshwater flow they need while also considering the context of other important water uses.

Current minimum flow rates set by various legal agreements and water use permits rely on generalized analyses not specific to conditions and species in Morro Bay. Participants in current and future management efforts will need to have better information about these resources to properly account for them in water management agreements. Important information may include: detailed habitat data, historical flow records (considering different uses being implemented over time), characterization of catchment hydrology, data showing the effects of specific discharge rates on in-stream habitats, and water depths required for specific species (Tharme, 2003). At the most sophisticated level, modeling results can be used to determine the flow available for in-stream habitat under different regimes. Minimum flow requirements should also consider the future effects of climate change on freshwater availability to the system as a whole (see discussion at the beginning of the Freshwater Resources section). The Estuary Program recognizes that minimum flow requirements are an important management tool but may not always meet the full suite of needs for particular species or habitats. Conservation actions taken by the Estuary Program will also incorporate a full, ecosystem-based view of freshwater needs.

The Estuary Program supports the development of a stronger collective understanding of freshwater flow needs for public trust resources. The Estuary Program has already taken steps to increase the quality and quantity of relevant scientific information available. In 2011, the program initiated a partnership project with LOCSD, private water purveyors, and the USEPA to develop a model of climate change impacts on groundwater availability in Los Osos. The Monitoring Program continues to collect flow data at many creek sites throughout the watershed. A technical workshop, attended by local water managers and resource experts, was held during the development of this CCMP and focused in part on data needed to determine environmental water needs. Additional supporting activities to address this action plan might include:

- Review of relevant existing literature and scientific information specific to the Morro Bay watershed
- Technical support and leveraged funding for appropriate scientific studies and monitoring efforts
- Continuation of stream flow monitoring
- Facilitation of projects that engage multiple stakeholders and increase scientific knowledge of local freshwater resources
- Technical support and leveraged funding for data collection efforts to inform minimum flow calculations and modeling
- Technical support for minimum flow planning efforts in conjunction with regulatory and municipal planning and species recovery plans
- Habitat and species population dynamics studies to inform minimum flow calculations and modeling

FWR-4

Chorro Valley Water Users Group

Encourage cooperative efforts across public agencies and landowners to better coordinate and manage water resources in the watershed.

Partners
Cal Poly, Cuesta College, CMC, City of Morro Bay, Camp SLO, County of SLO, Los Osos Community Services District, Regional Water Quality Control Board, CCC, Central Coast Water Conservancy, representatives of private water users.

Lead
County of SLO

Timeframe
Ongoing coordination.

Cost
$

Implementation Tracking
Number of meetings held. Actions taken as results of group collaboration.

Funding
Water Board, DWR

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Balancing the needs of diverse water users across the watershed to achieve sustainability requires collaboration and coordination. These water users include private landowners, private purveyors, and public agencies including the Regional Water Quality Control Board, Cal Poly, Cuesta College, San Luis Obispo County, the Los Osos Community Services District, the City of Morro Bay, and Camp San Luis Obispo (California National Guard, California Department of the Military). Effective management strategies will also come through the implementation of regional policy. Existing water resource planning and policy efforts, such as the Sustainable Groundwater Management Act (SGMA) and Integrated Regional Water Management (IRWM) Plan, as well as those that are currently in development will also influence the coordination and management of water resources in the watershed on a regional scale.

The Estuary Program supports collaborative solutions to water management issues across the watershed. The Estuary Program provides technical support, shares data, and convenes partners to develop collaborative solutions to water management issues across the watershed. Supporting activities may include:

- Facilitation of meeting planning and preparation for the water users
- Analysis of existing water usage, flow, and habitat data to inform group discussions
- Technical support in implementing any actions that arise from group discussions
- Encourage innovative approaches to water conservation in the watershed, such as trading, banking, and sharing water

Water Conservation and Re-Use

Even with well-developed and precise water management and planning, water conservation is undeniably crucial. California faces increasing demands on water coupled with diminishing supply. Although the population in the City of Morro Bay is not expected to grow rapidly over the next 25 years (less than 1% growth rate) (City of Morro Bay, 2010), Los Osos may grow as much as 35% over the next 25 years (Maddaus Water Management, 2011). More people mean more water demand. Climate change means a less reliable water supply. The two most productive actions that communities can take to combat these two forces is water conservation and recycled water (i.e., water re-use).

FWR-5

Water Conservation

Support efforts to enhance water conservation and re-use throughout the watershed among institutional, agricultural, and domestic users. *(Related 2012 action: BMP-10)*

Partners
County of San Luis Obispo, City of Morro Bay, LOCSD, private water purveyors, major private and institutional water users in the watershed, SLO Green Build, Low Impact Development Initiative, CSLRCD, San Luis Obispo Steelhead Initiative, California State Coastal Conservancy, Trout Unlimited

Lead
County of SLO

Timeframe
Ongoing.

Cost
$-$$

Implementation Tracking
The number and scope of water conservation/re-use programs. Gallons of water captured and potentially re-used in rainwater catchment projects. Number of education materials and events completed. Number of demonstration projects completed. When feasible, measurable reductions in water use at appropriate scales (individual landowner or municipality-wide, depending on the project). Completion of recycled water planning and assessment studies by relevant partners. Estuary Program actions to support the progress of partner jurisdiction sewer connection and wastewater treatment projects, including data sharing, local water quality monitoring, research support, and transfer of relevant knowledge between experts and implementing parties.

Funding
Water Board, CDFW, California State Water Board

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Conserving water and recycling treated wastewater reduces the demand for scarce freshwater resources. Although some water conservation measures may be regulatory (like requiring low flush toilets in new construction), many measures are not well suited to regulations or would be difficult to enforce. Voluntary incentive programs and education and outreach campaigns can be more effective in these cases. The Estuary Program already collaborates with local agencies to encourage water conservation among domestic users. In future outreach efforts, institutional and large-scale agricultural users should also be target audiences.

Examples of domestic water conservation measures include: appropriate timing and frequency of landscape watering; landscaping with native plants; installation of low flow shower heads and faucets; upgrading to more efficient dishwashers and clothes washers; and use of low-water irrigation techniques. Within municipalities, low impact development streets and parks can increase water infiltration and decrease the need for municipal landscaping watering; installation of rainwater catchment and greywater projects can also reduce water needs for landscaping. Additionally, the San Luis Obispo County Integrated Regional Water Management (IRWM) Plan presents a regional scale, holistic, and integrated view on water management and planning strategies across the County of San Luis Obispo. Through this plan, the Estuary Program can provide additional technical expertise on water conservation measures in the Estuary study area and connect specific water conservation projects with new funding opportunities.

Water recycling requires tertiary wastewater processing to convert wastewater into water that is usable for specified purposes, such as agriculture and landscaping irrigation. There are two major opportunities to explore the costs and benefits of recycled water in the Morro Bay watershed – the system upgrade, maintanence, and retrofit of the Los Osos sewer connection project and the upgrade of the Morro Bay wastewater treatment plant (see BMP-10 and BMP-12) While the Los Osos Water Recycling Facility has been implemented, there will still be a need for monitoring and coordination as recycled water use is expanded, particularly if there are surface flow discharges. There are both costs and benefits to recycled water distribution and use at the scale of community wastewater treatment plants. The processing of the wastewater into usable water can be very expensive and the applications of recycled water are limited. However, there are environmental benefits in reducing groundwater withdrawals and cost savings in reducing water needed from the State Water Project.

The Estuary Program will participate in and support interagency collaborations to reduce groundwater withdrawals and develop recycled water distribution as appropriate. Some activities in which the Estuary Program might engage include:

- Education and outreach materials and events to encourage water conservation by both domestic users and institutional and agricultural users
- Collaborative efforts with local municipalities to encourage water conservation
- Support the development of incentive programs to encourage water conservation practices, low impact development, and new technologies or techniques
- Demonstration projects that implement rainwater catchment and other water conservation measures
- Technical support for municipalities in implementing water re-use plans, as appropriate (including Integrated Regional Water Management Plan and the County Master Water Plan)
- Facilitate dialogue among municipalities and water management agencies to advance water conservation and water recycling, as appropriate
- Monitoring impacts of wastewater treatment projects and regulatory policy on water levels throughout the watershed
- Monitoring progress on implementation of wastewater treatment projects and regulatory policy outcomes, such as the Integrated Water Management Plan
- Sharing of relevant water quality data with project and regulatory partners in the Los Osos and Morro Bay wastewater projects
- Supporting agencies in any information needs related to estuary and creek impacts from project upgrades
- Providing technical expertise for any planned monitoring efforts related to new sewer system retrofit and project upgrade measures

FWR-6

Groundwater Re-charge

Encourage well-managed groundwater recharge through a variety of means, including encouraging permeable surfaces in land use development, stormwater controls, policy vehicles like the Sustainable Groundwater Management Act (SGMA), and floodplain restoration.

Partners
Public and private landowners, City of Morro Bay, County of SLO, LOCSD, CSLRCD, private water purveyors, LIDI, SLO Green Build, Water Board

Lead
County of SLO

Timeframe
Ongoing.

Cost
$ - $$$$
Costs vary with the technique. Low impact development that utilizes more permeable surfaces is generally not significantly more costly than other approaches; the costs of larger scale stormwater controls and floodplain restoration projects vary with type and scale.

Implementation Tracking
The number, type and scale of projects. Gallons of water retained in catchments. Number of square feet of impervious surfaces retrofitted to pervious surfaces.

Funding
Water Board, DWR, California State Water Board

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The climate of Morro Bay has distinct wet and dry seasons, with heavy winter storms sometimes bringing high intensity precipitation events that generate large amounts of runoff. Slowing the flow of runoff increases recharge of groundwater aquifers by allowing the water time to percolate through the ground. Limiting the amount of impervious surfaces created through development has a similar effect on groundwater recharge. There are many practical approaches that encourage infiltration. Green streets and pervious pavement reduce impervious surfaces, as do land use plans that encourage dense urban centers surrounded by open space (NOAA, EPA, ICMA, and Sea Grant, 2009). Bioretention practices, such as bioswales, vegetated street buffers, rain gardens, tree preservation, and rooftop gardens, help keep water on-site so it has time to percolate (San Luis Obispo Coalition of Appropriate Technology, 2010). In addition, rain barrels and cisterns collect water and store it on-site for landscaping and other uses, reducing both runoff and water demand from municipal supplies. Effective groundwater management practices can also be applied through the implementation of policy like the Sustainable Groundwater Management Act (SGMA), and can aid the Estuary Program in promoting groundwater management and recharge best practices across the Morro Bay watershed. This type of activity can include funding assistance for the implementation of groundwater recharge best practices and projects on private lands in the upper watershed. Staying informed as the program develops to determine the Estuary Programs potential role.

Besides encouraging recharge through rainfall retention, resource managers in the watershed can actively recharge water basins using treated wastewater. The wastewater treatment system in Los Osos includes such a program to help restore groundwater volumes and retard sea water intrusion into the aquifer. There are many costs and benefits associated with this approach and the Estuary Program encourages monitoring and data analysis to track the impacts, both positive and negative, of any recharge plan that is implemented.

Activities that may support this action include:

- Education and outreach materials and events to educate homeowners and local governments about effective low impact development techniques
- Collaborative efforts with other organizations encouraging low impact development
- Demonstration projects to show how to implement low impact development techniques
- Support for local municipalities in implementing low impact development as part of their land use planning and stormwater permitting as appropriate
- Support partners jurisdictions and agencies in the implementation of the stipulations of the Sustainable Groundwater Management Act

Climate Resilience Considerations

Drought is defined as "a long period of time during which there is very little or no rain (Webster 2016)." For this analysis, abnormally low rainfall is considered to be below the annual average and a prolonged period is over two years. In general, for the southwest region of the United States, there is high confidence that droughts will intensify during the dry season from lack of soil moisture (Southwest Climate Alliance 2013). This, combined with evidence that heat waves will become longer, more intense, and more frequent, will further compound these effects (National Climate Assessment 2014; IPCC 2014). The regional patterns of drought for Morro Bay and San Luis Obispo show much more variable rainfall patterns. Current trends seem to be moving towards a less stable precipitation regime with more deviation from the average from year to year. Drought may lead to both a decline in groundwater levels and more salt water instrusion. Lower water tables will result in lower base flows year-round and less water available for wetland and off-channel habitats. Additional activities that encourage well managed groundwater recharge and increase resilience to drought effects that may support this action include:

- Continued support for partner jurisdictions and agencies in the implementation of low impact development tools, implementation, and education
- Continue to stay abreast of groundwater management progess as SGMA policy and implementation measures continues to develop

Climate Change

Since the adoption of the first CCMP, climate change has increasingly become a focus of scientific research and public policy from the local to international levels. While there remains controversy in the public sphere concerning causation between human activities and rising global temperatures, there is strong scientific consensus that the global climate is changing, with average temperatures increasing. Many models suggest that this increase in temperature may affect weather patterns, precipitation, and sea levels, as well as numerous other environmental, economic, and social variables.

The scientific consensus and models at the global level do not directly translate to impacts at the local level. Individual cities and counties need high quality localized information and climate predictions to appropriately plan for future scenarios; however, this level of information requires detailed baseline data and advanced modeling analysis. A climate adaptation planning effort for San Luis Obispo County did present some predictions for the county as a whole, extrapolating global climate models to the local scale and using local expert knowledge and data. The final report from this effort suggests that by the end of this century the region could experience hotter, drier summers, more severe winter/spring storms, and sea level rise affecting coastal habitats and communities (Koopman et al., 2010).

Impacts from these predicted changes that will affect coastal areas of the county include: coastal inundation and sea level rise, ocean acidification, flooding, increased erosion from severe storms, increased risk of wildfire, and alterations in the distribution and viability of "edge" species most sensitive to these types of changes. Species and habitat distributions may be altered by changing climate conditions. Some species and habitats will suffer if appropriate areas for range expansion are not available due to other land uses. Timing of plant flowering and other reproductive or migratory patterns may be altered, throwing off symbiotic relationships. Reduced freshwater flow could impact estuarine species adapted to specific salinity conditions. Exotic and invasive species that may be better adapted to future conditions could outcompete native species. Ocean acidification could alter water chemistry in estuarine systems and result in biotic impacts (Miller, Reynolds, Sobrino, and Riedel, 2009).

Economic impacts along the coast are possible due to changes in the climate. Increased infrastructure damage from more severe storms, flooding of municipal facilities and tourism-related locations, increased risk of damage to harbor and commercial fishing infrastructure, and unpredictable impacts to commercially important fish populations and aquaculture would all be detrimental to local economies.

The public policy response to climate change has taken two general forms: efforts to lessen carbon dioxide and other greenhouse gas emissions that contribute to warming, and efforts to encourage adaptation and mitigation strategies, which prepare communities for changes so that adverse impacts are reduced. In November 2011, the County of San Luis Obispo approved a climate action plan that outlines emissions reduction strategies to meet a 15% reduction in emissions from the 2006 baseline by 2020, as well as mitigation and adaptation strategies for climate change impacts predicted to occur even with such a reduction (County of San Luis Obispo, 2011). This plan includes strategies for the unincorporated areas of the Morro Bay watershed and County services in the City of Morro Bay. The climate action plan also served as the basis for an Environmental Impact Report (EIR) addendum to the EIR for the County's Conservation and Open Space Element of the General Plan. The City of Morro Bay has completed a baseline inventory for greenhouse gas emissions as part of an emissions reduction program of the San Luis Obispo Air Pollution Control District (City of Morro Bay, 2005). The city has completed a Climate Action Plan and begun implementation.

The Morro Bay estuary and watershed is a complex system linked inextricably to its Mediterranean climate regime. Long-term changes to average temperatures and historic precipitation patterns will directly affect estuarine resources and ecological functions. Furthermore, rising sea levels, more severe winter storms, and altered precipitation patterns will have complex and costly impacts on the estuary, wetland and riparian areas, and bayside communities.

The management plan specifies several considerations and actions to address climate change in the Morro Bay watershed. In this section, three specific actions

plans are described, focusing on the role the Estuary Program can play in advancing local understanding of, and adaptation to, climate change impacts. **In addition to these action plans, there are many action plans in other sections of the plan that relate directly to addressing climate change impacts. These actions are marked with a ◉ symbol to document this connection. This integrated approach is important because climate change impacts will be far-reaching and the strongest approach to addressing them is to integrate the issue into all relevant spheres of our science and conservation work.** For actions that relate to restoration and conservation approaches, criteria must first be set for the goals of a particular project relative to climate change impacts. For example, there may be a range of predictions regarding sea level rise for a location. Before embarking on a restoration project in a location at risk of inundation, goals must be set regarding how the project will adapt to sea level rise.

Photo : Mike Bush

CLIM-1

Improve Understanding of Climate Change Impacts

Encourage scientific endeavors and research into the effects of climate change on the Morro Bay estuary and its watershed.

Partners
Cal EMA, Cal Poly, ICLEI, County of San Luis Obispo, DPR, DFW, NOAA, USEPA, USGS, Central Coast Climate Collaborative, City of Morro Bay, USC Sea Grant, California Sea Grant, TNC

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$ - $$$$
Costs will vary widely based on the scope of research.

Implementation Tracking
The number and scope of research efforts. Workshops and other communication efforts to share information with municipalities and resource managers.

Funding
NOAA, EPA, Sea Grant

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Perhaps the most critical need in regard to climate change and the estuary is scientific study to better understand what local effects will be. This information will be critical in developing strategic adaptation strategies and prioritizing actions that improve climate resilience in the Morro Bay watershed. Most climate research has focused on global impacts and general predictions of precipitation and temperature patterns across large areas. As smaller cities and counties plan for climate changes and impacts, more specific data and modeling on the local scale is needed. Such focused research is critical to both planning and implementation of adaptation measures in the Morro Bay estuary, watershed, and nearby communities.

As a conservation leader in the Morro Bay watershed, the Estuary Program can help promote the advancement of climate change understanding for local communities and resource managers, and support local efforts to predict impacts and plan for future changes. Some activities that the Estuary Program may complete to contribute to a stronger shared understanding of local climate change effects include:

- Promote long-term datasets to inform baseline conditions, trends, and climate change modeling efforts while identifying and prioritizing data gaps
- Partner with academic institutions and agencies to support the development and implementation of models and research that will improve understanding of climate change impacts in Morro Bay watershed
- Support ongoing and future efforts in the development of vulnerability assessments relevant to conservation and restoration efforts in the Morro Bay watershed
- Technical and policy support to local municipalities to share scientific information and help managers interpret research and modeling results
- Participation in regional data collection and modeling efforts to leverage scientific capacity in other nearby coastal communities
- Facilitation of sharing of data and research results between partners and regional entities

CLIM-2

Assist in the Implementation of Local Government Climate Action Plans

Encourage the implementation of Climate Action Plans by the County, City of Morro Bay and Los Osos Community Services District by providing technical support, participating in planning efforts, and identifying opportunities for partnerships and funding.

Partners
County of SLO, City of Morro Bay

Lead
County of SLO and City of Morro Bay

Timeframe
Timeframe for local plans and implementation is contingent on priorities among the local governments.

Cost
$$

Implementation Tracking
Estuary Program participation in CAP and other planning processes. Type and specifics of data shared to inform planning efforts. Participation in implementation efforts, as appropriate.

Funding
NOAA, EPA, Sea Grant

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Climate action plans (CAPs) outline strategies to reduce greenhouse gas emissions and prepare for impacts from climate change at the local or regional level. In California, climate action planning by cities and counties can be very effective, as most land use and planning decisions are made at the local level. Governments in San Luis Obispo County are on the forefront of planning for and adapting to climate change. The County and some cities in the region have begun addressing both emissions reduction strategies and adaptation policies through climate action plans. Many other cities, including Morro Bay, have completed supplementary greenhouse gas emissions inventories that further inform climate planning efforts. The County of SLO and City of Morro Bay have both adopted climate action plans that are currently being implemented to achieve state and local adaptation goals. Several specific adaptation strategies and actions in local CAPs have potential to directly or indirectly impact Estuary Program actions and watershed goals. In particular, the Estuary Program is interested in adaptation strategies and actions that protect environmentally sensitive habitats, minimize impacts to restoration and conservation efforts, and utilize nature-based techniques like living shorelines and dune restoration. It is important to note that as the community of Los Osos is unincorporated within the County of SLO, the LOCSD is to comply with climate planning policies laid out in the County's CAP. The state has taken a leadership role by incentivizing climate action planning. Two key pieces of legislation – the Global Warming Solutions Act (AB 32) and the Sustainable Communities and Climate Protection Act (SB 375) – direct local governments to plan for emissions reductions and transportation planning to reduce climate change impacts.

San Luis Obispo County has also incorporated climate change into more traditional planning documents. The County's Conservation and Open Space Element of the General Plan includes policies and strategies that address climate change (County of San Luis Obispo, Department of Planning and Building, 2010). The County Hazard Mitigation Plan incorporates climate change in the risk analysis and mitigation strategies (County of San Luis Obispo, Office of Emergency Services, 2011). Other planning efforts to increase energy efficiency, encourage alternative and communal transportation, and promote low impact development techniques also further climate change adaptation. The Estuary Program supports local agencies in planning for future climate scenarios in an environmentally sustainable and community-oriented manner.

Climate adaption planning, and related planning efforts, presents an opportunity to promote sustainable use of local natural resources in a way that benefits economic, social, and environmental outcomes. Climate adaptation planning efforts also work to promote and encourage community resiliency in the face of climate induced changes. The Estuary Program supports such a holistic approach through activities such as:

- Participation in public planning processes to inform planning for coastal habitats and communities and increase integration of climate change planning into traditional planning documents
- Collection and sharing of data to inform planning efforts at the local level
- Participation, in the form of technical support, capacity building, knowledge sharing, and identification of opportunistic funding sources that further implementation of CAPs as they relate to the Estuary Program goals and priority issues
- Facilitation of collaboration among stakeholders and government agencies to increase climate change understanding, integrate planning efforts, and promote climate adaptation responses that provide positive environmental benefits
- Encouragement of the alignment of local planning efforts with regional and state efforts

CLIM-3

Climate and Adaptation Education

Participate in or direct educational programs about the possible implications of climate change on the estuary and watershed, as well as, solutions and alternatives to address impacts; such programs should be consistent with state and local action plans or other adopted public policy.

Partners
County of San Luis Obispo, City of Morro Bay, LOCSD, San Luis Coastal Unified School District and individuals schools, Central Coast State Parks Association, Cuesta College, and Cal Poly

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing, but also contingent on the state of scientific knowledge (see CLIM-1) and information forthcoming in local Climate Action Plans (see CLIM-2).

Cost
$

Implementation Tracking
The number of education and outreach projects oriented toward the effects of climate change.

Funding
NOAA, EPA, Sea Grant, Private Foundations, Private Donations

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Education and outreach are necessary components of any climate adaptation efforts. Many adaptation and emissions reductions strategies require the cooperation of individual citizens when they make daily decisions – what form of transportation to use, what type of car to buy, how close to live relative to their jobs, and how to landscape and improve their home in ways that will aid in climate adaption. Informing citizens about what actions can help mitigate future climate change impacts is the first step to making a difference in the local community.

The Estuary Program boasts a strong community education program and maintains partnerships with many community organizations, schools, and other educational efforts. Educating the public about local climate action plans and steps they can take to prepare is a natural role for the program. Any education efforts would be done in cooperation with other state and local agencies directly involved in climate action planning, and would be largely contingent on an improved, science-based understanding of localized climate change implications for the estuary and related resources. Some activities that may help implement this action plan include:

- Development of bilingual education materials that explain climate action plans and ways citizens can help implement them
- Partnerships with other organizations and municipalities to develop climate change education materials and/or events
- Integration of climate change concepts and actions into other educational programming offered in the estuary and watershed

Environmentally Sound Estuarine Resource Use

Estuaries are well known for their rich environmental resources. But they are also valued for a wide variety of recreational, commercial, and industrial uses that thrive in coastal bays. Morro Bay serves many human uses: commercial fishing fleet, commercial aquaculture, tourism and related commercial uses, and many kinds of recreation. Some of these uses require significant alterations to the natural landscape while others are more passive pursuits. In addition, the scenic beauty of the bay attracts residential development and commerce to serve those residents. This broad array of uses highlights the need for maintaining balance between the uses humans depend on and the environment that makes those activities possible.

The communities within the Morro Bay watershed are small and close-knit. Most people are familiar with the recreational and commercial activities that occur on the bay. This familiarity helps mitigate some potential conflicts between different activities. Still, tourism (in the city of Morro Bay in particular) has increased significantly over the past decade and is likely to continue growing. With more people visiting and engaging in recreational activities, conflicts become more likely. Kayakers and paddle boarders may paddle in the channel designated for boats and fishing vessels, and may also disturb shorebirds that bird watchers come to see. Recreational boaters may disturb oyster farming operations. Denser coastal development and higher tourism visitation rates may increase litter and add marine debris to the estuary. These are just a few examples of possible conflicts – although some of them may never occur and others may be rare, they are important to plan for so everyone can enjoy the bay equitably.

Equitable and sustainable use of the bay also has great environmental advantages. A balance of human uses that is environmentally protective and responsible benefits the estuary and the people that depend upon it. Without such a balance, conflicts between uses often lead to environmental impacts – damaged and loss of habitats, disturbance of birds and other wildlife, and a greater volume of marine debris. Thus, an important issue facing the estuary's future is encouraging balanced and sustainable use of the land, water, and other resources in ways that protect and enhance its environmental qualities.

USE-1

Recreational Uses

Encourage the enjoyment of Morro Bay through environmentally responsible and sustainable recreational activities.

Partners
DPR, DFW, City of Morro Bay, County of SLO, DBW, California Coastal Commission, California State Coastal Conservancy, operators of commercial recreation outlets such as those offering kayak rentals and wildlife tours.

Lead
DPR

Timeframe
Ongoing.

Cost
$

Implementation Tracking
Programs or projects that encourage responsible recreation; upgrades to relevant facilities to reduce impacts. Numbers of materials, events and trainings that distribute information on sustainable recreational practices.

Funding
California Coastal Conservancy, California Coastal Commission, Private Foundations, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Many residents of and visitors to the Morro Bay area enjoy recreating in the beautiful and peaceful natural surroundings of the estuary. Popular recreation activities span the spectrum from bird and wildlife watching, walking along the waterfront, and fishing to kayaking, paddle boarding, and SCUBA diving. These pastimes generally have low impact on the estuary and its natural resources. Furthermore, most people engaged in these types of outdoor activities feel positively toward the environment and do not intentionally cause harm. Even with good intentions, however, wildlife can be inadvertently disturbed and habitats can be accidentally damaged.

The Estuary Program educates recreational users of the bay about how to enjoy the bay in an environmentally responsible manner, while still taking pleasure in their activity of choice. These educational efforts also incorporate information about recreational practices that reduce conflicts with other uses, such as shellfish farming and commercial fishing. Past educational efforts include information exchanges with local kayak and canoe rental companies, recreational information at education events, educational materials encouraging bird watching in ways that minimize disturbances to water fowl, and collaborative education efforts to educate the public about nesting areas of the snowy plover.

In addition, the Estuary Program supports upgrades to existing bay and harbor facilities so that they can be better enjoyed and better managed to protect the environment – for example, through improved waste disposal from recreational and live-aboard boats.

Recreation, if conducted in a responsible manner, can increase appreciation of the sensitive resources of the area and inspire people to work toward their continued protection and enhancement. The Estuary Program will continue to work to educate recreational users with activities such as:

- Continued collaboration with recreation-oriented businesses and community organizations such as boat and kayak rentals, tour companies, marinas, recreational fishing companies, and lodging businesses to encourage environmentally sound practices in their operations and to help educate their customers about how to enjoy local resources with minimum impacts
- Development of education materials to explain sustainable practices while also providing desired information, such as animal identification signage and placards
- Education efforts to bring awareness about the variety of uses occurring on the bay and how to minimize undesirable interactions
- Field trips and other education events to increase general knowledge of local species and habitats and how to enjoy them with sustainable recreational practices
- Collaboration with resource managers to mediate and help design solutions to observed conflicts between different recreational uses

USE-2

Shellfish Farming

Support the use of ecologically sound shellfish farming practices in the bay.

Partners
CDPH, DFW, State Lands Commission, NOAA NMFS, oyster farm operators, Water Board, California Coastal Commission

Lead
CDPH

Timeframe
Ongoing.

Cost
$

Implementation Tracking
Sharing and analysis of bacteria monitoring data. Support for bacteria source research. Number of BMPs implemented by oyster farmers. Number of closure days not related to rainfall.

Funding
EPA, NOAA, Sea Grant, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

A viable shellfish aquaculture industry can be a bellwether of the health of an estuary. As filter feeders, shellfish remove organic matter, detritus, and nutrients from the water column (Nelson, Leonard, Posey, Alphin, & Mallin, 2004; Crawford, Macleod, and Mitchell, 2003). This filtering process increases water clarity and can benefit water quality. For safe consumtion of shellfish, waters must be free of bacteria, biotoxins, or hazardous materials, making aquaculture another driver for improving water quality. The specific aquaculture methods can impact the surrounding environment, in particular nearby eelgrass beds. Current operations generally avoid impacts to eelgrass, but any future aquaculture activities should consider the updated science and be strategized to minimize ecological impacts.

Leases for oyster farming in nearshore waters are managed by DFW and are closely regulated by the California Department of Public Health (CDPH), California Coastal Commission, and the Army Corps of Engineers. CDPH requires water quality testing and monitors bacteria and biotoxin concentrations to ensure that shellfish are safe for consumption. The department also regulates harvesting and storage of shellfish until they are sold to consumers. In Morro Bay, the greatest regulatory issue for shellfish harvesting has been elevated bacterial concentrations in the growing waters.

The Estuary Program is supportive of the continuation ecologically sound shellfish aquaculture in the bay. Bacteria monitoring data is shared broadly with regulators and other Morro Bay stakeholders. Actions that the Estuary Program may take to encourage good farming practices and reduce impacts include:

- Continued measures that reduce bacteria pollution to the bay (see Best Management Practices section)
- Continued monitoring and research of bacteria levels and sources in the creeks and the bay
- Encouragement of shellfish farming BMPs that reduce detrimental effects on issues such as litter, nearby eelgrass, etc.
- Encourage policmakers to consider impacts to habitat as depuration becomes more widespread and utilize the updated science when renewing permits
- Encourage research on ecological impacts of invasive and non-native aquaculture species

Climate Resilience Considerations:
Ocean pH is projected to acidify by 0.3 to 0.4 from an average of 8.0 by 2100. The decrease in pH may lower the saturation levels of calcite and aragonite in the ocean (Raven et al. 2005), impacting invertebrate species' ability to form calcium carbonate shells. However these effects may be offset by increasing water temperatures that raise the saturation level for aragonite and calcite (Raven et al. 2005). Additional activities that the Estuary Program may take to further encourage practices to increase estuary resilience include:

- Staying updated on shore based activities, land uses, and projects that could negatively affect bay health and shellfish viability
- Continued monitoring efforts as the understanding of ocean acidification and climate science on shellfish population and growth continues to improve

USE-3

Commercial Fishing

Support commercial fishing port and working waterfront practices that are consistent with the protection of Morro Bay's water quality and habitat values.

Partners
Commercial fishermen, Morro Bay Commercial Fishermen's Organization, Central Coast Women for Fisheries, City of Morro Bay, DFW, NOAA NMFS, TNC, Cal Poly, California Coastal Commission, California State Coastal Conservancy, private foundations and other funders

Lead
City of Morro Bay

Timeframe
Ongoing.

Cost
$ - $$$

Implementation Tracking
Implementation of boat maintenance facilities and other good practices. Number of abandoned vessels removed or repurposed. Engagement in support activities for sustainable fisheries development. Engagement and support of partners' efforts in research of connections between estuaries and commercial fisheries.

Funding
NOAA, California Coastal Conservancy

Measurable Objectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Morro Bay has a long and proud history as a fishing village with a vibrant working waterfront. Historically, the off-shore commercial fishing industry provided jobs, infrastructure, and economic benefit to the local community. However, the industry started to decline in the late 1980s due to reduced quotas and catch limits, stricter gear requirements, rising costs, and more fishing area closures. This gradual decline led to abandoned fishing vessels and degrading dock infrastructure, such as unloading and processing facilities.

Deteriorating infrastructure and abandoned vessels impact both the economy and the environment. The greatest environmental impact is the release of toxic materials and debris. Lack of facilities also forces active fishing operations to use less environmentally sound practices in unloading fish and maintaining their vessels. Economic consequences for the area and fishermen include loss of jobs and municipal income. The Estuary Program has been an engaged partner in helping the city reduce environmental risks by removing abandoned vessels and mitigating degrading infrastructure.

Recently, the Morro Bay fishing industry has experienced some positive growth and implementation of sustainable practices. A partnership between local fishermen, the Nature Conservancy, and the City of Morro Bay aims at transitioning the local groundfish fishery to more environmentally sound gear types and more sustainable business practices. Other recent local improvements include the completion of an ice facility in the harbor and the successful operation of three offloading sites (Lisa Wise Consulting, 2008).

As many fishing operations are passed down from generations, people engaged in the industry are committed to Morro Bay and likely to feel connected to the local environment. Commercial fishing encourages stewardship of local resources because fishermen depend on a safe and clean harbor from which to operate. In a broader sense, commercial fisheries depend on estuaries as nursery habitats for commercially viable species. Having commercial fishing anchored in Morro Bay increases awareness and appreciation for this important relationship between estuaries and fisheries.

The Estuary Program supports efforts to use fishing practices that protect water quality and habitats in the bay. Activities to support such efforts might include:

- Supporting efforts to increase facilities for proper boat management (see BMP-8 and BMP-9)
- Education and research efforts to increase awareness and understanding of the relationship between estuary habitats and commercial fisheries
- General and technical support for activities that encourage environmentally sound fishing practices
- Continued assistance to the City of Morro Bay to remove or repurpose abandoned vessels

USE-4

Morro Bay Power Plant

Continue to stay informed on impacts to estuary species and ecosystem services as alternative energy and infrastructure systems are developed in conjunction with the existing Morro Bay Power Plant by working with the State, the Central Coast Regional Water Quality Control Board, California Coastal Commission, California Energy Commission, and other permitting agencies.

Partners
California Energy Commission, Water Board, California Coastal Commission, City of Morro Bay

Lead
California Energy Commission

Timeframe
Unknown.

Cost
$-$$

Implementation Tracking
Status of efforts in planning and permitting for alternative energy system implementation.

Funding
Water Board, California Coastal Commission

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

The Morro Bay Power Plant was used primarily to provide power during peak demand times (generally in the heat of summer). Currently, the Morro Bay Power Plant has been decommissioned.The power plant utilized once-through cooling, a process that has been recognized by the EPA and numerous permitting agencies as having significant detrimental environmental impacts (see History of the Morro Bay Power Plant on page 111). Today, as alternative energy and infrastructure systems such as offshore wind energy continue to be developed, efforts should be taken to minimize impacts to habitats of the estuary. Section 320(b)(7) of the CWA requires that each NEP review federal financial assistance programs and development projects, as consistent with Executive Order 12372, to assess whether those programs are consistent with their CCMP. Projects at the Morro Bay Power Plant location may intersect with this federal consistency requirement. The Estuary Program meets its federal consistency requirement by using the California Coastal Commission's (CCC) existing federal consistency review process. This is an established process in California that helps strengthen coordination among federal and state agencies regarding projects in the coastal zone. Actions the Estuary Program may take to support such efforts include:

- Support efforts by partners and others to evaluate possible approaches to minimizing impacts to estuary habitat and ecosystem services as alternative energy systems and infrastructure are developed
- If alternative energy and infrastructure systems, such as offshore wind energy, are to be considered by regulatory agencies, support for studies of impacts to wildlife populations from any expansion plans
- Participate in public planning and permitting processes of alternative energy and infrastructure systems in order to encourage sustainable use of estuarine resources

History of the Morro Bay Power Plant

The Morro Bay Power Plant is an aging facility constructed and first operated in the 1950s. Over the years, different plant owners have considered modernizing and expanding the plant in its current location, most recently when California was facing acute electricity shortages in the early 2000s. Permitting agencies, especially the Water Board, California Energy Commission, and California Coastal Commission, undertook extensive studies of the impacts of the plant, focusing on the cooling system by which cold water from the estuary is pumped through the facility's cooling system one time and then discharged into the ocean at higher than natural temperatures.

The primary concern with this "once-through" cooling is that large numbers of fish larvae, fry (young fish at the post-larval stage), and invertebrate larvae are entrained or killed. Entrainment occurs when these organisms are drawn into the facility during the cooling intake process and are killed by pressure and high temperatures (Bailey, 2007). Arrow goby are the most common fish entrained at the Morro Bay Power Plant (Tenera, 2001). Young organisms and small fish are also impacted by impingement, which is the trapping of organisms against screens that filter the water coming into the plant.

The USEPA is mandated by the Clean Water Act to regulate facilities that operate cooling intake structures. In California, this mandate is implemented by the California State Water Board. The California State Water Board's Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling establishes technology-based standards to reduce the harmful effects associated with cooling water intake structures on marine and estuarine life (California State Water Board, 2010). As regulations have been updated based on science showing impacts to organisms in the intake waters, technology requirements for these facilities have increased. Complying with the most recent regulations became cost prohibitive for the Morro Bay Power Plant because the plant was being used infrequently. After the energy crisis of the early 2000s, the plant had generally operated at minimum capacity, increasing power output only during peak demand times. Due to the infrequent use and increasing costs for compliance, the plant owner at the time (energy company Dynegy) opted to shutter the plant in early 2014.

The plant became the property of Vistra Energy when that company bought out Dynegy in 2018. The future of the plant site is currently unknown. One potential scenario is the development of off-shore wind facilities that could connect to the grid through the Morro Bay site. This development by Castle Wind LLC is still going through feasibility and permitting review. The Bureau of Ocean Energy Management (BOEM) regulates leases for offshore energy development.

Photo : Lynda Roeller

USE-5

Urban Development

Encourage strategic future development practices to minimize impacts to water quality and important habitats.

Lead
County of SLO and City of Morro Bay

Funding
NOAA, EPA

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Current Status
Analysis determined that the implementation tracking actions for this Action Plan were similar to those for BMP-7. Thus, USE-5 was eliminated and combined with BMP-7.

Education and Outreach

Many of the actions in this CCMP involve changing the behavior of individuals that live and work in the Morro Bay watershed. Behavior changes can require some technical skill, such as using agricultural best management practices, or be as straight forward as picking up after one's pet on a walk. As a non-regulatory organization, the Estuary Program's key tool for encouraging behavior change is through outreach and education to appropriate audiences about how to live, work, and recreate in and around the estuary in environmentally friendly ways. Part of achieving positive behavior changes includes increasing awareness about basic estuary science. People are more likely to make positive changes and minimize impacts to the surrounding environment when they understand and feel connected to that environment and the organisms that inhabit it. In this way, education and outreach serve as the backbone for all of the work of the Estuary Program.

"Education" refers to efforts to teach estuary science and other relatively complex concepts to specific audiences through repeated interactions and learning tools. "Outreach" refers to more general efforts to increase basic awareness and literacy of estuary concepts and behavior changes to broader audiences during short, more opportunistic interactions.

In fact, many of the action plans in previous sections of the CCMP include education and outreach components, as noted by the ★ icon. This section includes additional action plans focused on broader education and outreach efforts that increase awareness of the general ecology of the estuary and the services it provides to local coastal communities (such as recreational opportunities and flooding protection). The broad nature of these action plans may also help expand the audience interested in the Estuary Program and the estuary. Additionally, the education action plans in this section aim to share information from projects and monitoring completed by the Estuary Program and its partners.

Since adoption of the first CCMP, the Estuary Program has undertaken numerous education programs to: increase public appreciation the estuary's importance; share results from the VMP and other research efforts; encourage community projects that benefit the watershed and estuary environment; and support partners that involve the community in estuary-related work.

Examples of resulting educational materials and projects, many undertaken with partner organizations and agencies, include:

- An informational map that highlights estuary resources and the Estuary Program partners
- A series of public-friendly booklets covering the estuary's geology and physical characteristics, bird life, and water quality
- A public service announcement for local television about the estuary and the Estuary Program
- A nature center highlighting estuarine resources and ways to enjoy the bay while protecting resources
- Storm drain stenciling and plaques
- Clean boating informational packets and signs
- Informational and interpretive signs along the waterfront
- Summer camp programs to provide coastal environmental experiences for underserved youth
- Stormwater pollution prevention media campaign
- Bayside Living Guide, which details how to reduce impacts to the bay in everyday life
- Teacher workshops and K-12 educational materials
- Special events, field trips, and booths at community functions
- Multi-day "State of the Bay" triennial event
- Estuary Tidings and other progress reports explaining the status of the bay by specific metrics
- Online weekly blog sharing updates from the Estuary Program and partners
- Informative website and other multimedia tools to share information
- Social media accounts to share program news with the public
- Public meetings on important estuary issues
- Regional conferences on estuarine and watershed resources
- Awarding Community Project funding to various program partners
- Development of a community volunteer program, in addition to the VMP
- Development of bilingual education materials that explain climate action plans and ways citizens can help implement them

The Estuary Program will continue to inspire human connections to the estuary, encourage behavior that benefits the environment, foster wider community participation in protecting and enhancing estuarine resources, and communicate scientific research about changing conditions of the bay and watershed.

EO-1

Public Outreach and Education

Conduct general public education and outreach focused on the value of a healthy environment and the role of individuals in protecting the natural resources of the Morro Bay watershed, and to communicate the results of the Estuary Program conservation and monitoring efforts.

Partners
Virtually every participating agency and organization in the Estuary Program is involved in general outreach and educational programs.

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$ - $$$

Implementation Tracking
The number and nature of educational and outreach projects and materials, including the number of persons in the target audience reached by them. Community Project awards and leverage ratios.

Funding
EPA, California Coastal Conservancy, California Coastal Commission, Ocean Protection Council, Private Donations, Private Foundations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Increasing awareness about the plants, wildlife, and ecology of the estuary supports the health of the estuary and every project of the Estuary Program. As illustrated by the educational projects accomplished since the original CCMP was adopted, various media and methods can be employed to increase awareness, explain environmentally friendly practices, and share conservation and monitoring results. These methods include exhibits and signage, publications and information packets, electronic media materials and outlets, participation in community events, education field trips, nature exhibits, and hosting conferences and public workshops. The most effective method employed in a particular situation depends on the target audience, nature of the information to be communicated, and cost constraints. Education and outreach efforts are both strategic, planned to address important issues, and opportunistic, taking advantage of events, partnerships or funding that will leverage effectiveness on relevant messages to important audiences.

The Estuary Program utilizes an Education and Outreach Working Group to help set priorities and to develop annual work programs. This group of local educators and outreach professionals guides the efforts of the programs and acts as liaisons to the community at large.

One of the Estuary Program's most popular and effective education efforts is the Community Projects program. These are awarded to local agencies and organizations who undertake projects that implement CCMP action plans. Since the program was instituted in 2001, the Estuary Program has awarded 67 projects totaling approximately $245,000 to dozens of partners. Projects include signage, educational publications, displays, and special events, among many others. Frequently, funding partially supports much larger projects, thus significantly leveraging scarce education and outreach funding available to local organizations. In 2012, the education mini-grant program was folded into a broader community projects program. (See https://www.mbnep.org/community-projects/ for more information.)

Future public education and outreach efforts by the Estuary Program might include:

- Continuation of regular communication avenues, such as blog, social media, and the website
- Increased use of innovative technologies and social-based outreach techniques
- Maintenance and enhancement of the Estuary Nature Center
- Expansion of a community volunteer program providing volunteer opportunities beyond the VMP
- Partnership efforts to increase awareness of the estuary and behavior changes, such as educational signage, events, and focused media campaigns
- Outreach and education efforts to encourage environmentally friendly practices to minimize impacts from recreational and economic activities in the estuary
- Facilitation of specific behavior changes through programs, such as Mutts for the Bay

EO-2

State of the Bay

Host triennial "State of the Estuary" information exchange effort and prepare a public friendly report to review progress on CCMP implementation, communicate scientific knowledge about the estuary, recognize and address challenges, and educate and engage the public about estuary issues.

Partners
Various volunteer speakers and presenters, DFW, DPR, Cal Poly, Water Board, California Coastal Commission, City of Morro Bay, County of San Luis Obispo, CSLRCD, UCCE, among others, have participated in presentations in previous years. In addition, private consultants and local experts have also participated.

Lead
Morro Bay National Estuary Program

Timeframe
The State of the Bay and accompanying report will continue on a triennial basis.

Cost
$

Implementation Tracking
The events and accompanying reports; the number of attendees.

Funding
EPA, Private Foundations, Private Donations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

Many community members trace the original impetus for creating the Estuary Program to a State of the Bay conference undertaken by concerned volunteers in the 1980s. The power of this type of event to communicate information and to galvanize action was clearly demonstrated. Since the adoption of the original CCMP, the Estuary Program has hosted five State of the Bay events, the most recently in 2017. This information exchange and outreach effort provides a forum for communicating the latest science about Morro Bay to a spectrum of audiences. Some portions of the event focus on exchanging technical information between practitioners and scientists, while other components engage the general public and environmentally literate citizens. The State of the Bay also updates the community on the status of the CCMP's implementation and on several environmental indicators of the health of the estuary.

Executing this complex, multi-day effort requires at least a year of planning. The event not only requires basic logistical work (venues, agendas, speakers/papers, publicity) but also relies on organization and assembly of the underlying science. This requires a lengthy process of analyzing multiple years of monitoring data and conservation results in a comprehensive and easy-to-understand form. Even before data is analyzed, a myriad of potential topics must be assessed to find those most relevant and timely.

A public friendly report is released in advance of the State of the Bay and describes the basic health of the estuary. The data and technical analyses that underlie this publication are carefully portrayed in ways easily understood by the general public. The accumulation of the science, its public friendly translation, and then the writing, illustrations, layout, printing, and distribution constitute a substantial effort by the Estuary Program.

Future efforts to continue State of the Bay and the related publication may include

- Evaluation of the indicators used in the public friendly report to describe the health of the estuary, and determination of whether these questions are adequate or need updating
- Data analysis and supporting preparation for the public friendly report every three years
- Organizational efforts to continue the triennial State of the Bay, incorporating innovative communication techniques and new event formats
- Targeted outreach efforts to expand the audience for the State of the Bay

EO-3

Nature Center

Continue to maintain a public environmental information display at the Estuary Program offices that educates people about estuarine resources and encourages the protection of those resources; continue to support the efforts of the Central Coast State Parks Association, California Department of Public Resources, and other organizations that provide similar displays and exhibits.

Partners
USEPA, CCSPA, DPR, SWAP, and numerous other funders

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$

Implementation Tracking
The ongoing operation of the nature center; number of visitors.

Funding
EPA, California Coastal Conservancy, California Coastal Commission, Ocean Protection Council, Private Donations, Private Foundations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

One of the more visible projects of the Estuary Program has been the estuary nature center, located adjacent to the program offices in Morro Bay. The nature center is an important avenue to reaching general public members and visitors that may otherwise be unaware of the Estuary Program and the unique environment of the estuary. The center includes artwork, taxidermy, live fish, and other exhibits that educate visitors about the estuary's resources and ways to live in and visit the area while minimizing impacts to those resources. Certain elements of the center are permanent, while others rotate to address issues of current emphasis. Funding and support for the exhibits has come from numerous sources, including the USEPA, Coastal Commission, and local businesses and foundations.

Another important venue for informational and interactive exhibits is the Museum of Natural History located in Morro Bay State Park. The Estuary Program has collaborated with the Central Coast State Parks Association (CCSPA), the nonprofit that supports the museum with DPR, with Community Project funding, special events, field trips, youth camps, and other educational programs. In addition to the Estuary Program nature center and the museum, a few other groups maintain educational displays relevant to estuarine resources, including SWAP, the County of San Luis Obispo, and the Pacific Wildlife Rehabilitation Center. The Estuary Program supports these partners' efforts.

Future activities to continue the nature center and related displays might include:

- Increased education programming offered in association with the Estuary Nature Center and other displays
- Enhancement of permanent exhibits to update scientific knowledge and incorporate new technologies
- Creation of innovative, new rotating exhibits to draw repeated visitors

EO-4

Formal Education Programs

Continue to provide educational opportunities focusing on estuary and watershed science and conservation for PK-12 schools and college programs, as outlined in the Education Strategic Plan.

Partners
San Luis Coastal Unified School District, California Coastal Commission and the Whale's Tail program, CCSPA and DPR, Cal Poly, Cuesta College

Lead
Morro Bay National Estuary Program

Timeframe
Ongoing.

Cost
$

Implementation Tracking
The number and nature of school-related programs; the number of students participating; the number of teachers trained.

Funding
EPA, California Coastal Conservancy, California Coastal Commission, Ocean Protection Council, Private Donations, Private Foundations

Measurable Obectives
Developing measurable objectives can require scientific research to determine feasible and relevant metrics that will demonstrate change. A measurable objective for this action plan will be developed with next CCMP update, pending the results of technical studies and input from technical advisory committee(s), as appropriate.

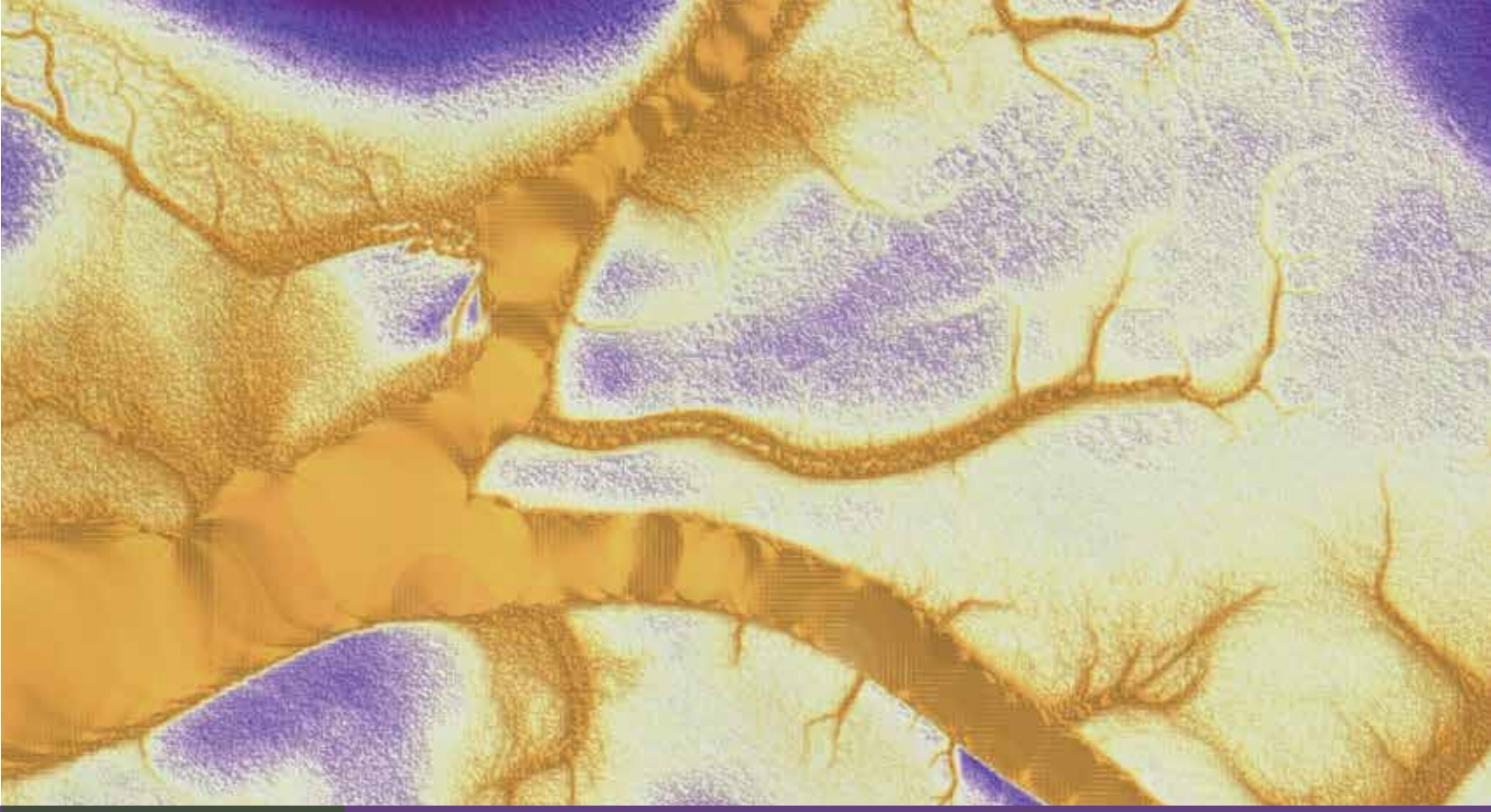
The Morro Bay estuary provides an excellent learning ground for all ages, but especially for school-age and college students. Lessons learned at school about the importance of the estuary and watershed, environmental science, and the ways people can affect the environment are frequently carried into the home to parents and siblings. Exciting students about estuary science can also be the starting point to scientific and conservation-oriented careers.

The Estuary Program's formal education efforts have focused on presentations and special events coordinated with local schools, as well as hosting field trips for local students and out-of-area underserved populations. In addition to direct contact with students, the Estuary Program has also conducted teacher training programs to strengthen environmental science, and estuary and watershed relevancy, in the curriculum. The Estuary Program will work toward a strategic approach on how the program can best assist local schools in enhancing their natural science curricula. In addition to working with schools, the Estuary Program has partnered with other organizations, such as the CCSPA, to provide formal education programming, such as field trips, teacher training, and day camps.

At the college level, the Estuary Program staff regularly lecture and lead lab sessions in oceanography, ecology, planning, environmental engineering, city and regional planning, and environmental science courses. These lectures provide students an opportunity to hear about science from people working on the ground and using scientific knowledge in their everyday endeavors. This kind of interaction can make scientific concepts, and scientific careers, more meaningful and accessible to students. The Estuary Program also supports student projects, including master theses and senior projects, to encourage young researchers to expand their knowledge of the estuary and its unique ecology.

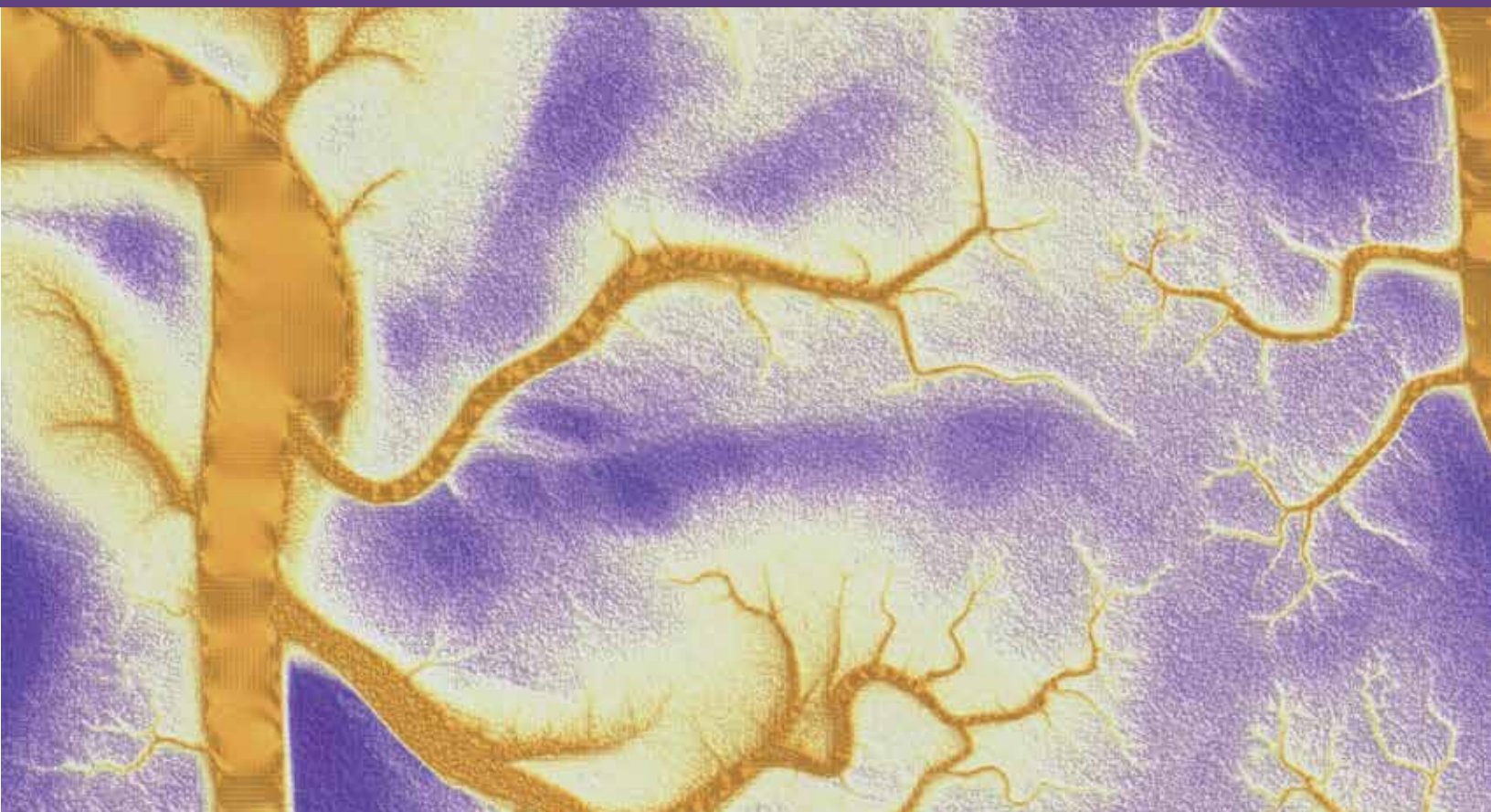
Future activities to continue formal education work may include:

- Teacher training opportunities to increase educators' understanding of estuary science concepts and their ability to apply those concepts in the classroom
- Collaborative work with local schools and teachers to increase estuary science in curricula
- Education field trips and other opportunities for students to learn outdoors and engage in the environment
- College-level lectures and lab sessions
- Mentorship of students desiring to complete scientific research about the estuary
- Provide local college students with opportunities to assist MBNEP with outreach and/or scientific activities as an internship, volunteer, or similar position. This includes partnering with related courses at local colleges to assist in outreach and scientific activities.



Chapter 4

Acronyms + Abbreviations



Acronyms + Abbreviations

Please refer to this list as you read through the CCMP:

ACOE	Army Corps of Engineers
ANEP	Association of National Estuary Programs
BF	Bay Foundation of Morro Bay
BLM	Bureau of Land Management
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
Cal EMA	California Emergency Management Authority
CAL-EPA	California Environmental Protection Agency
Cal Poly	California Polytechnic University
Camp SLO	Camp San Luis Obispo, California National Guard
CAP	Climate Action Plan
CAPE	Coastal Alliance on Plant Expansion
CCAMP	Central Coast Ambient Monitoring Program
CCC	California Conservation Corps
CCER	Chorro Creek Ecological Reserve
CCMP	Comprehensive Conservation and Management Plan
CCSPA	Central Coast State Parks Association (formerly Central Coast Natural History Association)
CDBW	California Department of Boating and Waterways
CDF	California Department of Forestry and Fire Prevention
CDC	Coastal Development Permit
CDPH	California Department of Public Health
cfs	Cubic feet per second
CMC	California Men's Colony
CREEC	California Regional Environmental Education Community
CSD	Community Services District
CSLRCD	Coastal San Luis Resource Conservation District
CWA	Clean Water Act
DBW	California Department of Boating and Waterways
DFW	California Department of Fish and Wildlife
DO	Dissolved oxygen
DPR	California Department of Parks and Recreation (includes California State Parks)
EC	Executive Committee
ESA	Endangered Species Act
GIS	Geographic Information System
ICLEI	ICLEI – Local Governments for Sustainability
IRWM	Integrated Regional Water Management
IWMA	Integrated Waste Management Authority
JPA	Joint Powers Authority

LID	Low Impact Development
LOCAC	Los Osos Community Advisory Council
LOCSD	Los Osos Community Services District
mgd	Million gallons per day
NEP	National Estuary Program
NEPA	National Environmental Protection Act
NERR	National Estuarine Research Reserve
NERRA	National Estuarine Research Reserve Association
NNE	Numeric nutrient endpoint
NOAA	National Ocean and Atmospheric Administration
NOAA Fisheries	National Ocean and Atmospheric Administration National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Science
OSPR	Office of Oil Spillage Prevention and Response (within Department of Fish and Wildlife)
QAPP	Quality Assurance Project Plan
SCCWRP	Southern California Coastal Water Research Project
SGMA	Sustainable Groundwater Management Act
SLO	San Luis Obispo
SLOSEA	San Luis Obispo Science and Ecosystem Alliance
California State Water Board	California State Water Resources Control Board
SWAP	Small Wilderness Area Preservation
SWPPP	Stormwater Pollution Prevention Plans
TAC	Technical Advisory Committees
TMDL	Total Maximum Daily Loads
TNC	The Nature Conservancy
TPL	Trust for Public Land
UCCE	University of California Cooperative Extension
USDA	United States Department of Agriculture
USDOF	United States Department of Forestry
USEPA	United State Environmental Protection Agency
USF	University of San Francisco
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultraviolet
VMP	Volunteer Monitoring Program
Water Board	Central Coast Regional Water Quality Control Board
WCB	Wildlife Conservation Board
WRF	Water Reclamation Facility
WWTP	Wastewater treatment plant

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Appendix A

Glossary

action plan	Actions the Estuary Program will undertake to support the conservation and sound management of the estuary and watershed.
appropriated	Term used to describe water rights that are permitted through the State Water Resources Control Board. When water rights in a specific watershed or system have been permitted to the maximum extent, that system is said to be "fully appropriated".
aquifer	Underground layer of rock or soil that contains water. The water is held in the spaces between the rock or soil particles. An aquifer holds groundwater.
bathymetry	The physical shape of a basin which contains water, with special attention to the contours of depth; variations in mean depth in a body of water.
best management practice (BMP)	Practices or combination of practices that are determined to be the most effective and practical means of controlling point and non-point source pollutants at levels compatible with environmental quality goals.
bioaccumulation	Accumulation of chemicals in the tissue of an organism over time because the rate of intake exceeds the organism's ability to remove the substance from the body.
biodiversity	The variety of life and its processes; it includes the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.
brackish	Less salty than seawater, but more salty than fresh water; an intermediate saline habitat that is usually found under low flushing conditions.
climate change	Climate change refers to any significant change in the measures of climate lasting for an extended period of time. Climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer. *(from USEPA definition)*
confluence	The meeting, or flowing together, of two of more bodies of water.
conservation easement	A voluntary, legally binding agreement that limits certain types of uses or prevents development from taking place on a piece of property now and in the future, while protecting the property's ecological or open-space values. These types of easements protect land while allowing the owners to retain many private property rights to live on and use their land. *(from The Nature Conservancy)*
dissolved oxygen	Oxygen that is present (dissolved) in water and therefore available for fish and other aquatic animals to use. If the amount of dissolved oxygen in the water is too low, then aquatic animals may die. Wastewater and naturally occurring organic matter contain oxygen-demanding substances that consume dissolved oxygen.

dredging	Any physical digging into the bottom sediment of a water body. Dredging can be done with mechanical or hydraulic machines, and it changes the shape and form of the bottom. Dredging is performed in order to maintain navigation channels that would otherwise fill with sediment and block ship passage.
E. coli (Escherichia coli)	A type of bacteria found in the digestive tract of warm-blooded animals that is used as an indicator of water quality in freshwater. The USEPA set limits on the amount of *E. coli* that should be present in waters used for recreational contact, such as swimming.
ecosystem	A community of organisms interacting with each other and with their environment.
ecosystem function	Exchanges of nutrients, energy, and waste between both the living and non-living components of an ecosystem. Ecosystem functions that have the capacity to provide goods and services to humans are termed ecosystem services.
effluent	Wastewater discharged into a body of water from point sources. The material which flows out of a pipe or facility into a water body (or another larger pipe). For example, the treated liquid discharged by a wastewater treatment plant is the plant's effluent.
emerging contaminants	Contaminants that are unregulated, or that may be present but not previously detected, and have the potential to cause adverse ecological and/or human health effects. Includes pharmaceuticals and personal care products, industrial chemicals at low concentrations, and chemicals that may affect hormone status called endocrine disruptors.
endangered (species)	A species is considered endangered when it faces possible extinction throughout all, or a significant portion of, its range. The predominant cause is loss of habitat.
endemic	A native species defined in terms of a restricted geographical range.
entrainment	Occurs when organisms are drawn into a facility's (normally a power plant) cooling system and are exposed to high pressures and temperatures that result in death. Small organisms, such as fish larvae are the most susceptible. *(from the USEPA)*
estuary	A semi-closed coastal water body which has free connection to the open sea and within which seawater is measurably diluted with freshwater. The degree of mixing and layering (freshwater tends to float on top of the sea water) depends on tidal conditions, river flow, and local currents. Estuaries typically support life forms which can tolerate varying salinities.
estuarine	Of or having to do with an estuary.
fauna	The animals of a given region or period considered as a whole.
fertilizers	Material added to the soil to supply chemical elements needed for plant nutrition.
filter feeder	Organisms that feed by filtering dissolved and suspended matter from the water around them (e.g., oysters).
floodplain	Low-lying areas susceptible to being inundated by flood waters. Generally adjacent to rivers, streams, lakes, estuaries, and other waterbodies, floodplains are also areas that sediment being carried by flood waters can be deposited.
flora	The plants of a particular region or period, listed by species and considered as a whole.
geographical information systems (GIS)	Computer mapping tool capable of overlaying data for manipulation and display.

geomorphology	The study of the physical features of land and how they are formed and modified.
greenbelt	Stretches of undeveloped land surrounding existing communities, serving the purpose of encouraging future development within existing communities rather than developing sprawl on the outskirts of urban areas.
groundwater recharge	Precipitation that infiltrates into the soil and adds to groundwater aquifers. Groundwater recharge occurs naturally or can be facilitated through specific development approaches (such as low impact development) or injection of water into aquifers using injection wells.
habitat	Geographical unit that supports the survival and reproduction of a given species or of individuals of a given species. This unit includes the presence of other organisms and abiotic factors that support the particular species being considered. *(from Encyclopedia of Earth, www.eoearth.org)*
heavy metals	Metallic elements, such as lead, mercury, silver, cadmium, copper, chromium, and zinc, which have relatively high atomic weights and may be toxic at high concentrations. Such metals are toxic to life and continuously pose a threat in aquatic environments because they can be re-suspended into the water column when sediment is disturbed.
hydrodynamics	The study of motion of liquids, and in particular, water. A hydrodynamic model is a tool able to describe or represent in some way the motion of water, including constituents carried by water (such as sediment).
hydrologic cycle	The continuous circulation of water in the Earth-Atmosphere system (also known as the water cycle). At its core, the hydrologic cycle is the motion of the water from the ground to the atmosphere and back again. The major processes that drive the hydrologic cycle are evaporation, transpiration, condensation, precipitation, and runoff. *(from NOAA, National Weather Service)*
impaired water body	Pursuant to the Clean Water Act, Section 303(d), a water body is listed as impaired if evidence exists that a violation, or potential future violation, of a water quality standard has or may occur.
impingement	Occurs when organisms are trapped against screens when water is drawn into a facility's (normally a power plant) cooling system. The injuries often prove fatal within a few days (e.g., fish lose gills and are unable to breathe). Young or small fish are most susceptible to being killed by impingement. *(from USEPA)*
impervious surface	Any pavement or other construction material (e.g., asphalt, cement, and roofing materials) that does not allow water to percolate through it to infiltrate groundwater. Stormwater water flows more rapidly over impervious surfaces and collects pollutants that are carried to nearby waterbodies.
implementation tracking	Measures by which the Estuary Program, partners, and the public can determine whether or not an action plan has been implemented and how far along it is. Many of the tracking measures are general in nature, recognizing that more specific measures will be developed for individual projects under each action plan.
Interlocutory Stipulated Judgment (ISJ)	A court-ordered agreement between parties to settle a legal dispute. In Los Osos, the ISJ created a working group of all parties involved in managing local groundwater resources. This working group is tasked with developed a basin management plan for the community.
intertidal	That portion of the shore which is between high and low tide levels; the substrate and organisms in the intertidal are alternately covered by seawater and exposed to the air.

invasive species	Non-native plants, animals, insects, and diseases which cause, or are likely to cause, significant impacts to our economy, environment, or human health.
littoral sand	Sand associated with the shore or nearshore coastal areas.
macroinvertebrate	Animals without a backbone that can be seen with the naked eye.
migration	The movement of animals between habitats to take advantage of more hospitable conditions during certain parts of the year. Many birds that spend summertime in northern climates migrate south in the winter to warmer weather and more readily available food sources.
migration corridor	A linkage between habitats in an ecosystem that counteracts habitat fragmentation and increases usable habitat for a variety of wildlife. Corridors may be contiguous for animals that move on land or a series of distinct stopovers for birds.
National Estuary Program (NEP)	The NEP was established under Section 320 of the 1987 Clean Water Act (CWA) Amendments as a USEPA place-based program to protect and restore the water quality and ecological integrity of estuaries of national significance. Section 320 of the CWA calls for each NEP to develop and implement a Comprehensive Conservation and Management Plan (CCMP).
National Pollutant Discharge Elimination System (NPDES)	As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.
nitrate	A form of the nutrient nitrogen that is readily absorbed by plants.
non-fouling paint	Boat paint that incorporates toxic substances to prevent marine organisms from growing on the hull.
non-point source pollution (NPS)	Pollution that enters water from dispersed and uncontrolled sources (such as stormwater and surface runoff) rather than through pipes. Nonpoint sources (e.g., forest practices, agricultural practices, on-site sewage disposal, automobiles, and recreational boats) may contribute pathogens, suspended solids and toxicants. While individual sources may seem insignificant, the cumulative effects of nonpoint source pollution can be significant.
nutrients	Any substance required by organisms for normal growth and maintenance. Mineral nutrients usually refer to inorganic substances derived from soil and water. Excessive amounts of nutrients, including nitrogen and phosphorus, may result in excessive growth of algae in waterways, leading to oxygen depletion and water quality degradation.
pathogen	An agent, such as a virus, bacteria or fungus, that can cause disease in humans.
permeable surface	Any pavement or other construction material that allows stormwater to infiltrate and contribute to groundwater recharge while also serving as a structural surface
pesticides	Any substance that is intended to prevent, destroy, repel, or mitigate any pest (e.g., insects, vermin, and weeds). *(from the USEPA)*
photosynthesis	The process by which plants and other organisms convert the energy in sunlight into organic matter and oxygen.
point source pollution	A source of pollutants from a single point of conveyance, such as a pipe. For example, the discharge from a sewage treatment plant or a factory is a point source.

public trust resources	Natural resources that are held "in trust" benefit of the public, for commerce, and other activities in which all citizens are free to engage. Originally applied to navigable waterways, this concept has been expanded through court rulings to include scenic, recreational, and wildlife resources in many areas.
Ranch Water Quality Plans	Plans that are developed by individual landowners, with support from the University of California Cooperative Extension and the Natural Resources Conservation Service. These plans help landowners address nonpoint source pollution, identify potential water quality threats and relevant BMPs on their property, and are written in line with local and regional water quality guidelines
rare (species)	Rare is a classification given to a species when, although not presently threatened with extinction, it exists in such small numbers throughout its range that it may become endangered if its environmental conditions worsen.
remediation	The removal of pollutants or contamination from an environmental medium, such as groundwater, soil, sediment, or surface water.
resiliency	The capacity of an ecosystem to absorb disturbances and still retain its basic function and structure.
riparian	Habitat occurring along the bank of a natural and freshwater waterway (e.g., river, stream or creek), which provides for a high density, diversity, and productivity of plant and animal species.
rotational grazing	The management of grazing livestock by strategically moving the animals through a series of pasture areas to allow vegetation to regenerate in previously grazed areas. This practice helps prevent overgrazing and promote optimal forage growth.
salinity	Concentration of salt in water, usually measured in parts per thousand (ppt). The salinity of seawater in the open ocean is normally between 30 and 35 ppt.
saltwater intrusion	Movement of saltwater into coastal freshwater aquifers due to groundwater pumping at a rate higher than the aquifer can be replenished by infiltration.
sediment	Mud, sand, silt, clay, and other particles that settle on the bottoms of waterways.
spawning	The process by which fish propagate by releasing eggs and sperm into the water column.
special status species	Federal and state classifications for plants and animals species that are either listed as threatened or endangered species, are formally recognized candidates for a listing, or are declining to a point where they may be listed.
stormwater	Excess water that flows over the land when the soil is infiltrated to full capacity during storm events. As stormwater moves across land, it can pick up contaminants (also referred to as non-point source pollution).
Stormwater Pollution Prevention Plan (SWPPP)	A required component of the NPDES process for construction or industrial facility activities.
substrate	Material that forms a stream or lake bed (silt, sand, gravel, cobble, etc.).
surface water rights	The right to use surface water. Surface water rights in California in some cases require a permit from the State Water Resources Control Board.

tertiary treatment	Wastewater treatment that goes beyond primary and secondary treatment and is used to increase the water quality of effluent produced. Tertiary treatment may address a number of issues, such as removing additional organic and suspended solid materials, nutrients, or toxic substances. In some cases, tertiary treatment generates effluent that is clean enough for re-use in specific instances.
tidal flushing	The time it takes for all the water in an estuary to completely cycle out (also called flushing time).
threatened (species)	A species is threatened when, although not presently at risk of extinction, it is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts.
total maximum daily loads (TMDLs)	A calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.
turbidity	A measure of the amount of material suspended in the water. Increasing the turbidity of the water decreases the amount of light that penetrates the water column. High levels of turbidity are harmful to aquatic life.
urban runoff	Water containing pollutants like oil and grease from leaking cars and trucks; heavy metals from vehicle exhaust; soaps and grease removers; pesticides from gardens; animal waste; and street debris, which washes into storm drains and gets carried out to the ocean.
wastewater	Water contaminated with the byproducts of domestic, commercial, agricultural, or industrial uses.
wastewater treatment	Processes that help remove solids, nutrients, and other pollutants from water before it is discharged or reused.
water column	Concept of a column of water that extends from the surface to bottom sediments in a waterbody.
watershed	The geographic region within which water drains into a particular river, stream, or body of water. A watershed includes hills, lowlands, and the body of water into which the land drains. Watershed boundaries are defined by the ridges of separating watersheds.
wetlands	Land where the water table is usually at or near the surface. Some wetlands contain water year-round; others may remain relatively dry for months, becoming moist only during periods of heavy rain. Wetlands are vital habitats for many species of plants and animals; they are protected by local, state and federal regulations.
wildlife	Undomesticated animals that live either in a single geographic area or migrate from one area to another.

Appendix B

Participants and Contributors from the 2001 CCMP

LOCAL POLICY COMMITTEE (LPC)

Rodger Anderson
Mayor, City of Morro Bay

Shirley Bianchi
District 2 Supervisor, San Luis Obispo County

Linda Chipping
San Luis Coastal Resources Conservation District

Chris Clark
The Bay Foundation of Morro Bay

Colby Crotzer (Alternate)
Morro Bay City Council

Brian Duke
Camp San Luis, California National Guard

Brad Hagemann, Chair
Central Coast Regional Water Quality Board

Richard Machedo (Alternate)
San Luis Obispo County

Cheryl McGovern
U.S. Environmental Protection Agency Region IX

Dave Paradies (Alternate)
Friends of the Estuary

Steve Soderstrom
Agricultural Representative

Gregory Smith (Alternate)
The Bay Foundation of Morro Bay

John Swift (Alternate)
Coast San Luis Resource Conservation District

Richard Watkins
Friends of the Estuary

Karen Worcester (Alternate)
Central Coast Regional Water Quality Board

Nancy Woo (Alternate)
U.S. Environmental Protection Agency Region IX

EX-OFFICIO LPC MEMBERS

State Water Resources Control Board
John W. Brown (Member)
Paul Lillebo (Alternate)

U.S. Environmental Protection Agency
Nancy Laurson, NEP Program Coordinator
Jessica Cogan, (former) NEP Program Coordinator
Betsy Tam Salter, (former) NEP Program Coordinator

California Coastal Commission
Peter Douglas, Secretary
Tami Grove (Alternate)

California Environmental Protection Agency
Winston H. Hickox, Secretary
Peter Rooney, (former) Acting
James Strock (former) Secretary
Crawford Tuttle (Alternate)

Central Coast Regional Water Quality Board
Russel M. Jeffries, Chair
Harold P. Fairley (former) Chair
Bill Newman (former) Chair

U.S. Environmental Protection Agency, Region IX
Felicia Marcus, Regional Administrator
Alexis Strauss (Alternate)
California Resources Agency
Mary Nicols, Secretary
Douglas Wheeler (former) Secretary
Craig Denisoff (Alternate)

PREVIOUS LPC MEMBERS

Jerri Chadwick
Friends of the Estuary

Sarah Christie, Alternate
San Luis Obispo County

Jane Diamond
U.S. Environmental Protection Agency
Region IX

Dave Elliott
Morro Bay City Council

Vern Jones
Central Coast Regional Water
Quality Control Board

Bud Laurent
District 2 Supervisor, San Luis Obispo County

Cathy Novak
Former Mayor, City of Morro Bay

Dave Paradies
The Bay Foundation of Morro Bay

Ellen Perryess
Co-Chair, Friends of the Estuary

Gary Ruggerone
The Bay Foundation of Morro Bay

James White
The Bay Foundation of Morro Bay

WATERSHED COMMITTEE MEMBERS

Rick Algert
Morro Bay Harbor Department

Carol Arnold
California Coastal Conservancy

Rob Blasberg
U.S. Army Corps of Engineers

Bill Boucher
Morro Bay Public Works Department

Les Bowker
Small Wilderness Area Preservation

Rosemary Bowker
Los Osos Community Services District

Albert Calizo
Bay Osos Filipino Association

Ellen Carroll
San Luis Obispo County Department of Planning & Building

Chuck Cesena
Cal-Trans

Linda Chipping
San Luis Coastal Resource Conservation District

Vince Cicero
California Department of Parks & Recreation

Brian Duke
Camp San Luis, California National Guard

Major Kelly Fisher
Camp Roberts, California National Guard

Joy Fitzhugh
Farm Bureau of San Luis Obispo County

Melody Fountain
U.S. Forest Service

D.J. Funk
Los Osos Community Advisory Council

Les Martin
Los Osos Community Advisory Council

Jack Hansen
Morro Bay Commercial Fishermen's Association

Bob Hardy
California Department of Fish & Game

Gordon Hensley
Los Osos Community Services District

Mark Jeude
California Department of Health Services

John Kellerman
California Men's Colony

Kim Kimball
Morro Bay Chamber of Commerce

Royce E. Larsen
University of California Cooperative Extension

Susan Lichtenbaum
Morro Bay Harbor Department

Margery Linquist
Natural Resources Conservation District

Tom Lott
Duke Energy Power Services

Hoa Ly
U.S. Army Corps of Engineers

Chuck Marshall
California Department of Fish & Game

Greg Martin
San Luis Obispo County Engineering Department

Suedene Nelson-Walker
Former Morro Bay Chamber of Commerce

Cathy Novak
Former Morro Bay Commercial Fishermen's Association

Brenda Ouwerkerk
San Luis Obispo County Agriculture Commissioner's Office

Ellen Perryess
Central Coast Natural History Association

Ron Popowski
U.S. Fish & Wildlife Service

David Pritchett
U.S. Fish & Wildlife Service

Colleen Ray
Central Coast Natural History Association

Greg Smith, Alternate
The Bay Foundation of Morro Bay

Ed Spaulding
Chevron Corporation

John Swift
Coastal San Luis Resource Conservation District

Diane Vavrek
Chevron Corporation

Don Warden
Warden Ranch Landowner

John Warrick
San Luis Obispo County Agriculture Commissioner's Office

Richard Watkins
Friends of the Estuary

Bill Weitkamp
University of California Cooperative Extension

James White, Chair
The Bay Foundation of Morro Bay

Mike Wulkan
San Luis Obispo County Department of Planning & Building

WATERSHED COMMITTEE PARTICIPANTS

Joe Asire
Los Osos Chamber of Commerce

Dan Bennett
U.S. Coast Guard

Bruce Bonifas
California Conservation Corps.

James Bower
Public-at-Large

Katherine Bower
Public-at-Large

David Chipping
Cal Poly State University

Bobby Jo Close
California Conservation Corps.

Jan DiLeo
San Luis Obispo County Parks & Recreation

Stephen Fine
U.S. Army Corps of Engineers

JoAnn Froland
Camp San Luis, California National Guard

Jody Giannini
Morro BayHarbor Advisory Board

Henrietta Groot
Coastal Alliance/Sierra Club

Robert E. Hendrix
Department of Public Services

Dave Highland
California Department of Fish & Game

Alex Hinds
San Luis Obispo County Department of Planning & Building

Monica Hunter
Friends of the Estuary

Lionel Johnston
Public at Large

Jim Keese
CalPoly State University

Bruce Keogh
City of Morro Bay, Public Works Department

Gary Ketcham
Cal Poly State University

Ralph Lingle
Sportsmen's Council

Sorrel Marks
Central Coast Regional Water Quality

Control Board

Wallace McCray
Morro Bay Planning Commission

Malcolm McEwen
Coast San Luis Resource Conservation District

Bill Millhouser
National Oceanic & Atmospheric Administration

Marla Morrissey
Morro Estuary Greenbelt Alliance

Annie Mueller
Los Osos Chamber of Commerce

Shauna Nauman
Morro Bay Community Development Department

Mike Oviatt
San Luisita Ranch

Ben Parker
California Department of Forestry

Chris Pattison
California Department of Fish & Game

Pete Pedersen
Cuesta College Biology Department

Scott Robbins
Natural Resources Conservation Service

Gary Ruggerone
Cal-Trans

Bill Schwebel
Williams Shellfish Farms

Mark Schwartz
California Men's Colony

Linda Shotwell
Cal Poly Farms

Stan Stein
Los Osos Community Services District

Kate Symonds
U.S. Fish & Wildlife Service

Jude Warnisher
Morro Estuary Greenbelt Alliance

Cass Wixom
Agricultural Representative

Don Wixom
Agricultural Representative

Jim Wood
Morro Bay Harbor Advisory Board

STATE WATERSHED PLAN COUNCIL

Walt Bremer
John Burch
Melodie Kreimes
Frank Little
Bill Newman
Frank Oakes
Norm Pillsbury
Steve Rebuck
Tom Stewart
Shaunna Sullivan
Jeff Wheelwright
Patti Whelen

TECHNICAL ADVISORY COMMITTEES

NEP TAC

Don Asquith
Susan Ayres
Curt Batson
Ray Belknap
Brock Bernstein
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Melissa Boggs
Bruce Bonifas
Cathy Borg
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Royden Nakamura
Shauna Nauman
Judy Neuhauser
Cathy Novak
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Cy R. Oggins
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Jim Watkins
Richard Watkins
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James White
Bill Williams
Regina Wilson
Karen Worcester
Jeffrey Young
Susan Zepeda
Candi Zizek

BAC TAC

Don Asquith
Susan Ayres
Curt Batson
Joyce Bertoldo
Rosemary Bowker
Marilyn Britton
Bruce Buels
John Chesnut
Vince Cicero
Jeff Edwards
Bruce Elliott
Major KellyFischer
Joy Fitzhugh
Brad Hagemann
Bob Hardy
Gordon Hensley
Bill Hoffmann
Vern Jones
John Kellerman
Bruce Keogh
Gary Ketcham
Chris Kitts
Randy Knight
Howard Kolb
Katie Kropp
Gregg Langlois
John Larson
Michael Lebrun
Carroll Leslie
Susan Lichtenbaum
John Lien
Sorrel Marks
Greg Martin
Deborah McArdle
Teresa McClish
Cheryl McGovern
Marina Michelle
Mark Moline
Melissa Mooney
Judy Neuhauser
Linda O'Connell
Matt Oliver
Dave Paradies
Ellen Perryess
Tim Sample
Bill Schwebel
Philip Teresi
Dean R. Tyler
Bill Williams
Regina Wilson
Karen Worcester
Jeffrey Young
Candi Zizek

BAY TAC

Susan Ayres
Brock Bernstein
John Chesnut
Vince Cicero
Bruce Elliott
Bob Hardy
Bill Hoffmann
Masaacki Hori
Eiji Imamura
Ellen Jagger
Randy Knight
Katie Kropp
Gregg Langlois
Lisa Langs
John Larson
Teresa Larson
Michael Lebrun
Susan Lichtenbaum
John Lien
Greg Martin
Deborah McArdle
Lisa McCann
Melissa Mooney
Nancy Myers
Judy Neuhauser
Linda O'Connell
Frank Oakes
Dave Paradies
Ellen Perryess
Tom Richards
Tim Sample
Alan Scott
Dave Smith
Jason Stannard
John Steinbeck
Julie Thomas
Rick Ware
Bill Williams
Karen Worcester
Jeffrey Young
Candi Zizek

CITIZENS ADVISORY COMMITTEE

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Grace Beigle
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Marilyn Britton
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Marla Morrissey
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Diana Sheridan
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Reg Whibley
Bill Williams
Jim Wood
Jon Wordsworth

VOLUNTEERS

Will Abel
Mary Adams
Matthew Allie
Cameron Allie
Alyce Andrews
Ruth Ann Angus
Florence Appel
Karl Appel
Susan Atlee
Jorge Baca
Tamara Baggett
Maya Bahan
Connie Baksic
Scott Baksic
Randy Ball
Barbara Baltimore
Darla Barclay
Diana Barnheart
Al Barrow
Christie Batchelder
Leah Bauer
Michael Behrens
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Jack Beigle
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Brian Dietterick
Andrew Dodson
Sean Dougan
Gene Doughty
Noah Doughty
Cheryl Dove
Gary Dove
Katie Drexhag
Abby Dworschack
Guy Easterling
Scott Eckardt
Tom Edell
Dave Elliott
Brandon Emerson
Denise Emerson
Ingrid Fagan
Marilyn Farmer
Chris Ferby
Lara Ferris
Carrie Filler
Zelma Fishman
Hilary Fleming
Carmen Fojo
Carolyn Frank
Judy Frankel
Carl Freeman
Jason Freeman
Tim Frein
Kerry Friend
Christina Fusillo
Jonny Gange
Nealy Gary
Dan Gates
Bill Geier
Sam Geier
Steven Gerdes
Shanda Gibbs
Claudia Goff
Jessie Goff
Garry Grabow
Stanley Grabowski
Sharon Grant
Terry Grant
Hannah Gray
Tina Grietens
Carmelita Gutierrez
Dave Hacker
Brad Hagemann
Jack Haley
Lynne Haley
Diane Hall
Brent Hallock
Julie Hanks
Rich Hanks
Richard R. Hansen
Lucas Hanover
Saskia Hanover
Tara Hanover
Vivian Hanover
Tyler Hanson
Bev Hardy
Meredith Hardy
Clint Harris
Rosemary Hathaway
Jim Havlena
Karen Havlena
Giles Healy
Erika Heine
John A. Helps
Tammy Hendricks
Michelle Heon
Rick Hernandez
Linus Heydon
Grant Himebaugh
Pat Howell
Susan Howell
Dawn Hutchinson
Davis Innis
Joanna Iwanicha
Ellen Jagger
Ana M. James
Aaron Jayne
Gene Johe
Alison Jones
Jeff Jones
June Jones
Leif Jones
Melissa Jones
Vern Jones
Gary Karner
Laurel Karren
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Sierra Kelso
Kristi Kempf
Scott Kimura
Ed King
Ray King
Kimberly King
Mary King
Jason Kirschenstein
Chris Kitts
Randy Knight
Sally Knight
Claire Knopf
Terri Knowlton
Eric Knudten
Carol Kolb
Howard Kolb
Sally Krenn
Katie Kropp
Michael Lacey
Nancy C. LaGrille
Machael Landino
Jeff Langman
Lisa Langs
Mike Lansdon
Leah Larson
Teresa Larson
Mary Leizear
Steve LePell
Hennie Lichtenbaum
Nadine Lilley

Ernie Lowry
Martine Lynch
Maura Mahon
Christopher Mann
Jim Marrocco
Tessi Marsh
Alan Martyn
Jackie Martyn
Steve Mathiew
Allie Matthew
James Matthiessen
Arlene Mayer
Norman Mayer
Earle Mayfield
Margaret Mayfield
Lisa McCann
Rob McCann
Sarah McCann
Matt McCarthy
Teresa McClish
Scott McCorkhill
Solomon McCrea
Eric McDonald
Margot McDonald
Marilyn D. McDonald
Malcolm McEwen
Cheryl McGovern
Diane McGrath
Natalie McKinney
Tara McMoore
Brendan McNamara
Daniel McNamara
Vincent McNamara
Patrick McNeill
Susan McTaggart
Jim McWilliam
David Mennel
Anna Mesmer
Michael Miller
Vita Miller
Dan Milligan
Kay Milligan
Mark Moline
Christina Montanio
Lynn Moody
Melissa Mooney
Bill Moore
Emma Moore
Jack Moore
Laura Moore
Rachel Moran
Patrick Moreland
Rachel Morgan
Thomas Morgan
Elizabeth Morin
Zotique Morin
Marla Morrissey
Daniel Morrison
Kari Morrison
Kathy Morrison
Kyle Morrow
Gerald Mueller
Jay Mueller
Eddie Myerholz
Nancy Myers
Elsa Nanson
Patrick Nanson
Tim Nanson
Raven Nassar
Allyson Neal
Matthew Neal
Eric Nelson
Kelley Nelson
Judy Neuhauser
Bill Newman
Dale Norrington
Dorothy J. Norwood
Cathy Novak
Gregory Nowell
Susan L. O'Connor
Connie O'Henly
Sherry Ortiz
Harvey Packard
Amy Palkovic
Dave Paradies
Phyllis Paradies
Al Pardo
Carrie Pardo
Karen Parrish
Jeff Patterson
Christine Pattison
Dede Pauze
Trerra Pauze
Roger Peletier
Chet Perryess
Ellen Perryess
Nicholas Peters
Bruce Peterson
Daniel Phares
Lauren Poe
Chris Prevost
Steve Pryor
Barry Putman
Anne Quinn
Colleen Ray
Mary Reents
Paul Reeves
Carol Ann Reinman
Ann Reynolds
Bill Reynolds
Patricia Riley
Scott Robbins
Mike Robertson
Grace Hayes Romero
Dorothy Rooney
Sylvia Rosenberg
John Roser
Brad Ross
Alisa Royer
Celeste Royer
Jim Royer
Gary Ruggerone
Nancy Ruhl
Kim Sanders
Fred Sears
Eric Sexton
Lila Sexton
Valerie Seymour
Chad Schoenthal
Steve Schubert
Sandy Schultz
Marne Settera
Nancy Severson
Linda Shotwell
Mary Singleton
Anthony Skinner
Bob Sloan
Kevin Smith
Robbyn Smith
Kelly Spitale
Kristina Spitale
Branden Stahl
Brian Stark
James Strong
Julie Strong
Craig Stubler
Emma Sturm
Mary Sturm
Joan Sullivan
Brycen Swart
Linda Tanner
Bunty Taylor
Cara Taylor
John Taylor
Denny Thatcher
Christina Thayer
Julie Thomas
Michael Thomas
Matt Timmes
Mark Tognazzini
Mike Tomac
Tina Torresan
Kara Tyler
Paul Twedt, Jr.
Jan Van Koehe
James R. Vilkitis
Lisa Villa
P. Jane von Koehe
Dan Wackerman
Justin Wada
Lori Wada
Stephen Wada
Jessica Walker
Beth Warner
Trevis Warner
Stacy Washmath
Saun Watkins
Jasmine Watts
Dick Webber
Sandy Webber
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Gerard Wells
Joseph Wells
Jeff Wheelwright
Matt White
Dennis Whittinghill
Bill Williams
Eunice Wilson
Ray Wilson
Regina Wilson
Melody Wiser
Steve Wiser
Bill Woodson
Karen Worcester
June Wright
Roger Zachary
Frank Zika

NON-FEDERAL MATCH SERVICE PROVIDERS

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Mills Copy Center
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Morro Bay Recreation and Parks, Meeting Facilities
Ted Peterson, Computer Consultant
PG&E, Computer/equipment donation
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CCMP REVIEWERS/COMMENTORS

Rosemary Bowker
Los Osos Community Services District

Ellen Carroll
San Luis Obispo County Department of Planning & Building

Linda Chipping
Coastal San Luis Resource Conservation District

Vince Cicero
California Department of Parks & Recreation

Jessica Cogan
U.S. Environmental Protection Agency

Mark Delaplaine
California Coastal Commission

Brian Duke
Camp San Luis, California National Guard

Dwight Dutschke
State Historic Preservation Office

JoAnn Froland
Camp San Luis, California National Guard

Henriette Groot
Coastal Alliance on Plant Expansion

Michael Giuliano
California Department of Transportation

Robert Hendrix
City of Morro Bay, Department of Public Services

Dave Highland
California Department of Fish & Game

Charles Lester
California Coastal Commission

Susan Lichtenbaum
Morro Bay Harbor Department

Lisa Horowitz McCann
Central Coast Regional Water Quality Control Board

Cheryl McGovern
U.S. Environmental Protection Agency Region IX

Marla Morrissey
Morro Estuary Greenbelt Alliance

Bob Neale
Sustainable Conservation

Ellen Perryess
Central Coast Natural History Association

Colleen Ray
Central Coast Natural History Association

Scott Robbins
Natural Resources Conservation Service

Ella Honeycutt
Natural Resources Conservation Service

Domenic Santangelo / Bruce Bonifas
California Conservation Corps

Pete Sarafian
Small Wilderness Area Preservation

Greg Smith
The Bay Foundation of Morro Bay

Anthony Spina
National Marine Fisheries Service

Richard Watkins
Friends of the Estuary

Adam White
Central Coast Regional Water Quality Control Board

COMMUNITY MEMBERS

Eric G. Barham
Larry Bender
Liz Blake
Jim Bower
Les Bowker
Bill Denneen
Bob Fraser
John Gaidos
Ronald Gaston
Henrietta Groot
Robert Hardy
Gary Karner
W. David Lees
Wallace McCray
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Doris Murray
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Bill Newman
Cathy Novak
Scott Overgaard
Jim Phillips
Rachelle Phillips
Gizella Raymond
Dorothy Rooney
Sylvia Rosenberg
Marie D. Smith
Ellen Sturtz
Judy Sullivan
Nelson Sullivan
John Swift
Roy Vigneault
Bill Woodson

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Melody Kreimes
Katie Kropp
Mary Leizear
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Linda Wheeler
Karen Worcester

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Appendix C

Federal Consistency Review

A review of federal activities for consistency with Comprehensive Conservation and Management Plans (CCMP) is one of seven purposes listed in Section 320 of the Clean Water Act (CWA). Many federal financial assistance programs and some federal activities have the potential to either enhance or adversely impact the goals of the Morro Bay CCMP. To achieve the stated goals and objectives within the CCMP effectively, local, state, and federal governments must strive for coordination.

Section 320(b)(7) of the CWA require that each NEP review federal financial assistance programs and development projects, as consistent with Executive Order 12372, to assess whether those programs are consistent with their CCMP. The requirement consists of two parts: (a) a one-time review of current federal activities or financial assistance for consistency with the CCMP; and (b) the development of a process for continued, ongoing review of future activities. The Morro Bay National Estuary Program conducted its initial review when drafting the CCMP published in 2001. Please refer to the 2001 version of the CCMP for that full analysis.

The Morro Bay National Estuary Program (The Estuary Program) currently meets its federal consistency requirement by using the California Coastal Commission's (CCC) existing federal consistency review process. This is an established process in California that helps strengthen coordination among federal and state agencies regarding projects in the coastal zone. The CCC has agreed to notify the Estuary Program of any federal activity that may affect the coastal area in or near Morro Bay and its watershed. The Estuary Program uses the CCC's existing mechanisms to comment on activities while retaining NEP authority to comment directly to federal agencies on specific projects, as appropriate.

Appendix D

CCMP 2022 Update Action Plan Status

The below action plans include those completed and/or removed from the 2012 CCMP update. The second section are those action plans which were combined due to similarity.

Completed or Removed Action Plans:

- BMP-4: Mine Remediation
- BMP-10: Los Osos Wastewater (move some actions to MON-2, MON-3, AND FWR-5)
- CREW-1: Watershed Crew
- LP-5: Enhance Public Recreation (no longer relevant)

Combined:

- BMP-3: Fire Management removed, combine some actions with ECR-12: Conservation of Upland Habitats
- LP-2: Restore Floodplains removed, combined with LP-1: Protect Special Habitats/Species
- LP-4: Reduce Water Demand removed, combined with LP-3: Direct Urban Development
- ECR-2: Riparian Corridors removed, combined with ECR-1: In-stream Habitat
- FWR-2: Scientific Info for Management removed, combine with FWR-3: Understand Flow for Public Trust Resources

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MORRO BAY
NATIONAL ESTUARY PROGRAM

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