California's Marine Protected Area Network

DECADAL MANAGEMENT REVIEW

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

CALIFORNIA MARINE PROTECTED AREAS

2022

MPA DECADAL MANAGEMENT REVIEW

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MPA DECADAL MANAGEMENT REVIEW

PROLOGUE

California's iconic coast is part of our state identity, a driver of our economy, and a place of wonder, cultural practice, and well-being. It is also home to one of the most diverse coastal and ocean ecosystems on the planet. To protect our extraordinary marine life and habitats for current and future generations, California has established a network of 124 Marine Protected Areas (MPAs), spanning 1,110 miles from Mexico to the Oregon border and protecting 16% of state waters. This Network is America's first science-based, statewide MPA network, the country's largest, and a globally significant accomplishment.

Since its passage over two decades ago, California's Marine Life Protection Act (MLPA) has guided the state and its vast array of partners in the planning, implementation, and adaptive management of our network of MPAs. Built upon an eight-year planning effort that combined extensive stakeholder input with rigorous science, the California Fish and Game Commission completed the statewide network in 2012. While there were significant challenges and lessons learned during the design and initial implementation of the Network, science, innovation, collaboration, and commitment ultimately enabled the successful design, adoption, and management of California's MPAs.

This Decadal Management Review represents the first ever comprehensive evaluation of the entire statewide MPA Network. While there remains much work to do, it is heartening to see that the unparalleled investments by the state, California Native American tribes, stakeholders, and partners are beginning to pay dividends. From the stakeholder-driven, science-based planning process to the four pillars of the management program, California's MPA Network has set the global standard for ecologically connected, well-managed MPAs.

As we embark into the next decade of MPA Management, we must steady ourselves for the challenges ahead. While we see evidence of MPA protections benefiting key species and habitats, we must continue to invest in long-term monitoring to further understand how MPAs are meeting the goals of the MLPA and what additional steps may be necessary to further strengthen the Network. We need to consider climate change impacts and ensure that California's MPAs promote ecosystem resilience and support sustainable fisheries outside their boundaries. We need to better understand how the MPA Network effects California's diverse coastal communities. We must strive to better integrate principles of justice, equity, diversity, and inclusion into all aspects of the management program and build upon current efforts to recognize Traditional Ecological Knowledge and the roles of California Native American tribes to help sustainably manage and steward our shared marine resources. Finally, we must maintain our steadfast commitment to support the MPA Management Program through a partnership-based approach that is well-funded, grounded in sound science, and informed by those who live near and utilize our coast and ocean.

To protect biodiversity and fight climate change, California has committed to conserving 30% of its lands and coastal waters by 2030. This ambitious call to action inspires us to accelerate and improve conservation across the state. In the face of rapidly changing conditions along our coastal and ocean environment, adaptively managing our MPA network to protect ocean life and economic, cultural, and spiritual benefits to all Californians will be important to meeting our 30x30 goal.

While we face daunting challenges to protect our coast and ocean amidst accelerating climate change, our Network is a source of hope and inspiration. We look forward to our shared work ahead helping our MPA Network adapt, evolve, and remain a global model of environmental stewardship.

Wade Crowfoot
California Natural Resources Secretary

Charlton H. Bonham
California Department of Fish and Wildlife, Director

CALIFORNIA MARINE PROTECTED AREAS

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Ocean surface-CDFW.

ACRONYMS

BRUV	Baited Remote Underwater Video
CC	Creative Commons
CCFRP	California Collaborative Fisheries Research Program
CCS	Center for Community and Citizen Science
CDFW	California Department of Fish and Wildlife
CFGC	California Fish and Game Commision
CINMS	Channel Islands National Marine Sanctuary
CMSF	California Marine Sanctuary Foundation
COVID-19	Coronavirus Disease 2019
CPFV	Commercial Passenger Fishing Vessel
CRFS	California Recreational Fisheries Survey
CTMPA	Chumash Tribal Marine Protected Area (Education Program)
DEWG	Decadal Evaluation Working Group
eDAR	Electronic Daily Activity Report
eDNA	Environmental DNA
eFINS	Electronic Fisheries Information Network
EIA	Ecological Impact Assessment
GPS	Global Positioning System
HAB	Harmful Algal Bloom
IUCN	International Union for Conservation of Nature
JEDI	Justice, Equity, Diversity, and Inclusion
LED	Law Enforcement Division
LGBTQ+	Lesbian, Gay, Bisexual, Transgender, Queer, and other gender and/or sexual orientation
LiMPETS	Long-term Monitoring Program and Experiential Training for Students
M2	Marine Monitor
MARE	Marine Applied Research and Exploration
MLPA	Marine Life Protection Act
MMA	Marine Managed Area
MMAIA	Marine Managed Areas Improvement Act
MPA	Marine Protected Area
MSLT	MPA Statewide Leadership Team
NCEAS	National Center for Ecological Analysis and Synthesis
NGO	Non-governmental Organization
OPC	California Ocean Protection Council
PISCO	Partnership for Interdisciplinary Studies of Coastal Oceans
PORTS	Parks Online Resources for Teachers and Students
PPIC	Public Policy Institute of California
RLF	Resources Legacy Fund
RMS	Records Management System
ROV	Remotely Operated Vehicle
SCP	Scientific Collecting Permit
SCUBA	Self Contained Underwater Breathing Apparatus
SMCA	State Marine Conservation Area
SMP	State Marine Park
SMR	State Marine Reserve
SMRMA	State Marine Recreational Management Area
TMSN	Tribal Marine Stewards Network

MPA DECADAL MANAGEMENT REVIEW

EXECUTIVE SUMMARY

CALIFORNIA'S VISION FOR MARINE ECOSYSTEM PROTECTION

California made conservation history in 1999 when the State Legislature passed the Marine Life Protection Act (MLPA). This new law mandated the redesign of California's pre-existing patchwork of marine protected areas (MPAs; Figure 1.1 and 1.2) to protect and help sustain its diverse marine life and habitats statewide. Though MPAs had already been growing in use as a marine spatial planning tool, the MLPA was unique in that it required California's new assemblage of MPAs to be designed and managed as an ecologically connected network. This founding legislation also prescribed six goals to strive for (Figure 1.2) and required that the MPA Network (Network) be adaptively managed in order to regularly review progress, learn from past actions, and correct course as needed.

ADAPTIVE MANAGEMENT IN ACTION

This report, the first Decadal Management Review (Review) of the Network since its statewide completion in 2012, is a key piece of the adaptive management process (Figure 1.4). Over the years, the MPA Management Program (Management Program) has evolved and been refined in response to emerging science, management needs, and a broad range of tribal and stakeholder input. A wide array of information sources has been synthesized for this Review to obtain a holistic appraisal of the progress made through implementation of the Network and Management Program towards meeting the goals of the MLPA (Figure 1.2).

A SOCIAL-ECOLOGICAL FRAMEWORK

A social-ecological framework was developed to help conceptualize the Network and Management Program within a broad system of connections (Figure 2.2). Various influencing factors act on the three central, interconnected components of the Network and Management Program: the governance, ecological, and human domains. Each domain affects and is affected by the other domains, and outcomes to ecological functions, ecosystem services, and human affairs and equity create feedback that affect the broader performance of the Network and Management Program.

THE MPA MANAGEMENT PROGRAM

A high degree of coordination and collaboration between numerous agency, tribal, academic, and non-governmental organization (NGO) partners is required for all aspects of the Management Program. The Management Program is organized around four pillars, each critical to Network success: research and monitoring, outreach and education, policy and permitting, and enforcement and compliance. The first decade of statewide MPA management has seen considerable growth in each pillar, with room for future development.

- **Research and monitoring** shifted from regional baseline projects (2007-2018) to statewide long-term monitoring in 2018, guided by the MPA Monitoring Action Plan (Action Plan). The Action Plan set a foundation for long-term ecological monitoring to evaluate the effects of MPA implementation statewide, and most of the key habitats comprising California's MPAs have been consistently monitored since then. Research on the effects of MPA implementation on the human domain in California is still in its infancy. Expansion of human dimensions research includes establishing priority research questions and approaches, strengthening partnerships with tribes and stakeholders, integrating MPA research more closely with fisheries management, and creating other connections to inform the ecological domain.

- **Outreach and education** has grown from a focus on developing physical MPA outreach materials, such as signs and brochures, to digital resources, such as websites and blogs, webinars and videos, social media, and mobile apps. The state continues to support and coordinate with partners to deliver accurate and consistent MPA messaging statewide. Additional work in this pillar is needed to reach more diverse audiences while remaining responsive to local needs, fisheries stakeholders, and tribes.

- **Policy and permitting** has evolved to clarify the conditions under which take is allowed or prohibited within MPAs. For example, refinement of MPA policy includes the addition of tribal take exemptions in some MPAs, prioritization of human health and safety when in conflict with MPA regulations, and plans to allow for incidental take in MPAs resulting from maintenance of pre-existing artificial structures. Take may also be permitted in MPAs for scientific and educational purposes through the California Department of Fish and Wildlife's (CDFW's) Scientific Collecting Permit (SCP) Program. Improvements to the SCP Program and the development of clear policy guidance on restoration in MPAs are top priorities for stakeholders.

- **Enforcement and compliance** of MPA regulations has improved in several ways over the years. A dedicated CDFW Marine Enforcement District was established in 2016 and a new patrol boat was acquired in 2021, both of which increased enforcement presence on the water. Wildlife officers were further empowered to enforce MPA regulations with the passage of two legislative amendments in 2015 and 2018 that better allowed penalties to be better adjusted to the severity of the violation. Additionally, the introduction of an electronic citation records management system in 2019 has helped officers identify violation hotspots, quickly analyze MPA citation data, and spot other trends in enforcement efforts over time. Despite these improvements, there is still a need for greater enforcement capacity, which could be achieved through a combination of increased funding and partnership-building with allied enforcement agencies.

Surfgrass at Rincon beach-CDFW.

MPA NETWORK PERFORMANCE

Evaluating MPA Network performance requires a holistic approach. A diverse array of data streams was integrated and analyzed to provide insights regarding MPA Network performance and connect results across habitats and domains. While most of the data inform the ecological domain, the Review also provides an initial glimpse of human use patterns across the Network.

» The detection of many MPA effects was expected to take time, but results already suggest that, for some species and habitats, California's MPAs support populations of bigger and/or more abundant fish and invertebrates. Although species-level responses to MPA implementation varied by bioregion, habitat, and sampling method, responses to MPA protection by fished species were strongest in the south coast where more fishing occurs. The magnitude of MPA effects on fished species may be directly linked to the levels of fishing pressure in and around the MPAs prior to and after gaining protected status. Community-level responses tell a more complicated story, and biodiversity metrics varied widely across bioregions and habitats.

» The MPA Network was designed to be ecologically connected to enhance populations of marine species and promote ecosystem integrity and resiliency. However, connectivity modeling has advanced since the initial Network design guidelines were developed. Updated connectivity models confirm that MPAs are more connected to one another and other parts of the coast than areas outside of MPAs. The science-informed design of the Network appears to enhance larval connectivity in MPAs across the Network. Furthermore, preliminary modeling results suggest that the positive effect of MPAs on the size and abundance of species within their boundaries also enhances their contribution to larval connectivity outside their boundaries.

» Resilience to climate change-driven events is thought to be a core benefit of a connected network of MPAs. From 2014 to 2016, a marine heatwave that affected the entire Pacific Coast initiated sweeping changes in ecological communities statewide and offered researchers an opportunity to study MPA responses to a major climate change-related event as it happened. Some ecological communities demonstrated greater resiliency inside MPAs compared to those

Survey in Asilomar SMR-Chenchen Shen CDFW.

outside of MPAs and recovered more quickly after the heatwave, though analysis across habitats in the central coast revealed that MPAs did not provide strong resilience against the marine heatwave (Figure 5.5).

» Human engagement in MPAs, measured through data from community science programs, CDFW's SCP Program, and citations issued by CDFW wildlife officers, is directly related to proximity to population centers (Figure 5.6). However, some MPAs that are not located near population centers still experience high human engagement. These MPAs share certain characteristics, such as proximity to State Parks or National Marine Sanctuaries, protection of sandy beaches or estuaries, and well-developed infrastructure. Some level of scientific research has occurred in every MPA across the Network, highlighting the role of MPAs in sparking scientific inquiry and acting as living laboratories.

Measuring the progress of MPA Network performance against the broader goals of the MLPA is a challenge. This first Review represents an important step to understanding the benefits of a connected network of MPAs by integrating MPA-focused information across habitats, domains, and program pillars. The results achieved thus far will help set expectations for anticipated progress and facilitate future performance evaluations and status reports.

SETTING SAIL

This Review provides an opportunity to reflect on progress made toward meeting the MLPA goals in the first decade of statewide MPA management. By limiting or prohibiting extractive activities, the Network has provided protection for populations of marine species and the habitats they utilize (MLPA Goals 1, 2, and 4). Furthermore, opportunities for research, education, and recreation have been enhanced (MLPA Goal 3). California's MPAs have been adaptively managed through improvements in management measures, sound science, and enforcement capacity (MLPA Goals 5, 6). While great strides have been made, this Review also highlights the need for more action. As California prepares to enter the next decade of MPA management, this first Review provides a number of priority management recommendations to help forge a path forward.

CALIFORNIA MARINE PROTECTED AREAS

Bat star in Scorpion SMR-Amanda Van Diggelen CDFW.

MPA DECADAL MANAGEMENT REVIEW

1. SETTING THE SCENE

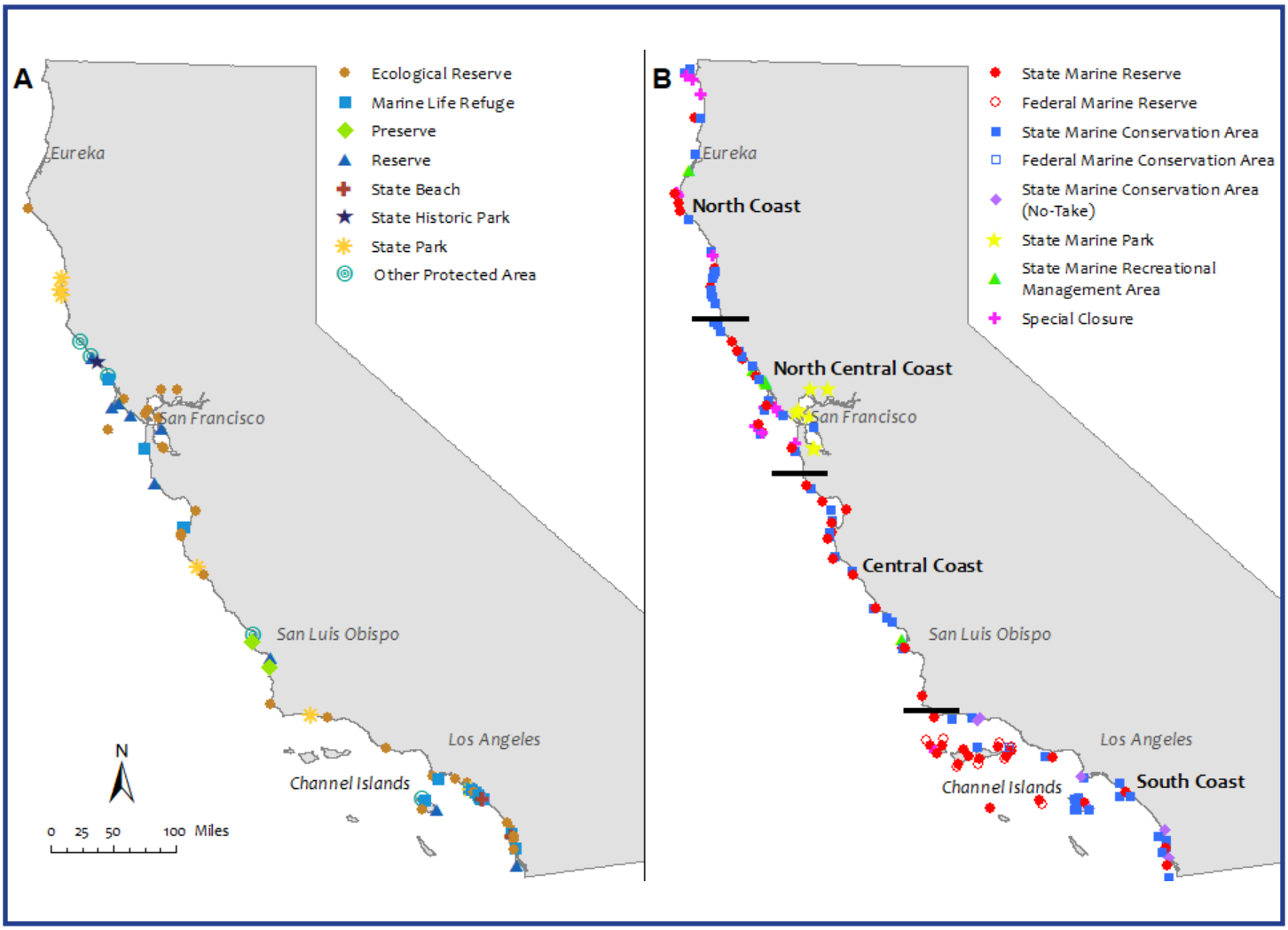
From rockfish swimming among the kelp forests to lobster hiding in rocky reef crevices, California's 5,285 square miles of state waters host an abundance of marine life in a variety of habitats. These incredibly diverse and productive ocean resources offer aesthetic, economic, educational, cultural, nutritional, and recreational opportunities that benefit us all. Maintaining the abundance of marine life and the ecosystems they depend on is critical to keeping them sustainable and available for future generations. Well-managed marine protected areas (MPAs) can help ensure places remain that function as complete ecosystems (Murray et al. 1999), provide natural laboratories for study (Bohnsack et al. 2004), build resilience in the face of a changing climate (McLeod et al. 2009, Hofmann et al. 2021), and support thriving populations of marine species inside and outside their boundaries (Lester et al. 2009, Marshall et al. 2019).

As home to some of the most biologically productive coastal waters in the world, California has long been a leader in ocean protection. Though marine protections have existed in some form in California since 1929 (Van Diggelen 2016), the state's early MPAs were designated in a piecemeal fashion. In 1999, the California State Legislature passed the landmark Marine Life Protection Act (MLPA), which mandated a redesign of the state's existing MPAs into a cohesive, ecologically connected statewide network (Network; Figure 1.1). The new MPA Network was intended to protect marine life and habitats more effectively, protect marine natural heritage, and improve recreational, educational, and study opportunities. These aims are included in the six goals of the MLPA (Figure 1.2), which laid the foundation for a more holistic approach to managing California's marine resources. In particular, the MLPA marked a shift in marine resources management by prioritizing ecosystem-based management rather than individual species or habitat management. Since its completion in December 2012, California's coastal Network of 124 MPAs and 14 special closures has achieved global recognition and serves as a model for marine conservation.

Gopher rockfish–John Ugoretz CDFW.

Implementing California's MPA Network was a groundbreaking achievement for ocean protection, and a series of related management and policy accomplishments have proceeded from the MLPA since 1999 (Figure 1.3). Now, the state has an opportunity to strengthen its commitment to adaptive management and integrate lessons learned from the first 10 years of Network management. Adaptive management is the cornerstone of California's guiding MPA legislation. In the context of the MLPA, adaptive management is an iterative process that facilitates learning from program actions to help determine those that are most effective. Monitoring and evaluation are emphasized, and management actions are designed so that, even if they fail, they will provide useful information for future actions. California has developed a three-stage adaptive management process to provide a responsive structural outline for continuously evaluating MPA management changes (Figure 1.4). This report, the foundation for the first statewide Decadal Management Review (Review) of the MPA Network and Management Program, is the culmination of this three-stage process and sets the stage for future adaptive management.

Figure 1.1 Map of California's MPAs before implementation of the MLPA in 1999 (A) and after establishment of the statewide MPA Network in 2012 (B). Horizontal black bars on the coastline in the right panel (B) delineate the boundaries of four of the five MPA planning regions: north coast (California/Oregon border to Alder Creek near Point Arena), north central coast (Alder Creek near Point Arena to Pigeon Point), central coast (Pigeon Point to Point Conception), and south coast (Point Conception to the California/Mexico border). MPAs within the fifth planning region, the San Francisco Bay, are not part of the redesigned coastal Network of MPAs.



Top: California sheephead-Miranda Haggerty CDFW.

GOAL 1: Protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

GOAL 2: Help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.

GOAL 3: Improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.

GOAL 4: Protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.

GOAL 5: Ensure California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.

GOAL 6: Ensure the state's MPAs are designed and managed, to the extent possible, as a network.

Figure 1.2 The six goals of the Marine Life Protection Act (Fish and Game Code 2853).

Top: Giant kelp in Point Sur SMR-Anna Neumann CC. Copper rockfish in Portuguese Ledge SMCA-MARE. Recreational divers accessing Laguna Beach SMR-Steve Wertz CDFW. Gray whale in Southeast Farallon Island SMR-nbawill CC. NC ROV Survey in Reading Rock SMR-Adam Frimodig CDFW. Octopus in Southeast Farallon Island SMR-MARE.

MPA NETWORK IMPLEMENTATION

After two unsuccessful attempts to implement the mandates of the MLPA, California found success during its third attempt. In 2004, the Marine Life Protection Act Initiative (MLPA Initiative), a public-private partnership among the California Natural Resources Agency, the California Department of Fish and Wildlife (CDFW), and Resources Legacy Fund (RLF; formerly Resources Legacy Fund Foundation), was formed to help guide MPA Network implementation (CDFW 2008). From 2004 to 2012, California blended cutting-edge MPA science with stakeholder needs in an extensive public planning process to design an ecologically connected MPA Network reflecting the MLPA goals. The first such effort in the United States, the new MPAs were established regionally, and five coastal planning regions were established to account for the unique ecology and oceanography of each region and best represent the diverse stakeholders of California's coastal communities. Planning for and implementation of MPAs within the fifth planning region, the San Francisco Bay, may only occur following the completion of historic ecosystem restoration and water reliability planning efforts in the Sacramento-San Joaquin River Delta.

The MLPA Initiative created a Blue Ribbon Task Force, Science Advisory Team, Statewide Interests Group, and four Regional Stakeholder Groups (one in each coastal planning region, established sequentially) to guide the design of the new MPA Network. These groups worked together to draft proposals for redesigning the MPA Network, which were presented to the California Fish and Game Commission (CFGC). CFGC, which has the sole authority to adopt MPAs under the MLPA, was heavily involved in further refinement of each region's proposals before adopting and implementing the newly redesigned MPAs. Although tribal engagement was at first limited, efforts improved as tribal representatives were added to the Regional Stakeholder Groups after the first planning region, and more meaningful tribal engagement in MPA management has occurred in recent years (see Section 3, Tribal Perspectives on MPA Management).

The newly adopted MPAs went into effect regionally: in the central coast in September 2007, followed by the north central coast in May 2010, the south coast in January 2012, and the north coast in December 2012 (Figure 1.3). Once completed along the open coast, the redesigned MPA Network covered approximately 16% of state waters, including 9% as no-take reserves. Prior to the MLPA, less than 3% of state waters were protected as MPAs, with less than 1% as no-take reserves.

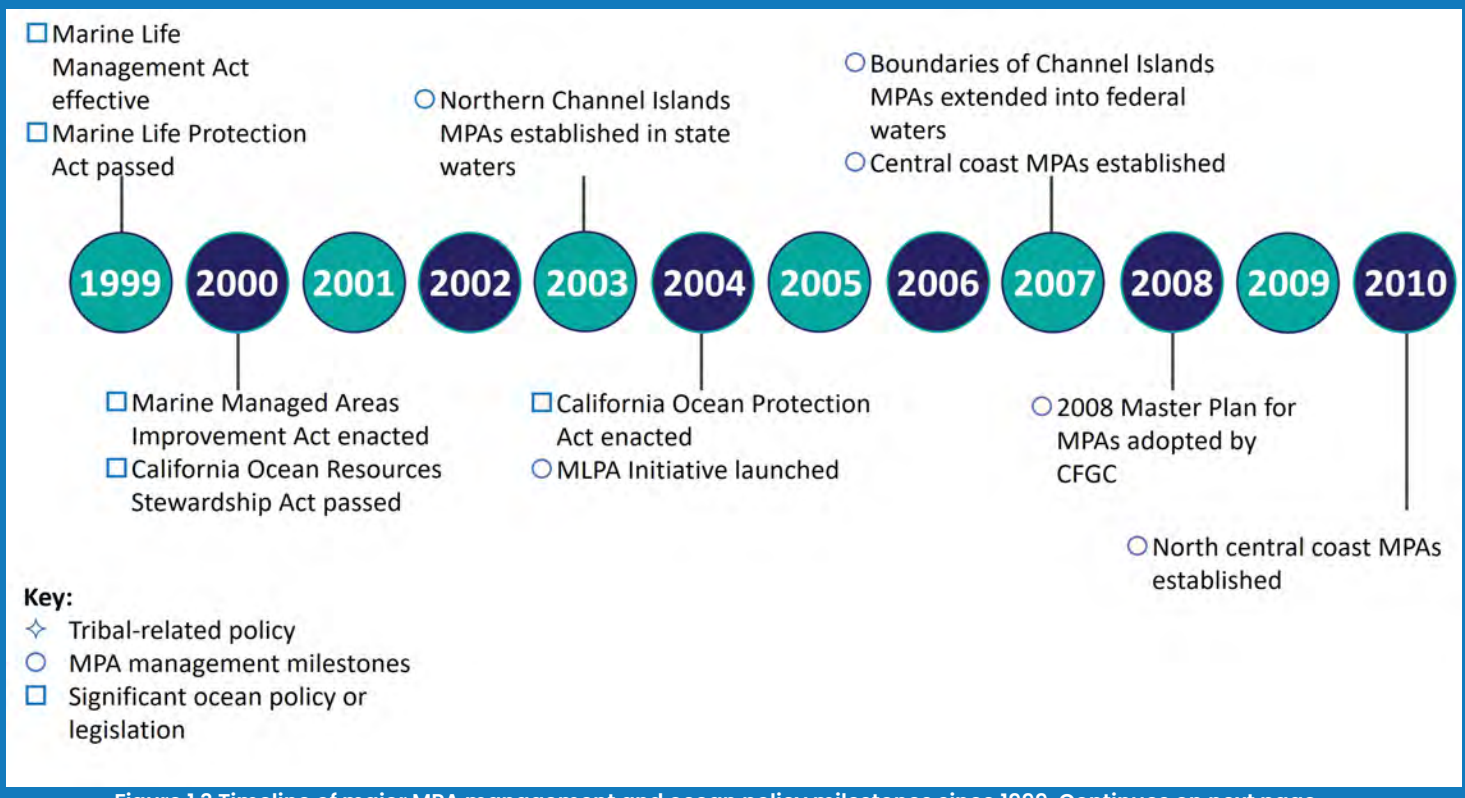


Figure 1.3 Timeline of major MPA management and ocean policy milestones since 1999. Continues on next page.

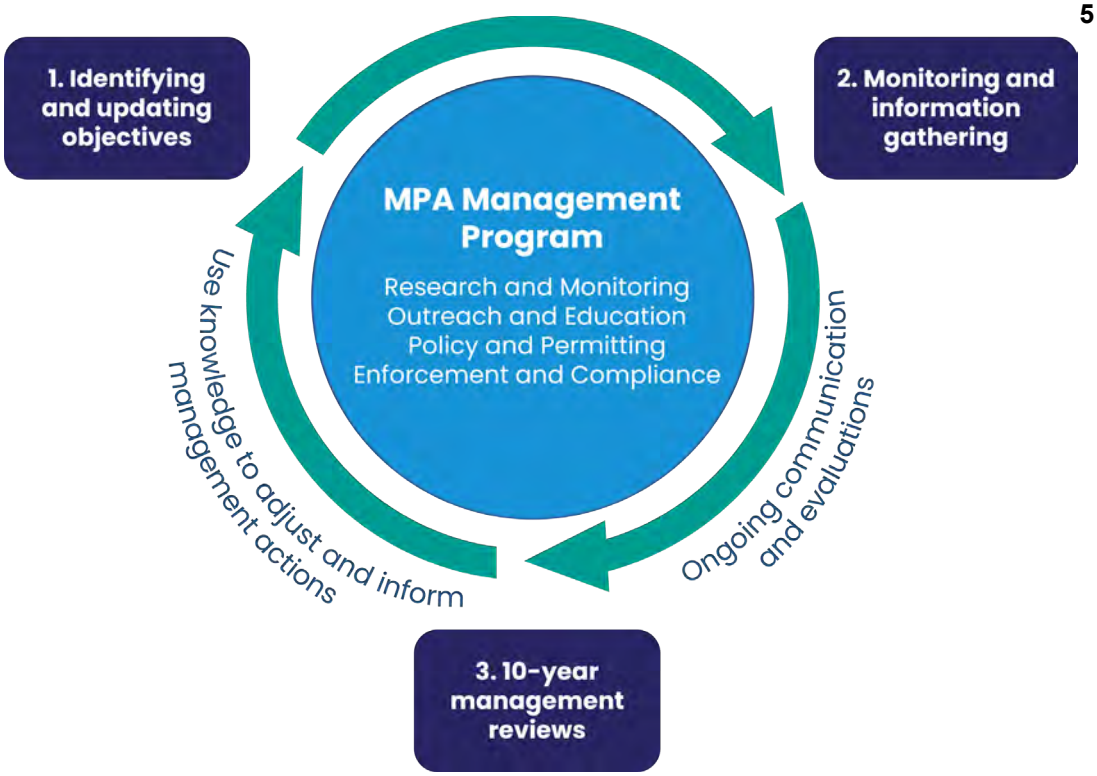


Figure 1.4 The MPA Management Program's three-stage approach to the adaptive management process.

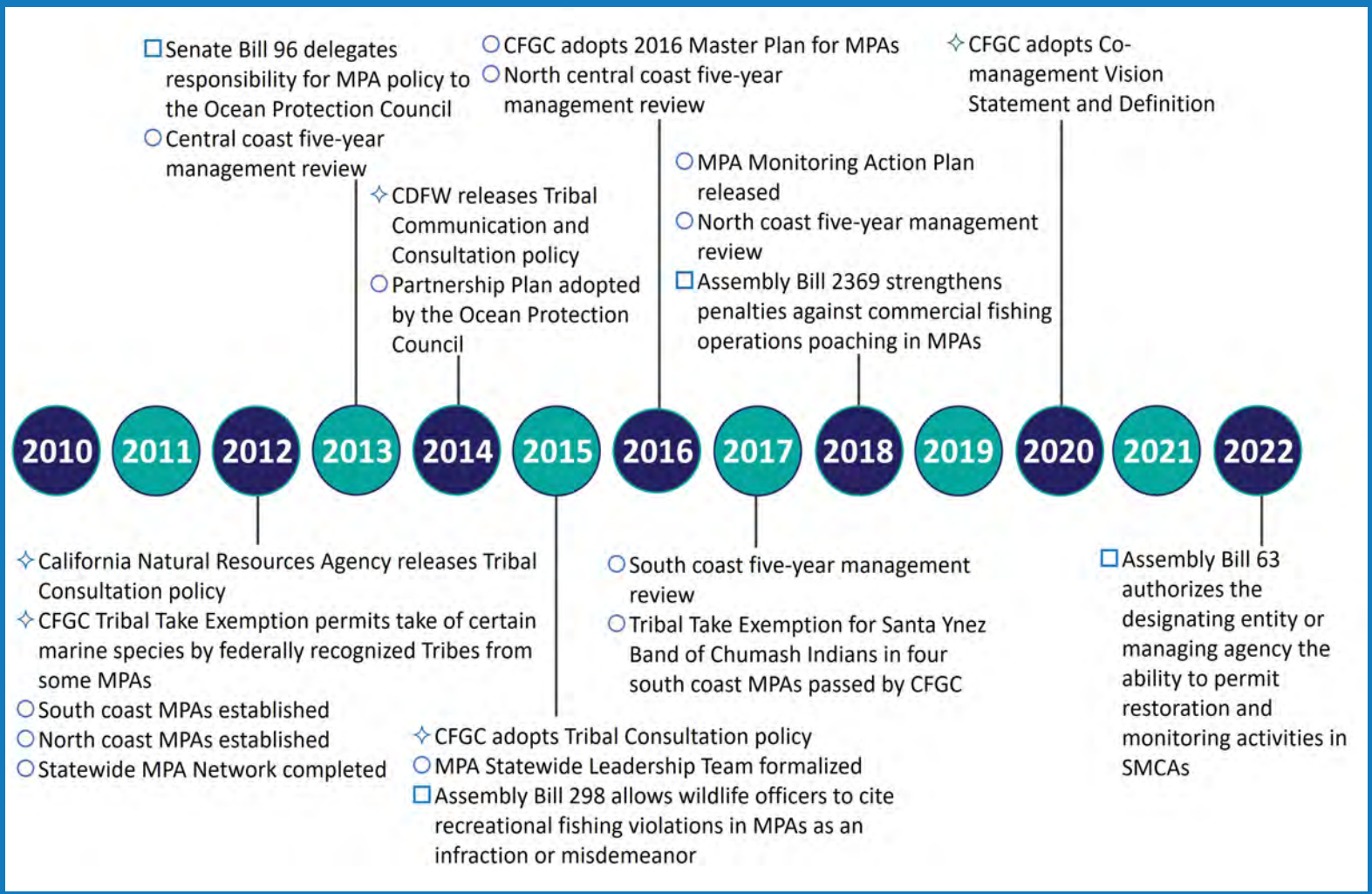


Figure 1.3 continued. Timeline of major MPA management and ocean policy milestones since 1999.

MPA DEFINITION AND CLASSIFICATIONS

MPAs are named, discrete geographic marine or estuarine areas seaward of the mean high tide line that may extend as far as the state's jurisdictional waters, generally zero to three nautical miles off the mainland coast and around offshore islands, and within bays and estuaries. MPAs are designed to protect and conserve marine life and habitats. In addition to limiting fishing and harvesting, California's MPAs prohibit or limit other forms of extraction and manipulation of habitat, such as beach nourishment, mineral or sediment extraction, oil platforms, and unpermitted scientific take.

In 2000, the Marine Managed Areas Improvement Act (MMAIA; Public Resources Code, Section 36700) created six new classifications for designating managed areas in marine and estuarine environments, of which four are employed in the MPA Network: state marine reserve (SMR), state marine conservation area (SMCA), state marine park (SMP), and state marine recreational management area (SMRMA). These new classifications became effective in January 2002 and replaced the 18 classifications that were previously used to categorize state marine managed areas. CFGC completed a formal rulemaking process in 2005 to rename each existing marine managed area using one of the new classifications. Later, during the CFGC rulemaking process to adopt new MPAs belonging within the Network, additional regulatory clarification was needed and two other designations were utilized: no-take SMCA and special closure (Table 1.1).

Table 1.1 Types of MPAs, marine managed areas, and special closures used in California's MPA Network, each of which has a designated color (from Van Diggelen et al. 2022).

Map Color	Classification	Number	% of State Waters	Summary
red	State Marine Reserve	49	9.0	An MPA classification that prohibits damage or take of all marine resources (living, geologic, or cultural), including recreational and commercial take
blue	State Marine Conservation Area	60*	6.5	An MPA classification that may allow some recreational and/or commercial take of marine resources (restrictions vary)
purple	State Marine Conservation Area (no-take)	10	0.6	An MPA classification that generally prohibits the take of living, geologic, and cultural marine resources, but allows potentially affected and ongoing permitted activities such as dredging and maintenance to continue
green	State Marine Recreational Management Area	5	0.1	A marine managed area classification that limits recreational and commercial take of marine resources while allowing for legal waterfowl hunting to occur; provides subtidal protection equivalent to an MPA (restrictions vary)
yellow	State Marine Park	1*	<0.1	An MPA classification that prohibits damage or take of any marine resources for commercial purposes (restrictions vary)
pink	Special Closure	14	0.1	An area designated by the California Fish and Game Commission that prohibits access or restricts boating activities in waters adjacent to sea bird rookeries or marine mammal haul-out sites (restrictions vary)

*The California Fish and Game Commission designated Cambria State Marine Conservation Area, which was subsequently also adopted as Cambria State Marine Park by the State Park and Recreation Commission with the same boundaries and no change to regulations. Therefore, this MPA has dual designations and is counted twice in the table.

MPA MANAGEMENT PROGRAM

The MLPA also required the development of a Master Plan to guide the formation of a Marine Life Protection Program, now known as the MPA Management Program (Management Program), which would inform the design and management of the Network. A Master Plan framework was developed in 2005 and directed the development of alternative MPA proposals in the central coast, the first planning region. A draft Master Plan for MPAs built around the science guidance used in the central coast region was approved by CFGC in February 2008 and steered the siting and design processes in the three remaining planning regions. The 2008 Master Plan also recommended that CDFW provide CFGC with comprehensive regional reviews of monitoring results five years after implementation within each region.

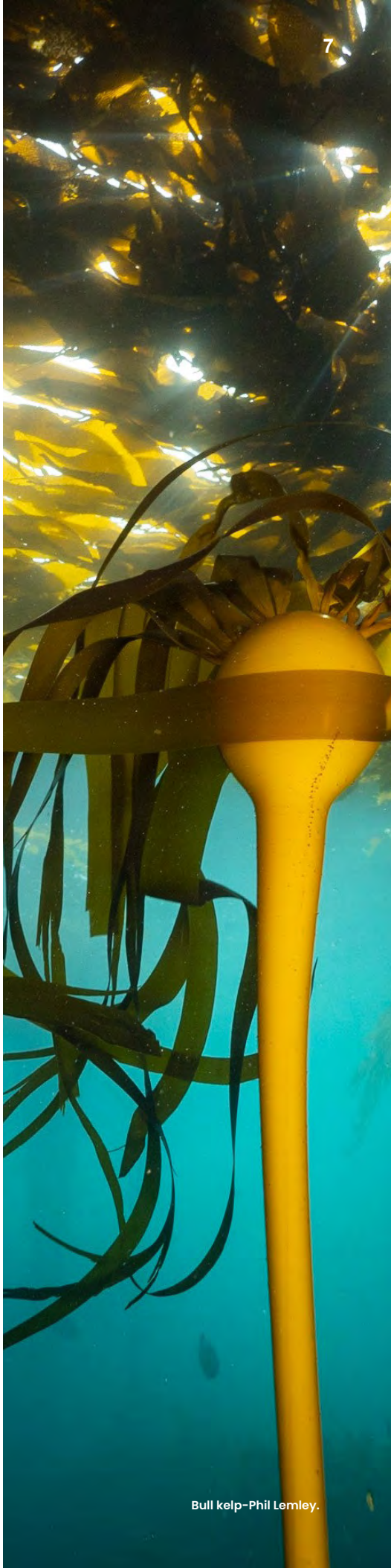
As a living document, the Master Plan was expected to evolve based on monitoring results and lessons learned in each region. The 2016 Master Plan for MPAs was approved by CFGC in August 2016 and shifted the focus from regional planning to statewide management. Accordingly, the review cycle changed from five to 10 years to facilitate adaptive management of the statewide Network in a more biologically appropriate, administratively feasible, and cost-effective manner.

The 2008 and 2016 Master Plans serve as complementary frameworks for MPA management, reflecting the adaptive management process and ongoing evolution of the MPA Management Program. The Management Program is now structured around four management pillars:

- Research and monitoring
- Outreach and education
- Policy and permitting
- Enforcement and compliance

Recognizing that this is the first statewide decadal evaluation of the MPA Network and Management Program, this Review balances highlighting the many accomplishments and outcomes achieved under each management program pillar with acknowledging current gaps in knowledge and areas for improvement. The results of this Review have informed a suite of recommendations that will launch California into the next 10-year adaptive management cycle and help us evaluate the key question: To what extent are the MPA Network and Management Program meeting the goals of the MLPA?

CALIFORNIA MARINE PROTECTED AREAS



Bull kelp-Phil Lemley.

MPA DECADAL MANAGEMENT REVIEW

2. APPROACH TO THE REVIEW

The four pillars of the Management Program inform this Review, linking the diverse activities undertaken as part of the Management Program to the broader MLPA goals. The four pillars represent management components accepted by MPA practitioners and managers globally as critical to the successful management and evaluation of MPAs or MPA networks (Gleason et al. 2013, Bennett and Dearden 2014, Van Diggelen et al. 2022).

This first Review has also been informed by the foundational MPA Management Program framework documents, integration of ecological and human use data, engagement with California Native American Tribes and stakeholders, and a diverse suite of input from partners and CDFW programs (Table 2.1). The Review includes detailed Management Program highlights, Network evaluation results, identification of knowledge gaps, and suggested areas for improvement resulting in broad adaptive management recommendations to inform future Management Program activities and reviews.

Top: Juvenile garibaldi-Derek Stein CDFW. Elephant seals sunbathing in Piedras Blancas, SMR-Calla Allison MPA Collaborative Network.

Table 2.1 Decadal Management Review components and information sources.

Component	Information Sources
MPA Management Program Framework	» 2016 Master Plan for MPAs » MPA Monitoring Action Plan » The California Collaborative Approach: MPAs Partnership Plan
Research, Monitoring, Science Guidance	» Results from baseline and long-term monitoring projects » Partner monitoring and community science » Scientific Guidance for Evaluating California's MPA Network Report » Climate Resilience and California's MPA Network Report » National Center for Ecological Analysis and Synthesis Report » California Connectivity Model outputs
Tribal Coordination	» Tribal Representatives on MPA Statewide Leadership Team » Decadal Management Review Tribal Steering Committee » Decadal Management Review Regional Tribal Consultants » Tribal Summary to Inform the State of California MPA Decadal Management Review Report » Tribal Marine Stewards Network
Stakeholder and Partner Coordination	» CDFW outreach and education highlights » Audience-focused community engagement meetings » Core partner highlight reports » MPA Management Review email inquiries » Public comment at agency meetings and outreach events » Direct inquiries from stakeholders
CDFW Cross-Project Coordination	» Law Enforcement Division, citation data » Scientific Collecting Permit Program » Marine Outreach Project » Fisheries programs and projects

Kelp forest scuba diving in Gull Isand SMR-Amanda Van Diggelen CDFW.

Figure 2.1 Map of the three bioregions defined in the Action Plan, delineated by distinct changes in ecological communities: north (California/Oregon border to San Francisco Bay, including the Farallon islands), central (San Francisco Bay to Point Conception), and south (Point Conception to the California/Mexico border).

Top: Bull kelp, school of blue rockfish, and spiny lobster–CDFW.

SCIENCE-BASED EVALUATION FRAMEWORK

While the MLPA goals guided design and implementation of the MPA Network and Management Program, they do not specify metrics for success. Following the 2016 Master Plan for MPAs, CDFW and partners have been laying the groundwork for evaluating Network performance and measuring Management Program progress. Similar to the design and implementation phase (CDFW 2016), the state relied on a science-informed process to distill the MLPA goals into measurable objectives and define core metrics of success (CDFW and OPC 2018, Hall-Arber et al. 2021, Caselle and Nickols et al. 2022).

In 2018, CDFW and the California Ocean Protection Council (OPC) developed the MPA Monitoring Action Plan (Action Plan) to address a core MLPA mandate to monitor, research, and evaluate MPAs at select sites to inform adaptive management. The Action Plan laid the groundwork for a long-term monitoring program that aligns with management needs and priorities. It also provided the first step towards defining a Network evaluation framework. Informed by both existing and emerging ecological and social science principles regarding MPAs and MPA networks, the Action Plan identified three core components as a blueprint for effective long-term monitoring:

1) Key marine species, habitats, human uses, and measures and metrics for data collection

2) Tiered monitoring site selection to balance cost with scientific rigor

3) Suite of evaluation questions and performance objectives

The Action Plan also defined three bioregions for long-term monitoring and ecological analysis: north, central, and south (Figure 2.1). The three bioregions are delineated by distinct changes in ecological communities and differ slightly from the four MLPA Initiative coastal planning regions (Figure 1.1).

Building from the Action Plan, from 2019 to 2021, OPC and the California Ocean Science Trust convened an interdisciplinary working group under OPC's Science Advisory Team to revise and refine the Action Plan's performance objectives and evaluation questions. This new team brought together experts in the fields of MPA science, population and community ecology, ecological and oceanographic modeling, anthropology, fisheries science, climate science, and natural resource management. This new team, designated as the Decadal Evaluation Working Group (DEWG), produced a report entitled "Science Guidance for Evaluating California's Marine Protected Area Network." The report translated

Salema in Laguna Beach SMR-Steve Wertz CDFW.

the high-level MLPA goals into scientifically tractable questions and approaches and identified priority questions and knowledge gaps for Network evaluation.

The DEWG described California's MPA Network and Management Program as an interconnected social-ecological system comprising three overarching domains focused on governance, ecology, and human dimensions (Figure 2.2). Each domain contains several elements that are influenced by MPA implementation and result in outcomes to ecological functions, ecosystem services, and human affairs and equity. Many external factors influence each domain's measurable responses to MPA implementation. Climate change is represented as the most prominent influencing factor that impacts the entire system.

In response to a critical DEWG recommendation to integrate analyses across habitats and domains, the state convened a working group of the National Center for Ecological Analysis and Synthesis (NCEAS). This working group brought together an interdisciplinary team of experts in the fields of natural science, fisheries, and human dimensions. The NCEAS working group analyzed existing data to address priority MPA evaluation questions outlined in the Action Plan and DEWG report (Caselle and Nickols et al. 2022). The analyses were integrated across habitats and focused on both ecological performance and human dimensions of the MPA Network.

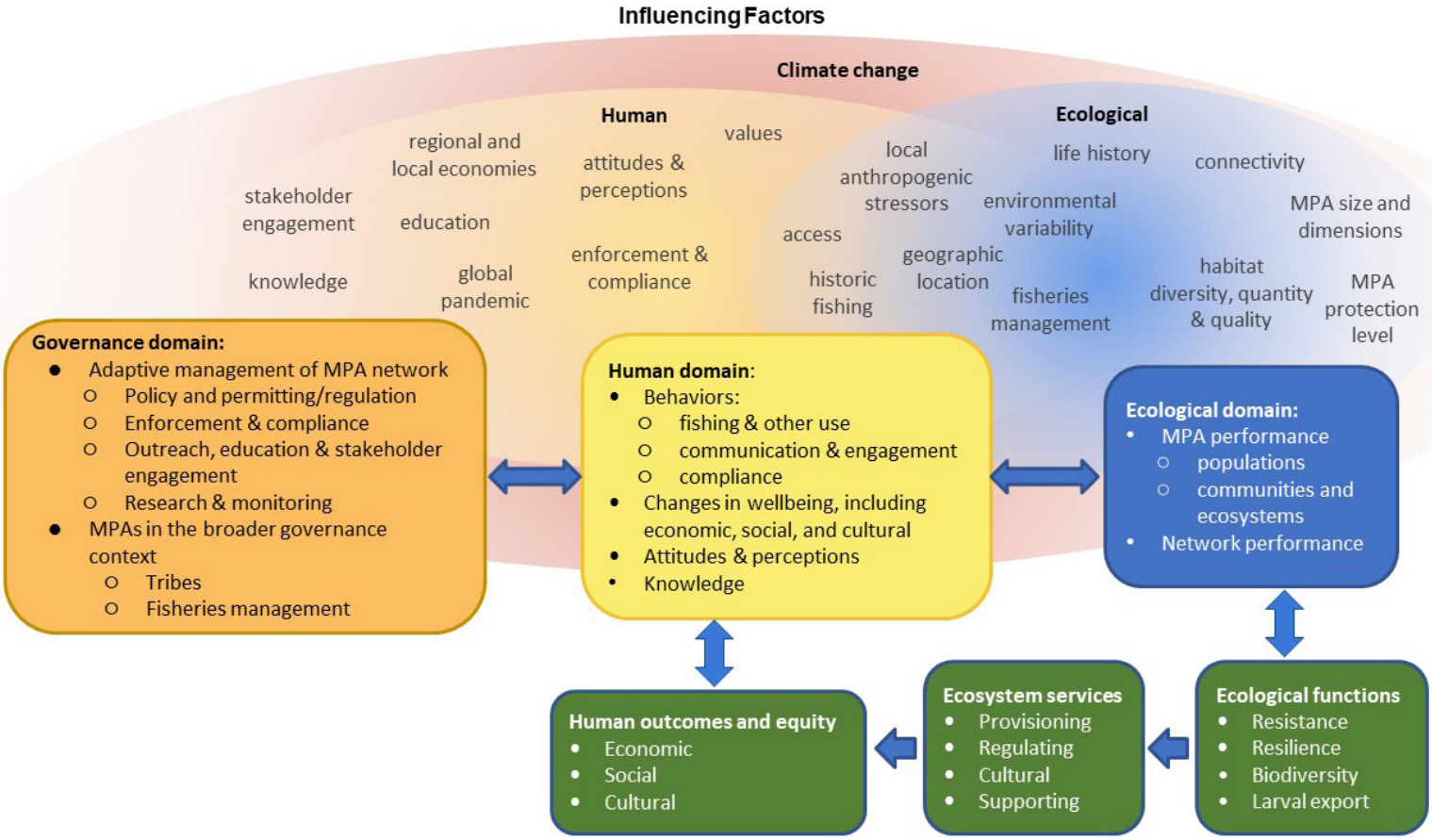


Figure 2.2 California's MPA Network and Management Program is described as an interconnected social-ecological system centered on governance, human, and ecological domains. The elements shown within each domain have multiple potential outcomes shown in the green boxes. Climate change and a suite of human and ecological factors influence how each domain responds to MPA implementation.

Top: Crescent City Dungeness crab-Christy Juhasz CDFW.

ENGAGEMENT AND INPUT FOR THE REVIEW

Recognizing the critical role that tribes, stakeholders, and partners play in the MPA Management Program, CDFW aimed to provide many venues for engagement and input for the Review. Tribes, ocean users, and others were actively invited to provide perspectives on priorities, definitions of success, management recommendations, and the roles of communities in MPA Network management. The state developed and leveraged several avenues of outreach and engagement to inform and invite tribal, public, and core partner input about the Review:

- The state leveraged well-established partnerships through the MPA Statewide Leadership Team (MSLT; Table 3.1) and MPA Collaborative Network to reach a wide range of government agencies, tribal representatives, and other organizations and stakeholders that engage in Management Program activities.

- CDFW solicited summary reports from core partners that have actively contributed to and informed Management Program activities over the past decade. CDFW received 21 reports from core partners (Appendix D).

- CDFW and OPC worked with a contractor to identify a Key Communicators Advisory Group, including tribal representatives, fishermen, non-governmental organizations (NGOs), and resource managers, to establish the MPA Network 2022 Decadal Management Review Outreach and Engagement Stakeholder Steering Committee (Steering Committee) and Tribal Steering Committee. The Steering Committees helped identify communication channels, strategies, target audiences, and known barriers to inform the Review (Appendix F.1).

- CDFW held a virtual Tribal Roundtable meeting with California Native American Tribes to engage, offer opportunities for formal consultation, and learn what tribes would like to see in the Decadal Management Review report.

- CDFW worked with regional tribal consultants to include tribal perspectives directly in the Decadal Management Review report via the Tribal Summary to Inform the State of California MPA Decadal Management Review (Appendix C).

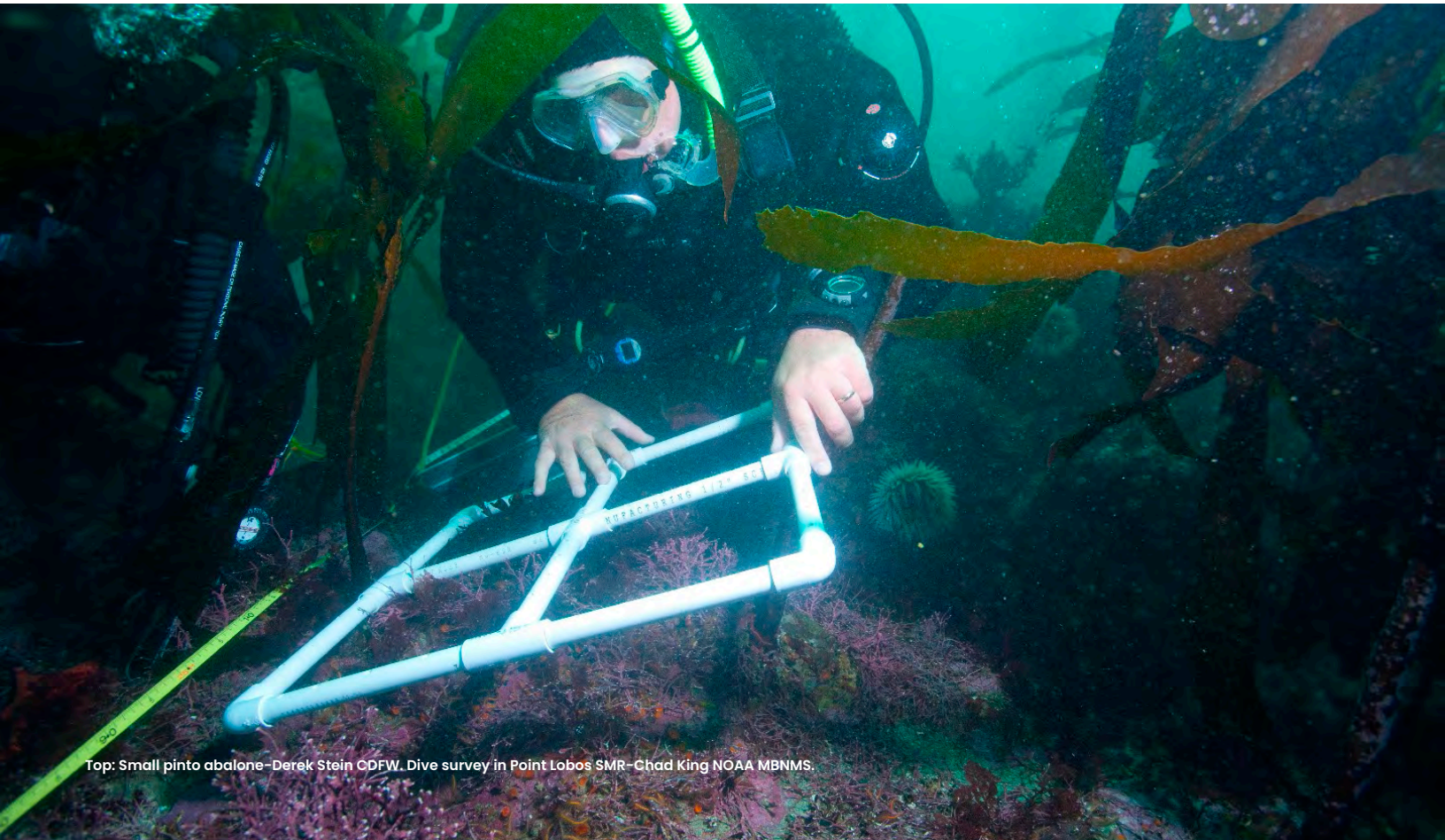
Top: Graphic map of California Native people's connections to natural resources-Carl Avery. Sea otter-CDFW.

- CDFW, in collaboration with OPC, hosted four online public community meetings curated to receive input from specific audience groups: the commercial fishing community, the recreational fishing community, non-consumptive recreational users, and government agencies and NGOs (Appendix F.2).

- Following the release of the MPA long-term monitoring technical reports, CDFW and OPC hosted an eight-part "Ask the Researcher" webinar series. Monitoring researchers presented the results from their projects and answered questions from the public. This webinar series was responsive to voices heard during the community meetings asking for more access to and dialogue with the researchers conducting MPA monitoring to better understand the science informing the Review (Appendix F.2).

- CDFW created a dedicated Decadal Management Review webpage to share information about the Review, solicit feedback, announce public meetings, and summarize meeting outcomes. CDFW also publishes regular blog posts, including updates about the Review, to CDFW's Marine Management News (Appendix F.3).

Beyond these more focused communication efforts, throughout 2021 and 2022, CDFW disseminated information and gathered input about the Review through many public engagement events, CFGC meetings, including its Marine Resources Committee and Tribal Committee meetings, and an MPA Management Review email address where the public could submit input. After this report is delivered to CFGC, a public forum is planned for March 2023 to highlight the work and findings of the Review.



Top: Small pinto abalone–Derek Stein CDFW. Dive survey in Point Lobos SMR–Chad King NOAA MBNMS.

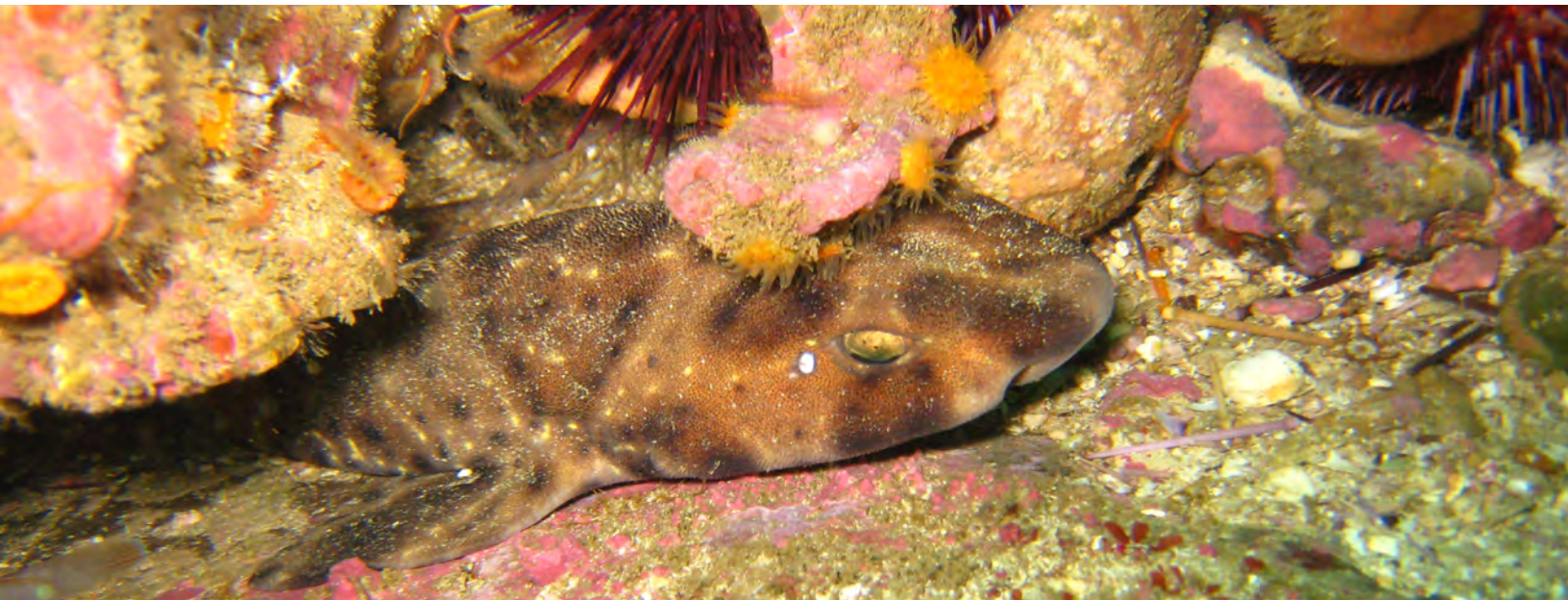
LIMITATIONS OF THIS FIRST REVIEW

During the MPA Network planning and design phase and Management Program development, the state made critical management decisions based on the best available science, stakeholder needs, and fluctuating resources that led to certain limitations in this first statewide Review (CDFW 2008, CDFW 2016, CDFW and OPC 2018). Because California's MPA Network implementation took place incrementally from 2007 to 2012, and some MPAs existed prior to the MLPA Initiative, not all the MPAs in the Network are the same age. Thus, variable ecological responses on regional and individual MPA scales are expected, especially for the many slow-growing, long-lived species that are expected to benefit from MPAs.

Furthermore, although a decade has passed since Network completion, California's MPA Network and Management Program are still considered young in the context of the time it takes for ecological and human communities to respond to management actions (Van Diggelen et al. 2022). Earlier studies and monitoring results in California as well as in other temperate marine ecosystems around the world suggest that ecological changes resulting from MPAs may take years or decades to detect (Starr et al. 2015, Kaplan et al. 2019, Nickols et al. 2019). In many cases, Management Program activities are ongoing and have not yet resulted in measurable outcomes to evaluate against MPA performance objectives and the MLPA goals. However, the Management Program maintains a long-term view and recommends adding targets to its progress-oriented decadal management evaluations.

Most importantly, influencing factors can greatly impact our ability to detect the direct effects of protection (Hall-Arber et al. 2021, Hofmann et al. 2021). These factors operate on local, regional, and network-wide scales. Examples of influencing factors include MPA design attributes, natural environmental variability, and current and past levels of fishing pressure both inside and outside MPAs, as well as other human-induced stressors. Climate change is perhaps the most influential of these factors, affecting every aspect of the Management Program and functioning of the Network. OPC and the California Ocean Science Trust convened an interdisciplinary working group under OPC's Science Advisory Team to investigate the potential of the MPA Network to contribute to climate resilience. Their report, entitled "Climate Resilience and California's Marine Protected Area Network," serves as a starting point for understanding how this global phenomenon will affect and interact with MPAs in California (Hofmann et al. 2021). These broader limitations, as well as specific challenges called out under each Management Program pillar in Section 4, should be considered while interpreting the results, highlights, and recommendations presented in this Review.

Top: Leatherback sea turtle-CDFW. Swell shark off San Miguel Island-Derek Stein CDFW.

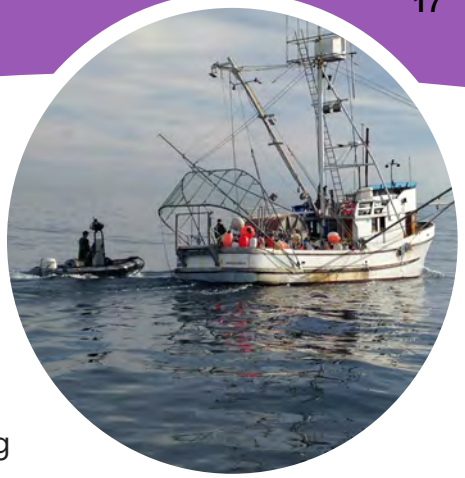


MPA DECADAL MANAGEMENT REVIEW

3. GOVERNANCE AND PARTNERSHIPS

MPA governance in California includes regulatory authority, management, and policy, with each function led by a different state agency or combination of agencies (CDFW 2016). Managing the MPA Network is a collaborative, partnership-based effort (OPC 2014). CFGC is the primary decision-making authority for MPA regulations and designating MPAs. CDFW is responsible for managing the MPA Network, providing biological data and expertise to inform CFGC decisions, and enforcing MPA regulations. OPC is the lead for guiding the policy direction for the MPA Network and works broadly to advance the Governor's priorities for healthy coastal and ocean ecosystems. Additionally, the MSLT is an advisory body to the Secretary for Natural Resources that is actively engaged in MPA management by ensuring communication, collaboration, and coordination among entities that have significant authority, mandates, or interests relating to the MPA Network. Efficient coordination and collaboration among marine and coastal management agencies and tribes, coupled with active engagement from the ocean community, makes protection of California's marine environments more robust and effective.

Two spot octopus-CDFW.



ADAPTIVE MANAGEMENT

Adaptive management lies at the core of the Management Program, and this process is informed by a cycle of formal management reviews (Figure 1.4). This report is the foundation for the first Decadal Management Review of the MPA Network and Management Program. Initially, 5-year reviews were conducted for each of the four MPA planning regions completed along the open ocean coast. However, following completion of the statewide Network, a 10-year review cycle was determined to be more biologically appropriate, administratively feasible, and cost-effective (CDFW 2016). Independent of the 10-year review cycle, CDFW provides to CFGC an annual high-level summary of activities for each pillar of the Management Program.

Part of the adaptive management process is recognizing when changes to MPA laws or regulations may be necessary for better functioning and management of the Network. Changes to MPA regulations can be proposed at any time via public petitions under the CFGC rulemaking process. Beginning October 2015, any public petitions for a regulation to be added, amended, or repealed must be submitted to CFGC via the authorized petition form on CFGC's website. If the regulation change petition is accepted, CFGC will decide whether to grant the petition and proceed with the rulemaking process, based upon CFGC staff's recommendation, CDFW's initial evaluation, if any, and oral or written public comments received. Following completion of the MPA Network, four legislative bills and 12 regulatory packages were implemented to improve governance of the Management Program, while several regulation change petitions have been denied or await CFGC action (Appendix G).

LEGISLATIVE AMENDMENTS

The California State Legislature can amend MPA laws through Senate or Assembly Bills. Since 2013, the Legislature has made several amendments to improve the Management Program. These amendments (Appendix G):

- Delegated responsibility for direction of MPA policy to OPC (Senate Bill 96, 2013)
- Provided wildlife enforcement officers with the flexibility to cite recreational MPA violations as an infraction, for minor offenses, or a misdemeanor, for more serious violations (Assembly Bill 298, 2015)
- Enhanced penalties for illegal commercial fishing operations within MPAs from a previous maximum of $1,000 to the current maximum of $40,000 for first time offenders, while repeat offenders could also face jail sentences, heavier fines, and suspension of their commercial fishing license (Assembly Bill 2369, 2018)
- Included restoration as an allowable activity within the SMCA designation definition to maintain consistency with the MMAIA (Assembly Bill 63, 2020)

Top: CDFW LED approaching a commercial fishing vessel-CDFW LED. Below: CDFW Officer star.

REGULATORY AMENDMENTS

Since 2008, CFGC has adopted amendments to the California Code of Regulations, Title 14, Section 632 to improve the clarity, access, and enforceability of MPA regulations. These amendments (Appendix G):

- Corrected and clarified regulations to remove errors
    - Corrected the regulations for a seasonal special closure that was mistakenly adopted as a year-round closure
    - Repealed a special closure that was placed around private land
    - Clarified SMRMA regulations to prohibit take of all living, geological, or cultural marine resources, with certain exceptions
- Updated boundary coordinates to be more refined and enforceable, as well as to align with ancestral tribal lands
- Added tribal take allowances within certain SMCAs
- Updated allowable activities, such as harbor maintenance and anchoring and mooring, in specific MPAs and allowed transit through MPAs with spearfishing equipment to address concerns about safety and access
- Simplified MPA names

Top: California sea lions-Claudia Makeyev CDFW. Kelp forest-Steve Lonhart NOAA.

MPA STATEWIDE LEADERSHIP TEAM

The MSLT advances MPA Network management by leveraging resources and bridging interagency efforts that cut across jurisdictions. Establishment of the MSLT was guided by the MMAIA, which mandated a State Interagency Coordinating Committee. Convened by the Secretary for Natural Resources, the MSLT was formed in 2014 with 14 founding members and has since expanded to 20 member organizations, including state and federal agencies, tribal representatives, and NGOs (Table 3.1).

"The California Collaborative Approach: Marine Protected Areas Partnership Plan" (Partnership Plan) is a key document developed by the MSLT and adopted by OPC in 2014. The Partnership Plan outlines the partnerships necessary to successfully implement the Management Program. For example, the California State Water Resources Control Board's Water Quality Control Plan for Ocean Waters of California offers water quality protections that benefit MPAs and help advance the goals of the MLPA, including protecting marine life and habitats (OPC 2014, Appendix D.5). The Partnership Plan highlights opportunities for collaboration and provides guiding principles for improving MPA management across sectors and scales. The Partnership Plan demonstrates a commitment for all partners to work together in support of California's MPA Network.

A key task identified in the Partnership Plan is the creation of an MSLT Work Plan to outline strategic priorities and guide partnership efforts. The MSLT has released three work plans spanning 2015-2018, 2018-2021, and 2021-2025. These work plans have served as a key tool to identify opportunities for action across all four management pillars, leverage resources and expertise, and hold members accountable for identified outcomes.

Table 3.1 California's MPA Statewide Leadership Team membership as of November 2022.

State Government	Tribal Government Representatives *	Federal Government	Non-governmental Partners
» Ocean Protection Council » Department of Fish and Wildlife » Fish and Game Commission » Department of Parks and Recreation » State Lands Commission » Coastal Commission » State Water Resources Control Board	» North coast: Resighini Rancheria » North central coast: Kashia Band of Pomo Indians (alternate: Graton Rancheria) » Central coast: Vacant » South coast: Santa Ynez Band of the Chumash Nation	» Coast Guard » Fish and Wildlife Service » Army Corps of Engineers » Bureau of Land Management » National Marine Sanctuaries » National Park Service	» Ocean Science Trust » MPA Collaborative Network » Resources Legacy Fund

* Regional tribal government representative seats may change over time.

Scuba diver in a kelp forest in Blue Caverns SMCA-Amanda Van Diggelen CDFW.

MPA COLLABORATIVE NETWORK

Regional Tribal Representation

CALIFORNIA OCEAN SCIENCE TRUST

RESOURCES LEGACY FUND®
CREATIVE SOLUTIONS. LASTING RESULTS.

CALIFORNIA Water Board
STATE WATER RESOURCES CONTROL BO
REGIONAL WATER QUALITY CONTROL BOA

NATIONAL MARINE SANCTUARIES

Logos for MPA Statewide Leadership Team.

JUSTICE, EQUITY, DIVERSITY, AND INCLUSION

With the recognition that some communities have historically been underrepresented in marine protection policy development and even harmed by marine protection policies, the Management Program is committed to upholding the principles of justice, equity, diversity, and inclusion (JEDI). One of the first lessons learned during MPA Network implementation was the importance of incorporating stakeholder and tribal input into the design and designation process. Over the years, the state has worked with the MPA Collaborative Network to promote engagement in MPA management among local community members. Efforts have been made to increase the accessibility of MPA information, provide opportunities to contribute to MPA research through community science, and expand equitable engagement practices. However, the state recognizes persistent deficiencies in engaging with tribes, fishermen, and communities underrepresented in marine policy development.

Recently, the state has prioritized addressing social inequities and integrating environmental justice into its policies and actions. Starting in 2021, many state agencies, including CDFW, CFGC, and OPC, developed JEDI work plans to commit to recruiting and retaining a more diverse workforce and better achieve equitable outcomes for all Californians. The recommendations contained in this Review and the current MSLT work plan identify specific actions to take within the Management Program to incorporate JEDI. One early outcome from the 2021-2025 MSLT work plan is the completion of the 2022 workshop series, Building Pathways to Justice, Equity, Diversity, and Inclusion for California's Coast and Ocean, funded by OPC and RLF and organized by the MPA Collaborative Network and Just Communities. During the workshops, Just Communities helped explain how justice, equity, diversity, and inclusion impact coastal conservation in California. A summary of key takeaways from this workshop series provides guidance for integrating more inclusionary practices into MPA management.

TRIBAL ENGAGEMENT

The state strives to engage with California Native American Tribes early and often, through both formal consultation and informal conversations, about legislation, regulations, policies, and other matters that may affect tribal communities. Both tribes and the state recognize the significant benefits of increased tribal engagement in MPA management. In February 2020, CFGC adopted a co-management vision statement and definition in concert with CDFW and California Native American Tribes, which sets the foundation for discussions going forward as the state begins to identify opportunities to advance co-management of the MPA Network in close collaboration with tribes. The MSLT's most recent work plan provides further background on the state's commitment to its important relationships with California Native American Tribes, as affirmed in state and federal law, and recognizes the inherent right of these tribes to exercise sovereign authority over their members and territory.

Top: Sea otter-CDFW. Native American tribal dancers-Elizabeth Billy.

TRIBAL PERSPECTIVES ON MPA MANAGEMENT

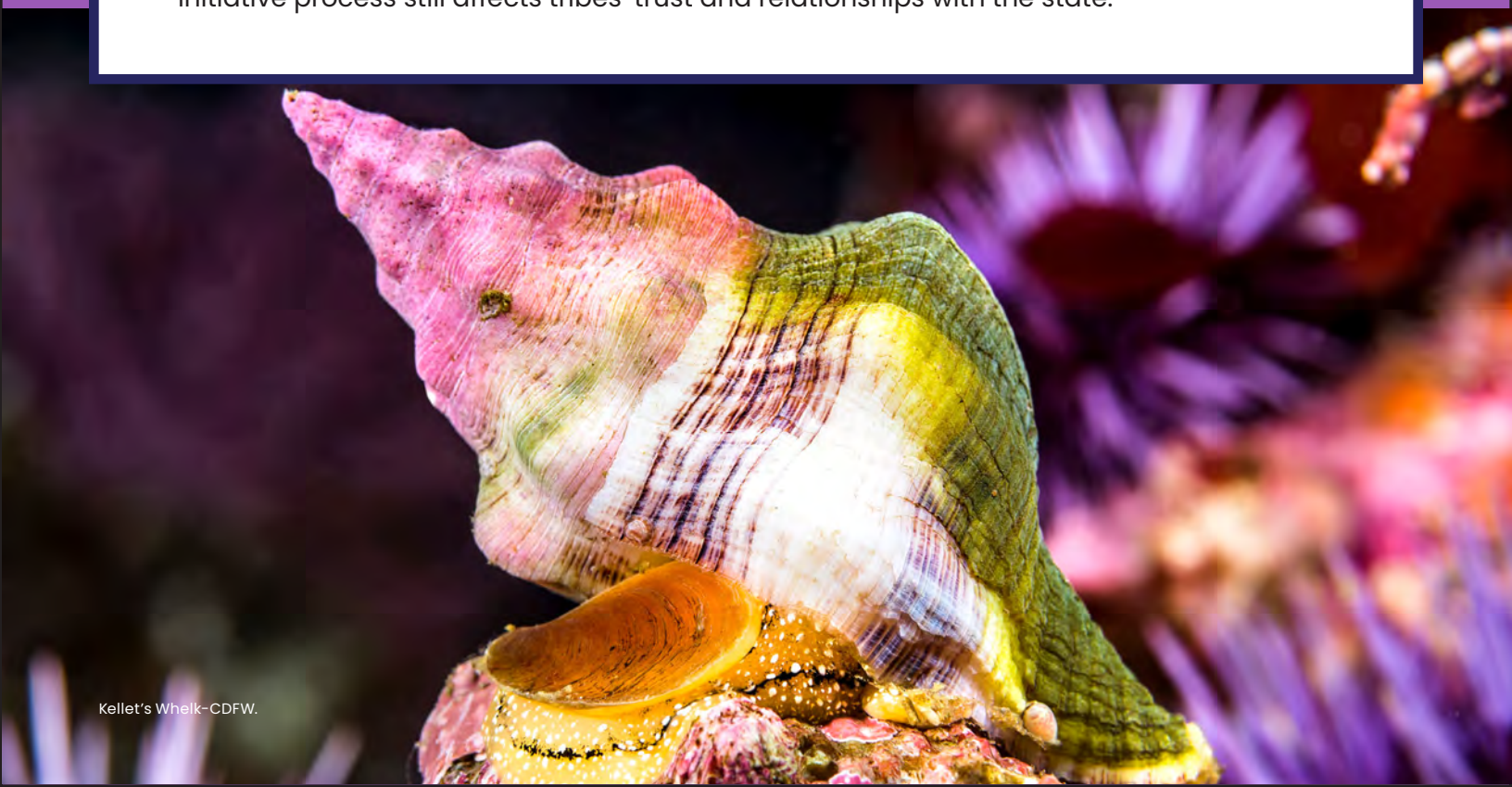
The following perspectives were provided directly by tribal representatives through a report delivered to CDFW to inform this Review. For a more comprehensive summary of tribal perspectives, please refer to the full report in Appendix C.

TRIBES' INTRINSIC RELATIONSHIPS WITH COASTAL AND OCEAN RESOURCES

Indigenous peoples have inhabited the California coast since time immemorial. California Native American Tribes remain the original stewards of California's coast and ocean despite a history of genocide, forced relocation, and systematic oppression. Tribes rely on the coast and ocean for food, medicine, ceremony, and other customary and beneficial uses, responsibly using natural and cultural resources in accordance with traditional practices. Tribes have never ceded their inherent rights to harvest and gather from, or hold religious ceremonies in the marine environment. Nor have they surrendered their obligation to manage marine resources sustainably in support of a resilient ocean for all beings.

ABSENCE OF MEANINGFUL TRIBAL ENGAGEMENT IN THE MLPA AND PLANNING FOR CALIFORNIA'S MPA NETWORK

Limited, and at times absent, tribal representation was a theme throughout the early California MPA planning process. The state gradually recognized the inadequacy of the MLPA Initiative structure with respect to inclusion of tribes. In recognition of this oversight, tribal representatives were added to Regional Stakeholder Groups after the central coast planning process. In addition, a tribal representative was appointed to the North Coast Blue Ribbon Task Force to guide development of policy on tribal issues. One of the most significant actions taken by the state to respond to the needs of tribes was the creation of tribal take exemptions. However, to spur such a change required significant energy and advocacy from tribes and partner organizations. Although tribal engagement with MPA management is improving, the initial exclusion of tribes from the MLPA and MLPA Initiative process still affects tribes' trust and relationships with the state.



Kellet's Whelk–CDFW.

EVOLUTION OF TRIBAL INVOLVEMENT IN MPA MANAGEMENT PROGRAM

The state has made strides to learn from its past mistakes and to continue to develop a mutually beneficial and equitable partnership with Coastal California Tribes within the MPA Management Program. Core to this commitment is the inclusion of tribal representatives in decision-making bodies, and the support of both tribal-led research/monitoring and education/outreach projects. Some of these actions include:

- Tribal representation on the MPA Statewide Leadership Team
- Creation of the Tribal Marine Stewards Network
- Support for tribal-led science in MPA baseline monitoring
- Support for tribal outreach and education efforts on MPAs

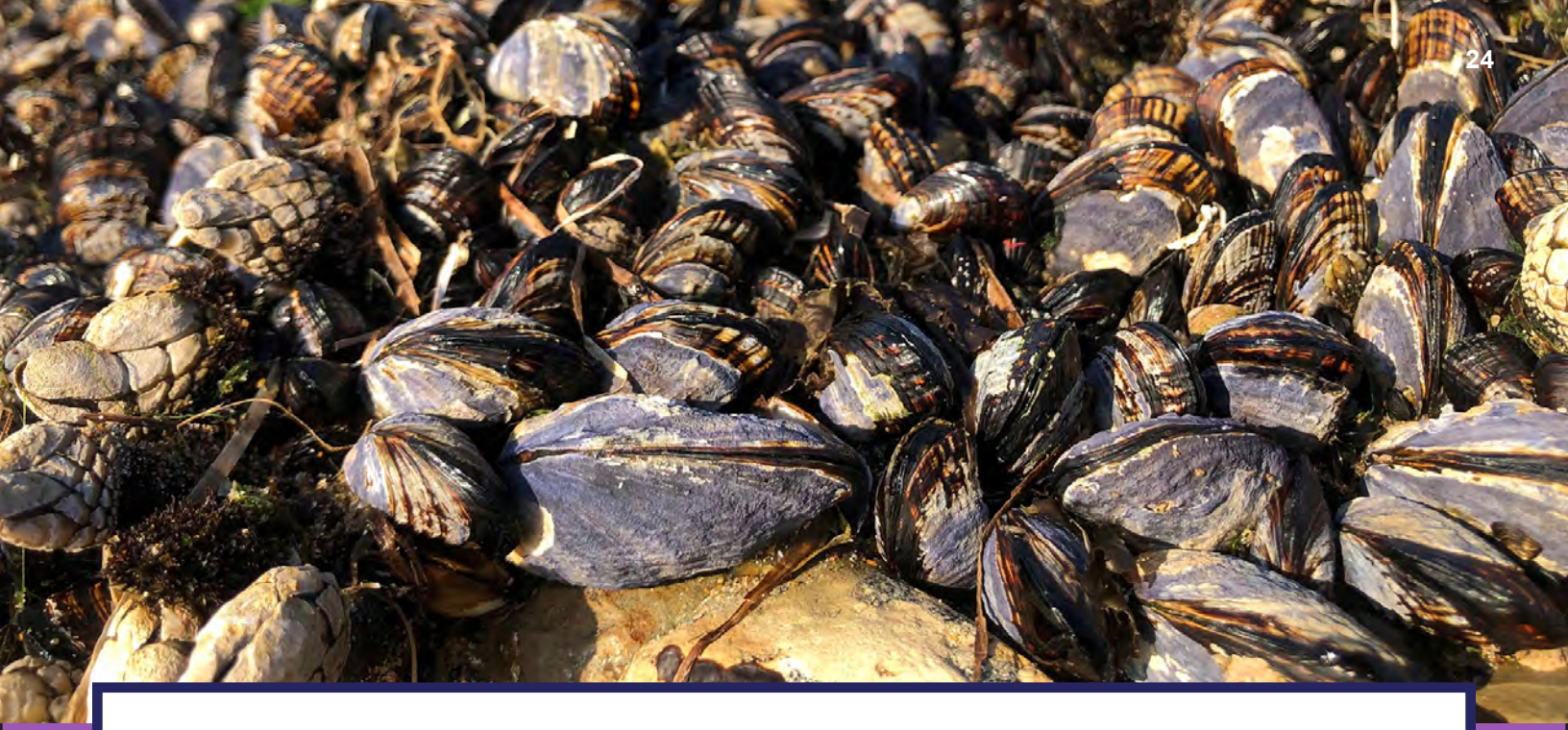
CURRENT MPA MANAGEMENT PRIORITIES FOR TRIBES

A collection of past tribal priorities and perspectives on California MPA management was primarily gleaned from online records of public comments about MPA management provided by tribal members in a number of contexts, including but not limited to: state resource agency public meetings, published resource management reports on tribal engagement, news articles, tribal websites, and websites of NGOs that regularly engage with tribes.

Input on current priorities was also directly solicited through informal conversations coordinated by regionally-based tribal consultants in partnership with CDFW, a virtual Roundtable with tribes hosted by CDFW in May 2022, and consultation with the Decadal Management Review Outreach Tribal Steering Committee. The major themes that emerged while ascertaining current tribal priorities include:

- Co-management of resources between tribes and state agencies
- Building tribal capacity for engagement with MPA management
- Improved education, outreach, and communication between tribes and state agencies
- Enhanced enforcement efforts for fishing/harvesting, especially those species that tribes rely on

Mussels in Montana de Oro State Park-Claudia Makeyev CDFW.



Coastal California Tribes remain the original stewards of our land and waters despite a history of oppression by state and federal governments. Tribal cultural tradition holds that beyond simply having the right, tribes have the obligation to protect the natural environment that sustains us all. To effectively honor that obligation, the State of California must ensure that tribes can meaningfully take part in all natural resource decision-making processes, including the MPA Management Program.

Interviews, surveys, public meetings, and a review of past comments have revealed two major themes in how tribal individuals view California's MPA Management Program: the state is making progress towards meaningful tribal inclusion and there is much more to be done before tribes feel they are equal partners in the shared goal of achieving sustainable coastal resource use. State agencies with natural resource management mandates can continue to make strides towards respecting the inherent rights and obligations of tribes by building positive relationships through effective engagement, creating a pathway to eventual tribal co-management of resources, and building the capacity of tribes to participate in agency processes. While this framework has been researched and developed specifically for those who have authority in the management of MPAs, it can be applied in natural resource management contexts statewide.

Top: Mussels in Montana de Oro State Park-Claudia Makeyev CDFW.
Below: Representation of traditional mussel harvesting-K'imaw Native Coloring Book, Hoopa.

FINANCIAL INVESTMENT

Planning and designation of the MPA Network required considerable financial support from both public and private sources (CDFW 2008), and continued investments are critical for ongoing MPA Network management. OPC has invested more than $56 million in the MPA Management Program between 2011 and July 2022, and CDFW spends, on average, over $4 million annually on MPA management activities, with additional resources dedicated to MPA enforcement. RLF provides another major source of funding, contributing more than $25 million in philanthropic match funds toward MPA implementation and management since 2012. These investments are complemented by in-kind contributions from partners, including an estimated $20 million annually of in-kind resources and volunteer efforts by the MPA Collaborative Network in service to the Management Program (Appendix D.11). These investments from multiple agencies and organizations both demonstrate significant support for California's MPA Network and facilitate its success. While financial resources vary from year to year, and funding priorities will shift, the state is committed to continuing to develop and invest in the MPA Network and Management Program.

Lingcod in Point Lobos SMR-Chad King NOAA.

4. MPA MANAGEMENT PROGRAM

A DECADE OF PROGRESS

The first decade of statewide MPA management has significantly advanced programmatic activities. This was accomplished through a high degree of coordination and collaboration with many MPA partners. The MPA Management Program is supported by four pillars: research and monitoring, outreach and education, policy and permitting, and Enforcement and Compliance. The achievements accomplished under each pillar and recognition of areas needing program improvement will help inform future adaptive management priorities.

California Collaborative Fisheries Research Program (CCFRP) fishers off Anacapa Island SMR-C. Honeyman CC.

MPA DECADAL MANAGEMENT REVIEW

RESEARCH AND MONITORING

KEY HIGHLIGHTS

- More than 50 universities, agencies, organizations, and tribes participated in regional monitoring projects during MPA baseline monitoring from 2007-2018. Data and results informed an initial 5-year management review of each planning region.
- The MPA Monitoring Action Plan was implemented in 2018 and guided eight statewide long-term monitoring projects, with results reported in early 2022.
- Monitoring results show a variety of regional and statewide species- and community-level ecological responses to both MPA protection and changing ocean conditions.
- Long-term monitoring will continue beyond 2022, and will aim to explore more cost-effective monitoring approaches, expand MPA human dimensions research, improve linkages to fisheries management, and better integrate community science.

Bull kelp-CDFW. Research diver doing a kelp survey-Kate Vylet CDFW.

MPA MONITORING PROGRAM OVERVIEW

The MLPA goals stress the importance of balancing the protection of California's nearshore biodiversity and ecosystem integrity with the needs of the human communities that utilize it. MPA research and monitoring is the one management pillar that equally addresses all six MLPA goals, as it aims to scientifically evaluate progress toward each goal. The MPA Monitoring Program was designed to collect the information needed to examine the effects of MPA protection on individual species and habitats, as well as on coastal human communities (CDFW and OPC 2018). Comparisons between baseline and long-term monitoring data, as well as inside-outside MPA comparisons, are the basis for examining trends and effects of MPA implementation in California for this Review and beyond.

Baseline monitoring occurred sequentially across the four planning regions from 2007-2018 (Table 4.1). Monitoring projects targeted a suite of key ecological and human use metrics to get a "snapshot" of regional conditions at or near the time of MPA implementation. These baseline conditions are used to detect and compare against any future changes occurring along California's coastline. The four planning regions (Figure 1.1) were designed to best represent the diverse stakeholders of the state's coastal communities, and MPAs within the same planning region share the same implementation date.

Top: CCFRP scientist measuring a lingcod in Anacapa SMR-C. Honeyman CC. Brown gorgonian in Blue Cavern Onshore SMCA-Steve Lonhart NOAA MBNMS.

Table 4.1. Summary of baseline monitoring projects, including links to final products that summarize key findings from each region.

Coastal Planning Region	Number of Projects	Data Collection	Analyze, synthesize, and share information	Products
Central Coast (Pigeon Point to Point Conception)	5	2007-2010	2010-2013	Baseline monitoring projects State of the California Central Coast CDFW 5-year management review
North Central Coast (Alder Creek to Pigeon Point)	11	2010-2012	2012-2016	Baseline monitoring projects State of the California North Central Coast CDFW 5-year management review
South Coast (Point Conception to US/MEX border)	10	2011-2013	2013-2017	Baseline monitoring projects State of the California South Coast CDFW 5-year management review
North Coast (CA/OR border to Alder Creek)	11	2013-2016	2016-2018	Baseline monitoring projects State of the California North Coast CDFW 5-year management review

In order to avoid data gaps over time, monitoring within each region continued in some habitats as funding permitted while implementation and baseline monitoring was occurring in subsequent regions. The first coordinated, structured statewide long-term monitoring approach was catalyzed following the development and release of the Action Plan in 2018, once baseline monitoring was complete across all regions. In coordination with CDFW and with funding from OPC, California Sea Grant administered an open call for monitoring proposals. Seven projects were selected and funded to initiate a coordinated monitoring effort across the entire MPA Network and targeted sandy beach and surf zone, rocky intertidal, kelp forest, nearshore rocky reef, and mid-depth rocky reef habitats, as well as nearshore oceanogrpahic seascapes and perspectives held by fishing communities. In 2019, OPC funded the establishment of an additional long-term monitoring project, a coordinated statewide estuary MPA monitoring framework to address data gaps in this key habitat identified in the Action Plan.

The long-term monitoring highlights presented here are condensed snapshots of the wealth of information collected in the nearshore habitats and fishing communities across the state during baseline and long-term monitoring. Results focus on MPA effects, as well as general observations about the diverse habitats and coastal communities connected by California's MPA Network. MPA effects are determined through both baseline vs. long-term and MPA vs. reference site comparisons, and regional results correspond to bioregions (Figure 2.1) rather than planning regions (Figure 1.1). To take a deep dive into the full monitoring results, please see long-term MPA monitoring technical reports and explore the data (Appendix B).

Still shots of baited remote underwater video (BRUV) as a rockfish (top) and soupfin shark (bottom) swim by-Shoshana Lescht-Smith CDFW. Middle: BRUV recovery by diver-Laura Percos.

Sandy beach and surf zone habitats provide an important connection between land and sea for marine species and humans alike. This project gathered information about surf zone fish populations, shorebirds, and drift seaweed, or wrack, to conduct the first statewide assessment of sandy beach habitats. Although MPA effects were hard to assess in this habitat due to data gaps and the absence of baseline data, the results provide critical insights about this understudied habitat.

- Observations of surf zone fish varied depending on survey method (Figure 4.1). The abundance and species richness of fish observed through baited remote underwater video (BRUV) was higher inside MPAs. However, no significant differences were detected between MPA and reference sites in beach seine collections.
- Differences between surf zone fish abundances inside and outside MPAs varied across bioregions and species groups.
- Shorebird populations and kelp wrack were interconnected. The abundance of shorebird species across the MPA Network was directly linked to the amount of wrack.
- Kelp wrack was more abundant in the central bioregion, where the ranges of giant and bull kelp overlap.

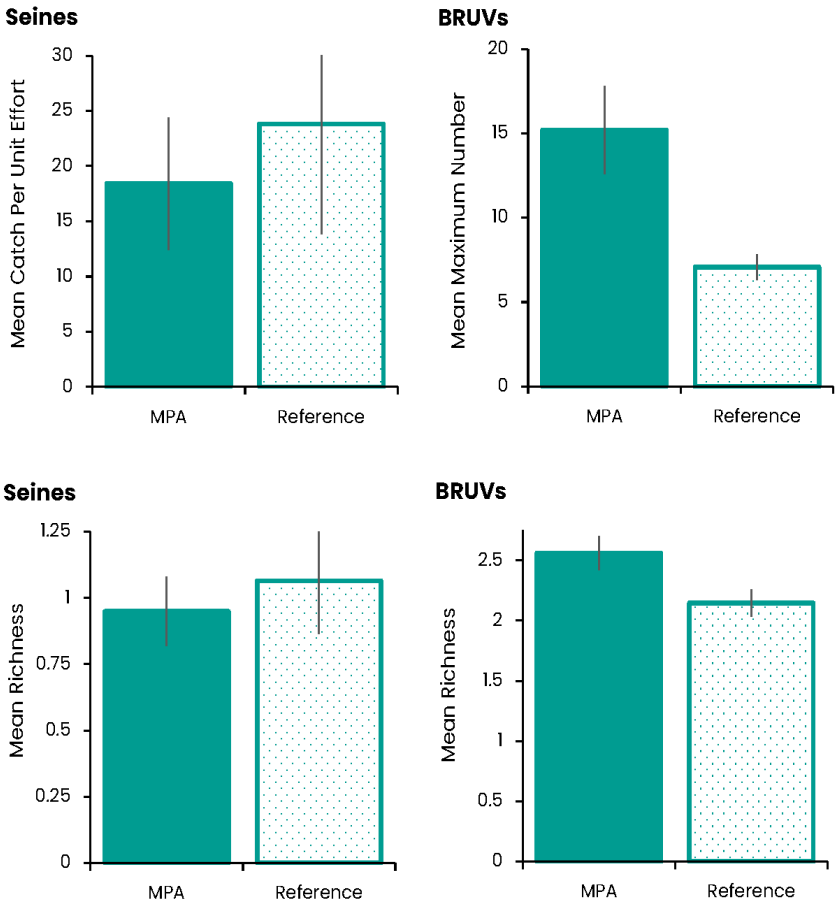


Figure 4.1 Statewide trends in the abundance (Top) and species richness (Bottom)of surf zone fish inside and outside MPAs and between beach seine and baited remote underwater video (or BRUV) survey methods (adapted from Appendix B.1).

A sandy beach seine pull at Laguna Beach SMR-Amanda Van Diggelen CDFW.

Rocky intertidal habitats are some of the most diverse, well-studied, and dynamic ecosystems in the world. Monitoring in this habitat has been ongoing in California for decades and aims to measure biodiversity and community-level responses to MPAs and ecologically and culturally important species.

- Species diversity in rocky intertidal habitats was higher inside MPAs over time than reference sites.
- Intertidal communities inside MPAs were more stable over time than reference sites, even during and after the unprecedented 2014-2016 marine heatwave. On the central coast, community stability during and after the heatwave was linked to higher larval connectivity between sites (Figure 5.4).
- Seaweed and invertebrate species abundances, including harvested species like mussels, increased both inside and outside MPAs, but the change was more pronounced inside MPAs.
- The size and abundance of ecologically and economically important species, such as red and black abalone, increased in both MPAs and reference sites, but changes were more substantial inside MPAs.

Kelp forests and shallow rocky reefs are found in nearshore waters along much of California's coastline and boost biodiversity, enhance recreational opportunities, and support important fisheries. Researchers SCUBA dive in kelp forests and their rocky surroundings to collect information about the physical and biological attributes that make this habitat so important to coastal communities.

- Fished species in southern California, such as California sheephead, kelp bass, and spiny lobster, showed greater positive responses in abundance and size under MPA protection than non-fished species.
- Fish populations in MPAs experienced the strongest positive responses to protection in regions where more fishing occurred prior to protection, in particular the south coast.
- Environmental monitoring within MPAs showed that north coast kelp forests are more exposed to stressful physical conditions like changes in ocean acidity than those in central and south coast MPAs.
- Analyses at regional scales proved more insightful than combined statewide analyses.

Bat star in Asilomar SMR-Tamara Heitzenrater CDFW. Reef check survey diver-Amanda Van Diggelen CDFW.

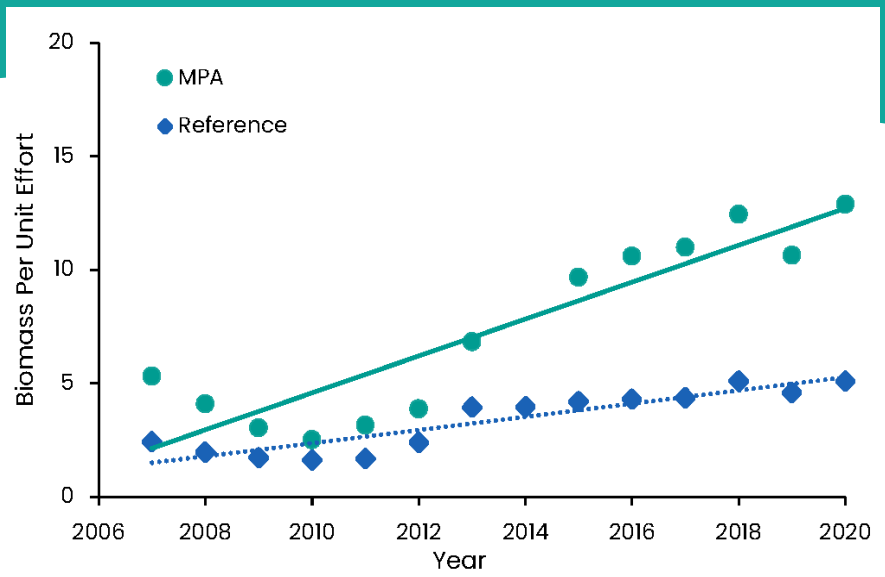


Figure 4.2 Increase in fish biomass over time in MPAs and reference sites observed in CCFRP surveys on the central coast (adapted from Appendix B.4).

Nearshore rocky reefs provide habitat for many fish species of commercial and recreational importance. The California Collaborative Fisheries Research Program (CCFRP) brings together the recreational fishing community and members of the commercial passenger fishing vessel (CPFV) fleet with MPA researchers to conduct catch and release surveys to collect information on California's diverse nearshore fish assemblages.

- Fish were bigger and more abundant inside MPAs than in reference sites across the state. More than 70% of fish species observed were larger in both size and numbers inside MPAs.
- On the central coast where the program has been operating the longest, there was enough data to confirm that fish biomass increased faster in MPAs than reference sites over the 14-year time series (Figure 4.2).
- The strength of the MPA response on the central coast largely depended on the level of fishing pressure in areas outside of MPAs. The higher the fishing pressure in unprotected areas, the greater the difference in fish populations between MPAs and reference sites.
- Larger MPAs experienced greater increases in the abundance and biomass of fish than smaller MPAs.

Mid-depth and deep reefs encompass a larger area than any other nearshore habitat in state waters. They are the primary targeted habitat for many commercial and recreational fisheries. SCUBA divers are unable to visit these depths safely, so visual tools such as remotely operated vehicles (ROVs), human-piloted submersibles, and underwater video technology are used to collect information about the species that live deep under the ocean's surface.

Top: Blue banded gobies in Arrow Point to Lion Head Point SMCA-emshaph CC. Box crabs and metridia-Michael Prall CDFW.

- Rocky reefs in the northern and central bioregions were more extensive and boasted higher quality habitat for reef-dwelling species than in the southern bioregion. Overall, the quality of rocky habitat was similar between MPAs and reference sites.

- Overall, fish abundances increased across the state, in part due to good recruitment years and other fishery management actions such as Rockfish Conservation Areas that complement protection in MPAs.

- Invertebrate population responses varied across the state. Coral and sponges were more abundant in MPAs, while sea star and urchin abundances fluctuated both inside and outside MPAs and across regions. Populations of the commercially fished sea cucumber increased in southern California MPAs.

- Several fish species, such as copper rockfish, have increased in abundance and size under MPA protection, though generally, population responses varied across bioregions.

Estuaries and coastal marsh habitats act as connections between the open coast and nearshore watersheds. They are some of the most impacted habitats by human activities. Although estuaries were first monitored during the north coast baseline surveys, the long-term estuarine MPA monitoring project started in 2019 and produced the first comprehensive statewide monitoring framework for estuarine MPAs in California. Researchers and partners identified a suite of metrics and ecological indicators to help inform management strategies in estuarine MPAs statewide and have conducted one year of field sampling so far.

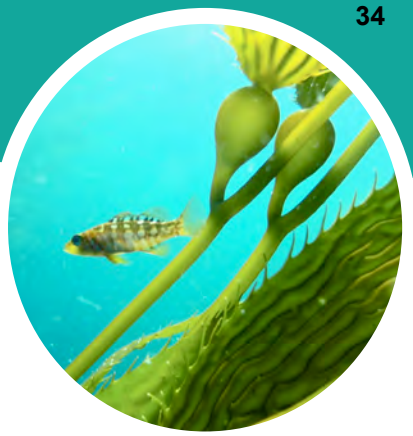
- Physical metrics such as temperature and salinity varied within and across regions, types of estuaries, and seasons.

- Species composition varied by MPA designation, estuary type, and survey method. Fish seines and cast nets caught different types of fish than hook and line fishing.

- Over 30 different fish species were observed in MPAs and reference sites. The most commonly sampled fish were threespine stickleback, topsmelt silverside, and Pacific staghorn sculpin, as well as several goby species.

- Estuary conditions and species composition were largely driven by whether the estuary mouth at the transition zone to the ocean was open or closed.

Top: Night smelt sampling in Pacifica-Ken Oda CDFW. Elkhorn Slough-CDFW.



Nearshore oceanographic conditions across the MPA Network were characterized by the Integrated Ocean Observing System to explore how changing conditions affect nearshore ecosystems and interact with the effects of MPA protection.

- Oceanographic and habitat information was integrated into the California MPA Data Dashboard that provides snapshots of ocean conditions across the MPA Network.

- MPAs and reference sites experienced similar ocean conditions within bioregions. Ocean conditions in the south coast, including the Channel Islands, were more diverse than in the north or central coasts.

- Historic and future model projections showed that MPAs statewide protect higher percentages of habitats that could provide climate refugia compared to other state waters.

- Models showed a predicted increase in harmful algal blooms across the state, especially in the northern and central bioregions.

The commercial fishing community is an important partner in the management of California's MPAs and fisheries. Through focus groups, surveys, and spatial modeling techniques to examine changes in fishing effort over time, researchers sought to explore the effects of MPA implementation on the socioeconomics and well-being of the commercial fishing community across 18 ports and of CPFV operators across five regions in state waters.

- Out of the 85 commercial fishermen and 20 CPFV operators who participated in focus group meetings, most felt that MPAs have had a negative effect on marine resources as well as fishermen's livelihoods and well-being.

- Some commercial fishermen and CPFV operators expressed concerns that MPAs could harm marine resources by concentrating fishing pressure outside their boundaries. Others believed they did not have enough information to assess the outcomes of MPAs or could not separate MPA effects from influencing factors, such as environmental variability and other fisheries management actions. Focus group participants did note that some species, such as rockfish, lingcod, lobster, and sea cucumber, may have benefited from MPAs.

- Commercial fishermen identified the ability to recruit labor, infrastructure, and access to potential harvest as top challenges to their economic well-being (Figure 4.3).

- Spatial models that incorporated information from CDFW commercial landing receipts and important fishing grounds identified by the fleet during the regional planning process showed increased catch in areas adjacent to MPAs following implementation.

Kelp bass recruit with giant kelp in Blue Cavern Onshore SMCA-Mark Winscher CC.
Scientists deploying a large oceanographic sensor/IOOS buoy-James R. Wilkinson.

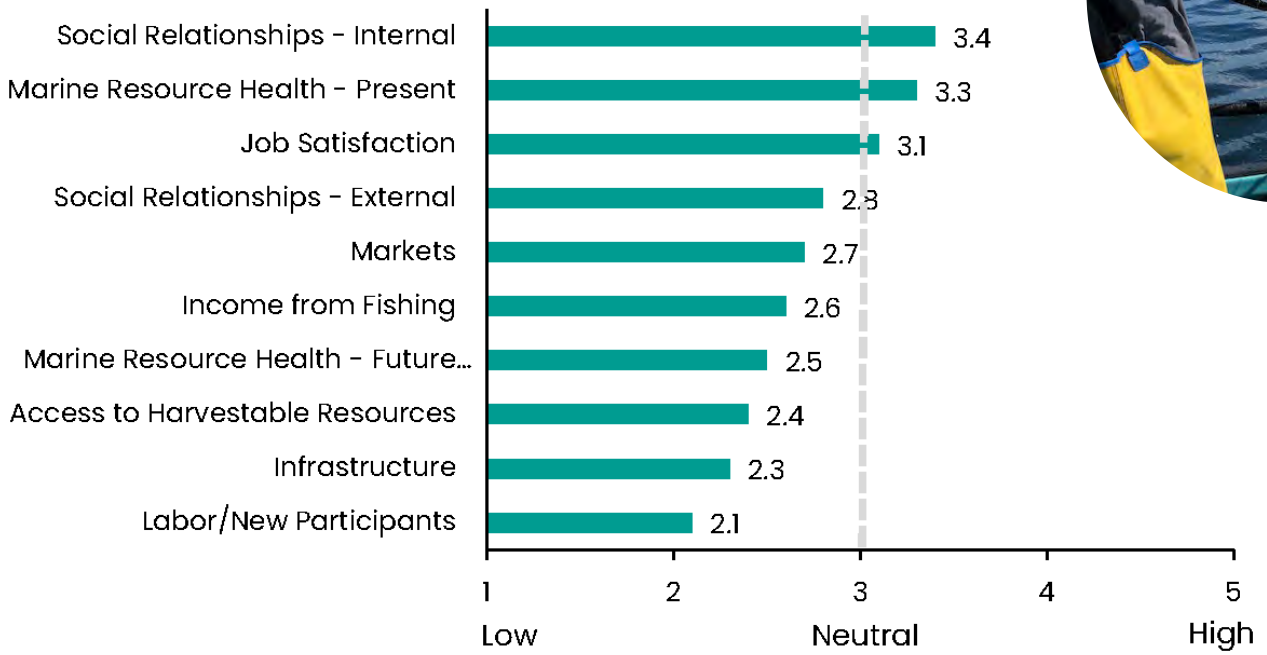


Figure 4.3 Average statewide scores from commercial fisheries focus group participants rating the factors affecting their well-being, ordered from highest to lowest (adapted from Appendix B.7).

Top: Retrieving Dungeness crab-Christy Juhasz CDFW. Monterey squid fishing boats-Carrie Wilson CDFW.

EXPLORE CALIFORNIA'S MARINE PROTECTED AREA MONITORING RESULTS & DATA

Explore information about marine species, habitats, oceanographic patterns, and human dimensions by visiting the online tools and web pages linked below.

MPA LONG-TERM MONITORING DEEP DIVE

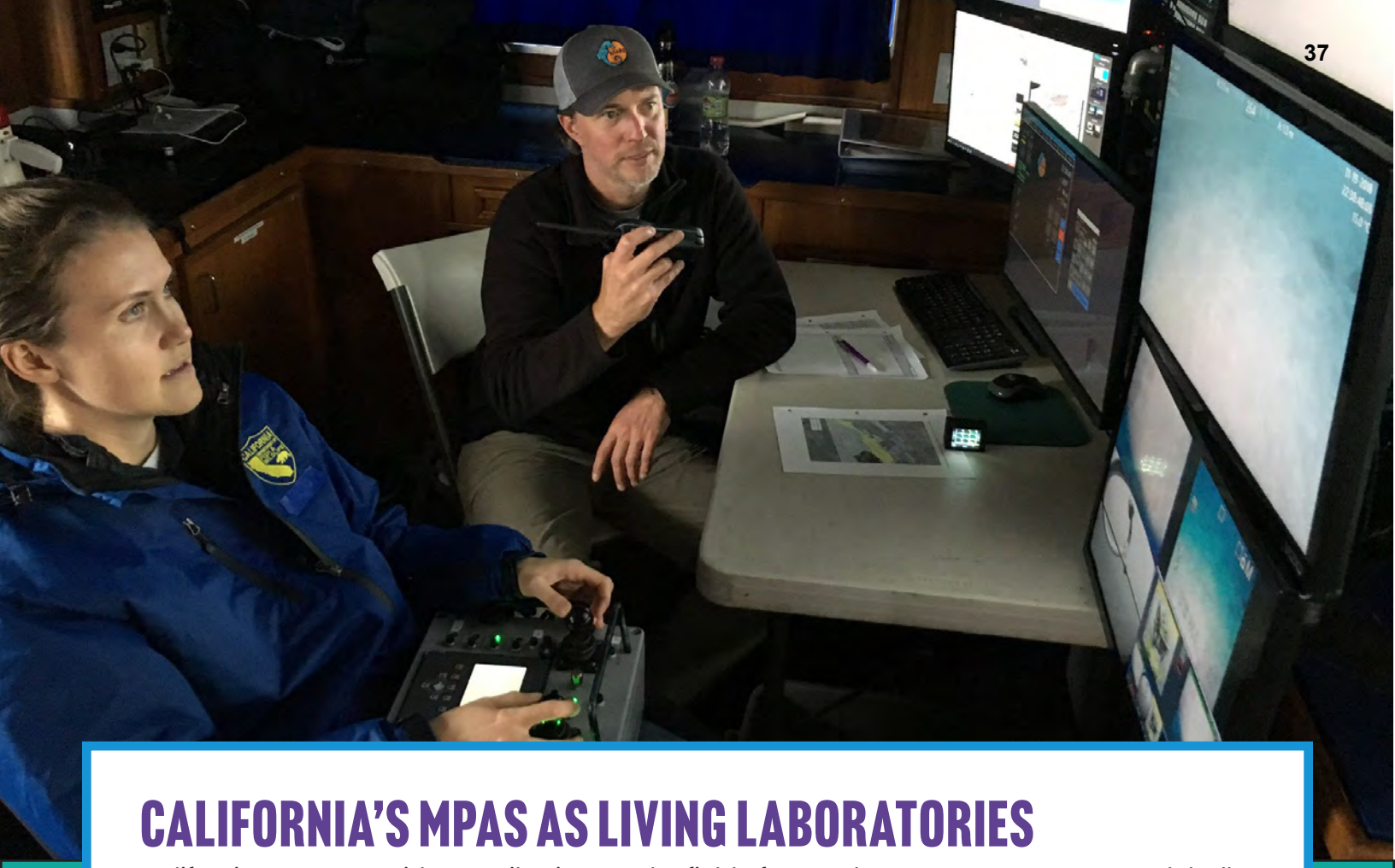
Explore beyond the monitoring highlights provided in this report and do a deep dive into the detailed results provided by the long-term monitoring technical reports, snapshot reports, and project websites:

- Evaluating the performance of California's MPA Network through the lens of sandy beach and surf zone ecosystems
- Assessment of rocky intertidal habitats for the California Marine Protected Area Monitoring Program
- Monitoring and evaluation of kelp forest ecosystems in the MLPA Marine Protected Area Network
- California Collaborative Fisheries Research Program—Monitoring and evaluation of California marine protected areas
- Monitoring and evaluation of mid-depth rocky reef ecosystems in the MLPA Marine Protected Area Network
- Estuary Marine Protected Area Monitoring Project
- Integrated ocean observing systems for assessing marine protected areas across California
- Establishing a statewide baseline and long-term MPA monitoring program for commercial and CPFV fisheries in the State of California

CALIFORNIA MPA MONITORING DATA PORTAL

In 2022, the state launched the California MPA Monitoring Data Portal on DataONE, a public data repository that aims to connect data sources and make scientific information about the natural world more accessible to everyone. The data portal houses all documents and datasets associated with MPA monitoring. Updates to the data portal will continue as new data and information become available.

Harbor seal swimming over kelps and sea grass in Matlahuayl SMR La Jolla Cove-Miranda Haggerty CDFW.



CALIFORNIA'S MPAS AS LIVING LABORATORIES

California's MPAs provide contributions to the field of natural resource management globally. MPAs enhance research opportunities and act as valuable living laboratories (MLPA Goal 3). A comprehensive body of peer-reviewed literature featuring research conducted on California's MPAs has been published since the passage of the MLPA in 1999. At least 101 scientific journal articles and 32 graduate-level research projects representing 42 universities utilized or focused on California's MPAs from 2000-2021 (Appendix D.18). Research publications featuring California's MPAs have gradually increased over the last two decades (Figure 4.4) and cover topics ranging from ecology to policy and human dimensions.

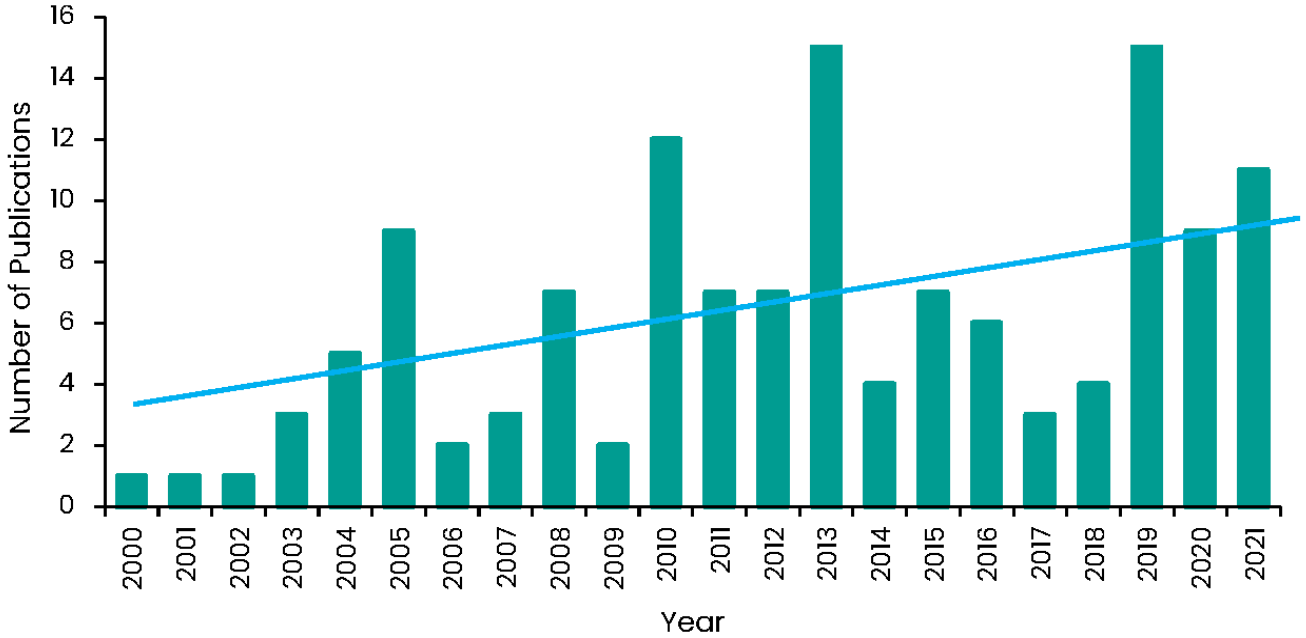


Figure 4.4 Number of published journal articles featuring California's MPAs from 2000-2021 (adapted from Appendix D.18).

Above: ROV command center manned by CDFW Environmental Scientist Amanda Van Diggelen and MARE's Andy Lauerman-Mike Prall CDFW.

TRIBAL MARINE STEWARDS NETWORK

In 2020, OPC supported four Coastal California Tribes (Resighini Rancheria, Tolowa Dee-ni' Nation, Kashia Band of Pomo Indians, and the Amah Mutsun Tribal Band) to establish a Tribal Marine Stewards Network (TMSN) that enhances the capacity of tribes to monitor and manage their ancestral territories, which include MPAs. During the two-year pilot, TMSN focused on developing program foundations, including organizational development, strategic planning, community engagement projects that foster healing and education, coastal monitoring, and coordination of activities that advance these projects. MPA ecological monitoring conducted by TMSN tribes targeted surf smelt and sea stars. Tribes also partnered with MPA Watch to monitor human uses and the Scripps Institution of Oceanography to create 3D intertidal habitat maps inside and outside of MPAs. Additional activities undertaken by TMSN included harmful algal bloom monitoring and oyster reef restoration. These tribally-led initiatives that build ecological, community, and cultural resilience return management responsibilities to California Native American Tribes and ultimately move tribes and the state closer to co-management of the MPA Network. In 2022, TMSN received additional funding from OPC beyond the pilot phase, which will allow the program to scale up, add tribal partners, and further promote organizational development.

HUMAN DIMENSIONS OF CALIFORNIA'S MPA NETWORK

Although the protection of ecosystems is at the core of the MLPA goals, human communities in California are inextricably linked to the state's coastal resources, both affecting and being affected by the performance of the MPA Network. Management actions and priorities within the social-ecological system that defines the MPA Network (Figure 2.2) have, to date, been heavily weighted towards the ecological domain. However, California is taking steps to better integrate human dimensions into MPA management through several efforts that have helped inform this Review.

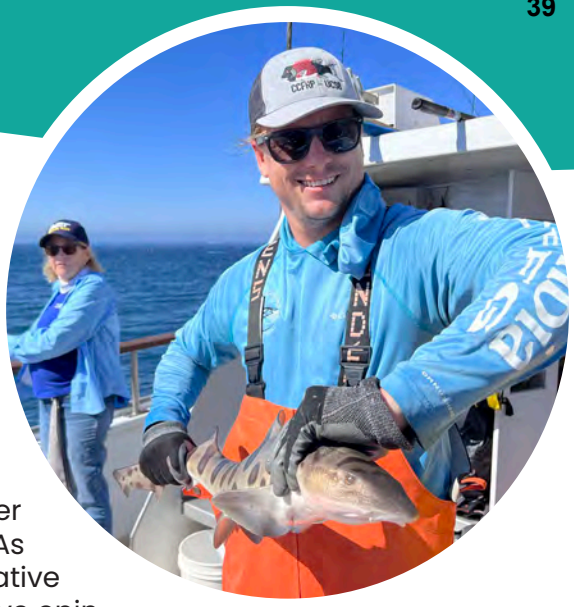
HUMAN PERCEPTIONS OF CALIFORNIA'S MPAS

MPAs affect humans in many ways, and in turn, people's values, attitudes, and perceptions can influence their behavior and interactions with marine spaces and their support for the MPA Network and management actions (Hall-Arber et al. 2021). Work conducted by human dimensions researchers, CDFW, and other monitoring partners reveal how California's ocean users perceive the state's MPA Network.

The Fishing Community

In general, individuals representing commercial and CPFV fishing sectors reported a negative opinion of the MPA Network and Management Program (Appendix B.7). Key to their dissatisfaction was a perceived lack of communication from natural resource managers. Many fishermen believed that their knowledge and expertise was not valued or considered in decision-making and distrusted state agencies and MPA science. However, fishermen expressed a desire to strengthen communications with CDFW and OPC about MPA management, research, and funding opportunities and participate in MPA monitoring and restoration activities.

Purse seine vessel in the Monterey squid fleet-Carrie Wilson CDFW.



When research programs make an effort to include members of the fishing community, their perspectives about MPAs are likely to improve. For example, CCFRP engages the recreational fishing community with academic and agency scientists in monitoring fish populations across the MPA Network. While primarily focused on ecological data collection, CCFRP conducted a statewide survey in 2021 to gauge the perceptions and opinions about MPAs held by participating volunteer anglers.

- Anglers' attitudes toward MPAs became more positive after volunteering with CCFRP (Figure 4.5). Attitudes toward MPAs varied regionally. South coast anglers reported more negative opinions about MPAs prior to participating in CCFRP. Positive opinions increased more dramatically in this region after engaging in MPA monitoring with CCFRP.

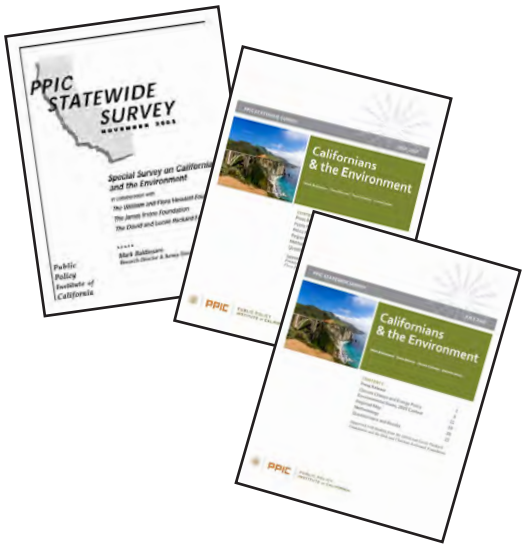
- Most survey respondents believed that fish protected in MPAs were more abundant and bigger than those outside MPAs.

- Most program participants were knowledgeable about MPAs and indicated that MPAs were in fact designed to conserve nearshore ecosystems and enhance fisheries.

- Many program participants believed that groundfish stocks were adequately or well managed by the state.

PUBLIC POLICY INSTITUTE OF CALIFORNIA SURVEYS

The Public Policy Institute of California (PPIC) conducts annual statewide surveys, unaffiliated with the MPA Management Program, to deliver information on the perceptions, opinions, and public policy preferences of California residents. PPIC first included a question about marine reserves in their 2003 statewide survey, and later surveys (2006, 2017, 2018, and 2020) have also included questions regarding MPAs. In 2003, PPIC found that 75% of Californians were in favor of creating marine reserves along California's coast, and more recent surveys show that support for MPAs in California has increased over time. For example, in 2017, 77% of respondents expressed a belief that it is very important that California has MPAs, and in 2020, 89% of Californians surveyed responded in favor of maintaining existing MPA rules and boundaries.



Top: Leopard shark caught and released by CCFRP in Anacapa SMR-C. Honeyman CC.

Ocean Businesses

In 2022, CDFW developed and released a survey gauging the effect of MPAs on ocean businesses in California (Appendix E.1). Approximately 300 consumptive and non-consumptive coastal recreation businesses (e.g., dive shops, recreational fishing charters and outfitters, boat and kayak rental shops, tour guides) were emailed a survey about how their business was impacted by MPA implementation and their level of engagement in MPA outreach. Of the 44 businesses that responded:

- Most expressed being very or extremely familiar with California's MPA Network.
- A higher percentage of respondents believed that MPAs have had a negative effect on their business than a positive effect (Figure 4.6). About a third of respondents believed that MPAs have had neither a positive nor negative effect on their business or were unsure about their effect.
- Over half of the respondents have distributed or displayed MPA information for their customers, utilizing MPA brochures and maps.
- Businesses that have not displayed MPA information expressed that materials were not available to them, they did not support MPAs, or they did not believe their business was the appropriate venue.

Top: Surfing Moonlight Beach in Swami's SMCA-Breezy Baldwin CC. Stand-up paddleboarder along South Point SMR-Morgan Ball.

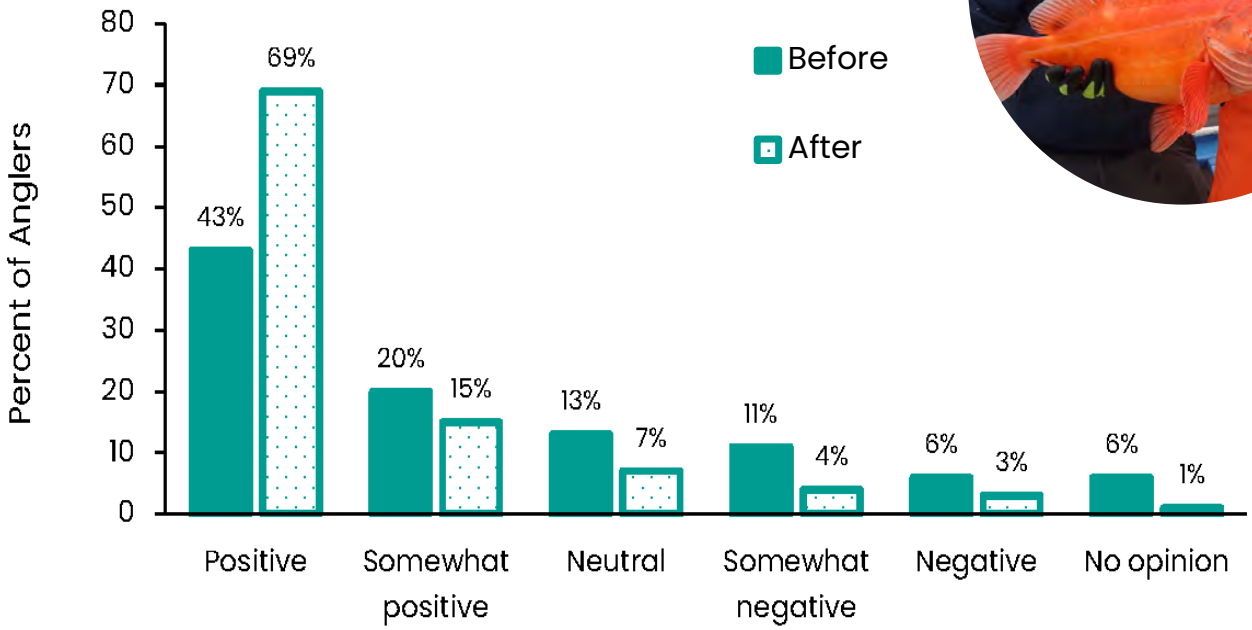


Figure 4.5 Changes in anglers' opinions about MPAs before and after volunteering with CCFRP (adapted from Appendix B.4).

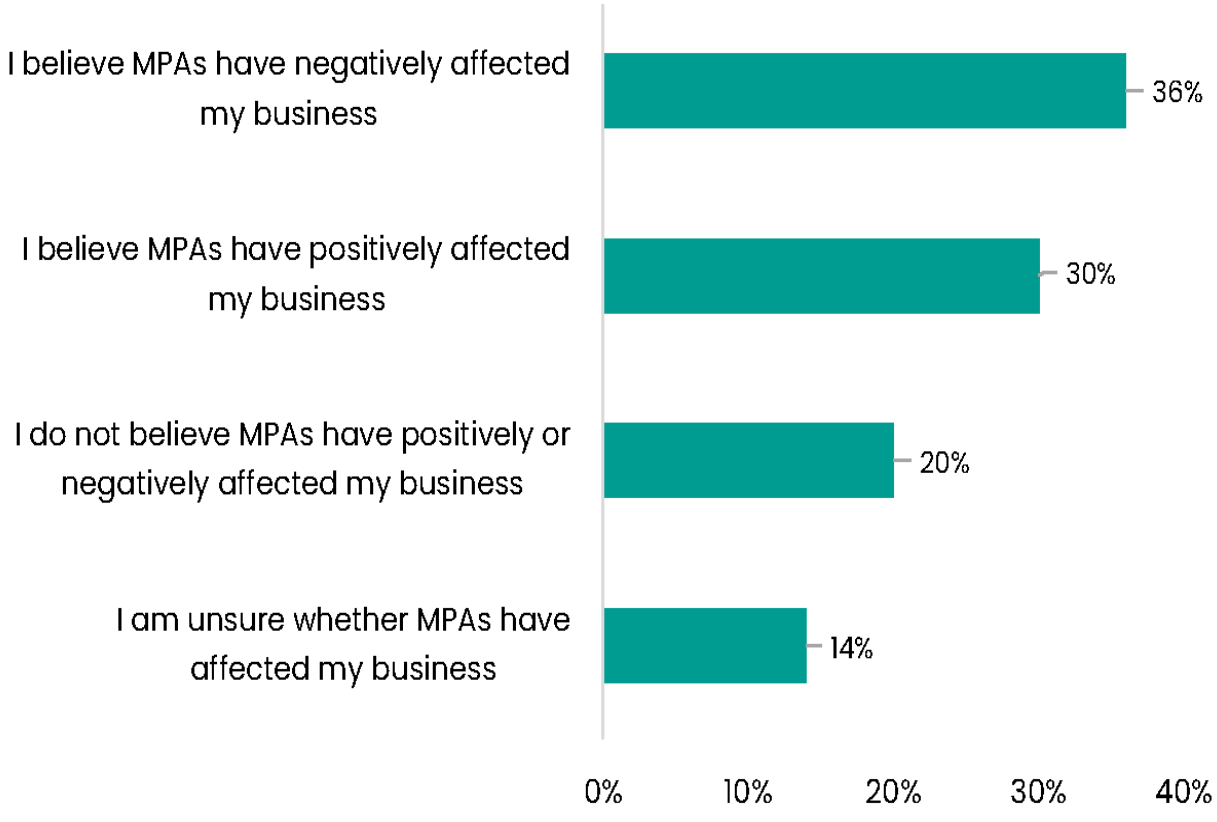


Figure 4.6 How survey respondents believed MPAs have affected their business (from Appendix E.1).

Top: A yelloweye rockfish temporarily caught and quickly released by CDFW Environmental Scientist Sara Worden with CCFRP off Stewarts Point SMR-Tom Mattusch.

MPAS AND FISHERIES MANAGEMENT

The ecosystem-focused goals of the MLPA are inextricably linked to fisheries management in California and provide a complementary management framework to California's primary fisheries law, the Marine Life Management Act (MLMA) (CDFW 2018, Hall-Arber et al. 2021). MLPA Goal 2 specifically calls out species of economic value as important for sustaining, protecting, and rebuilding. MPAs are expected to provide several ecological and socioeconomic benefits to fisheries in California (Botsford et al. 2009, Wertz et al. 2011, Edgar et al. 2014), as well as inform federal fisheries management strategies for the West Coast region.

MPA Benefits to Fisheries

Results from long-term monitoring projects and other research efforts reveal the potential for MPAs to enhance stocks and fishing opportunities both within and outside of their boundaries through several mechanisms. By protecting larger, older individuals, MPAs can benefit fisheries through enhanced reproduction and population connectivity (Harrison et al. 2012). Older individuals produce higher quality offspring (Hixon et al. 2014) which can disperse on ocean currents and help sustain and replenish populations both inside and outside MPAs (Harrison et al. 2012, Baetscher et al. 2020). Critical habitat protection within MPAs for certain species can also help benefit fish stocks and promote population connectivity.

Adult marine species may travel from within an MPA to outside its borders, a phenomenon called spillover. Spillover from MPAs can benefit economically important fisheries when fish and invertebrates move outside MPA boundaries and contribute to fished stocks (Lenihan et al. 2021, 2022, Di Lorenzo et al. 2016, Appendix B.4). Spillover is difficult to quantify, but results from long-term monitoring and other

Top: Round haul net vessel-Steve Wertz CDFW. CCFRP fishing volunteers holding the MPA Banner in Bodega Bay-Sara Worden CDFW.

regional studies in California provide evidence that the phenomenon is occurring around some MPAs in the Network.

- CCFRP conducts tag and recapture studies of fish statewide. While recapture events are very rare, CCFRP estimated a spillover rate of up to 20% for tagged and recaptured fish (Appendix B.4).

- Results from lobster trap studies around three Northern Channel Islands MPAs showed a dramatic increase in lobster catch and biomass both inside and outside MPA boundaries between 2008 and 2018, demonstrating that MPAs are not only helping lobster populations within their borders, but also contributing to the fishery through spillover (Lenihan et al. 2021).

- Fishing behavior also shows evidence of spillover, especially near the boundaries of MPAs. Members of the fishing community often report "fishing the line," or targeting the areas just outside MPA boundaries to take advantage of potential spillover effects (Cabral et al. 2016, Lenihan et al. 2021, 2022).

Integration of MPAs and Fisheries Management

Both state and federal fisheries managers utilize MPA monitoring data and partnerships to evaluate fish population status and management strategies. The MLMA Master Plan outlines several goals to conserve California's economically important marine resources. MPA data has helped inform fisheries stock assessments, population status and life history patterns, and state Fisheries Management Plans (FMPs), which are one tool for fostering sustainable fisheries called out in the MLMA.

- Red abalone density and size data collected during both baseline and long-term MPA monitoring by both subtidal and intertidal monitoring groups, as well as CDFW's abalone surveys, are informing the management of red abalone and updates to the Abalone Recovery Management Plan.

Red abalone munching on kelp-Derek Stein CDFW.

- It is estimated that 15% of spiny lobster habitat is protected within California's MPA Network. The Spiny Lobster FMP, adopted by CFGC in 2016, integrates MPA data collected by south coast kelp forest MPA monitoring partners to examine the effects of MPAs on spiny lobster populations and the lobster fishing community.

- MPA monitoring data collected by the Channel Islands National Park Kelp Forest Monitoring Program and CDFW were utilized to examine how MPAs could benefit the warty sea cucumber fishery. CDFW estimates that 16% of warty sea cucumber habitat occurs inside the boundaries of MPAs in southern California, which protect spawning aggregations of warty sea cucumber (CDFW 2019; more information can be found in this video).

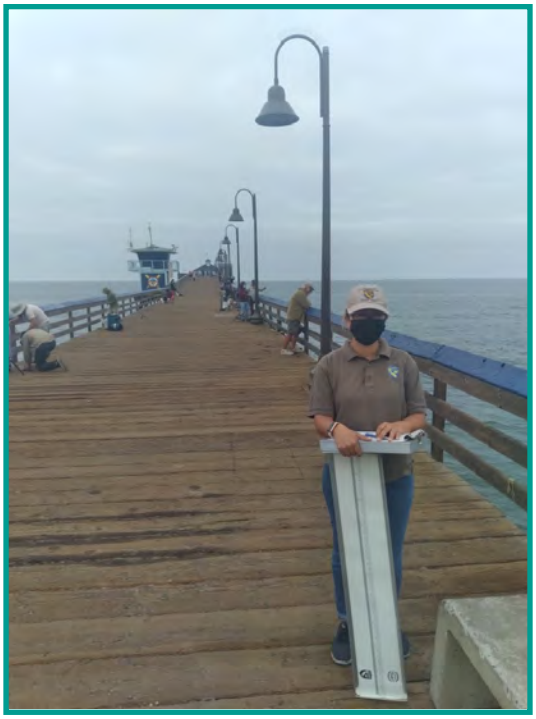
- Federal fisheries managers have recently tapped into MPA monitoring data for broader West Coast stock assessments:

  - CCFRP data have informed several rounds of stock assessments of important nearshore rockfish species and are considered one of the most robust datasets on these species.

  - Using MPA monitoring data collected by Marine Applied Research and Exploration (MARE) via ROV, CDFW scientists are working on spatial models of nearshore rockfish species biomass to inform upcoming stock assessments, such as copper and quillback rockfish. The Scientific and Statistical Committee of the Pacific Fishery Management Council reviewed and approved MARE's ROV sampling methods and CDFW's analytical approach in 2020. CDFW will also use these methods to evaluate the contribution of MPAs to nearshore fisheries.

Top: Scientific illustration of a warty sea cucumber-Claudia Makeyev CDFW.
California spiny lobster with red urchin-Derek Stein CDFW.

MAPPING RECREATIONAL FISHING EFFORT



While fine-scale spatial data on recreational fisheries is typically scarce, CDFW invests significant resources to collect information from recreational anglers along the California coast. To estimate catch and effort for all sport-caught finfish, CDFW conducts the California Recreational Fisheries Survey (CRFS), with supplemental sampling from the Ocean Salmon Project, and uses information from logbooks submitted by CPFV operators. Annually, CRFS conducts more than 7,000 sampling assignments and contacts more than 68,000 fishing parties. Although recreational catch and effort estimates are typically made at the district scale, CRFS samplers survey anglers about their catch location at a much finer scale, within a one by one nautical mile microblock. This higher resolution data, collected with cooperation from recreational anglers and CPFV captains, makes CRFS a valuable source of information for both MPA and fisheries management.

The aggregate CDFW data on estimated statewide catch from both private boat and CPFV anglers indicates that total catch has risen and fallen, but no consistent trend is apparent from 2006-2021, despite MPA implementation and various other changes in fishing regulations during this time (Figure 4.7). While district-level estimates of recreational catch and effort remain the priority for CDFW, work is underway to make the fine scale spatial data collected through CRFS available to inform management. Future analyses using catch location may reveal spatial shifts in fishing activity following MPA implementation.

Clockwise from top: CRFS sampler Paulina Arellano at Imperial Beach-Mike Curthoys CDFW. Marcus Fain measuring fish aboard a recreational sportfishing boat-Stephanie Hammond CDFW. CRFS sampler Helen Acosta interviewing an angler on a beach south of Humboldt Bay-Ed Roberts.

Figure 4.7 Estimated statewide catch (teal bars) and effort (blue line) of sport-caught finfish for both private boat and charter boat anglers combined from 2006-2021 (RecFIN). Due to the COVID-19 pandemic, CRFS was unable to sample April-June 2020, resulting in an incomplete picture of recreational catch and effort in 2020.

CDFW wildlife technicians Terrance Manilla and David Astrue sampling a salmon boat at a safe distance in 2020-CDFW. Lingcod perched on a rock-MARE.

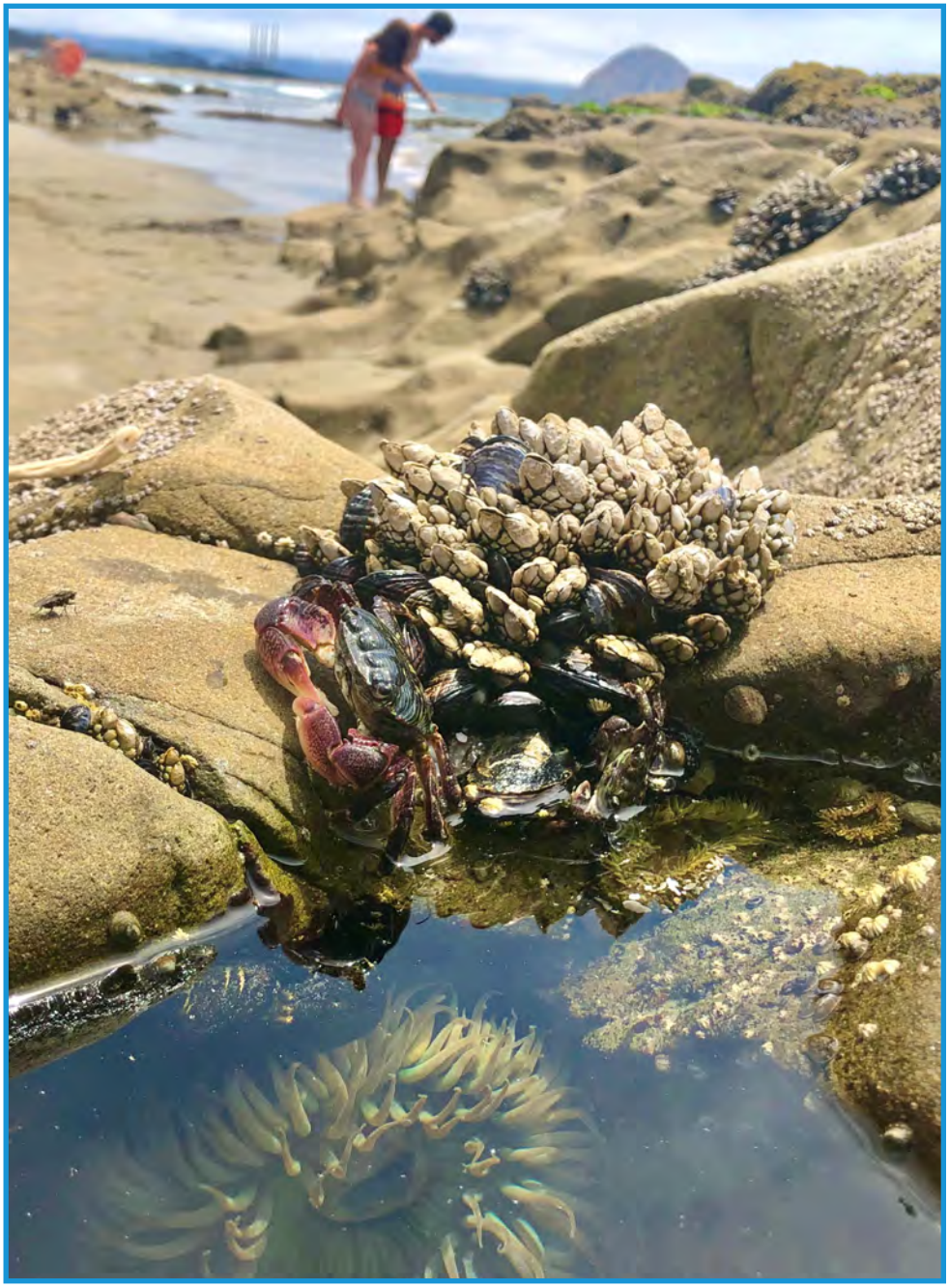
MPA WATCH

Since 2008, MPA Watch has been training community scientists to collect human use data in and around MPAs, documenting general recreation patterns in MPAs and determining whether MPA regulations are followed. After more than 34,000 surveys at 75 MPAs along the California coast, MPA Watch surveyors have established that consumptive activities, which are not necessarily in violation of MPA regulations, make up only 2.4% of the total activities reported in MPAs (Appendix D.12). Inside MPAs, tidepooling was more likely, recreational boating was more likely, and onshore fishing was less likely than at non-MPA sites (Appendix D.6).

Onshore fishing was **less likely** inside of MPAs

Tidepooling was **more likely** inside of MPAs

Recreational boating was **more likely** inside of MPAs



Tidepool explorers in Morro Bay-Claudia Makeyev CDFW.

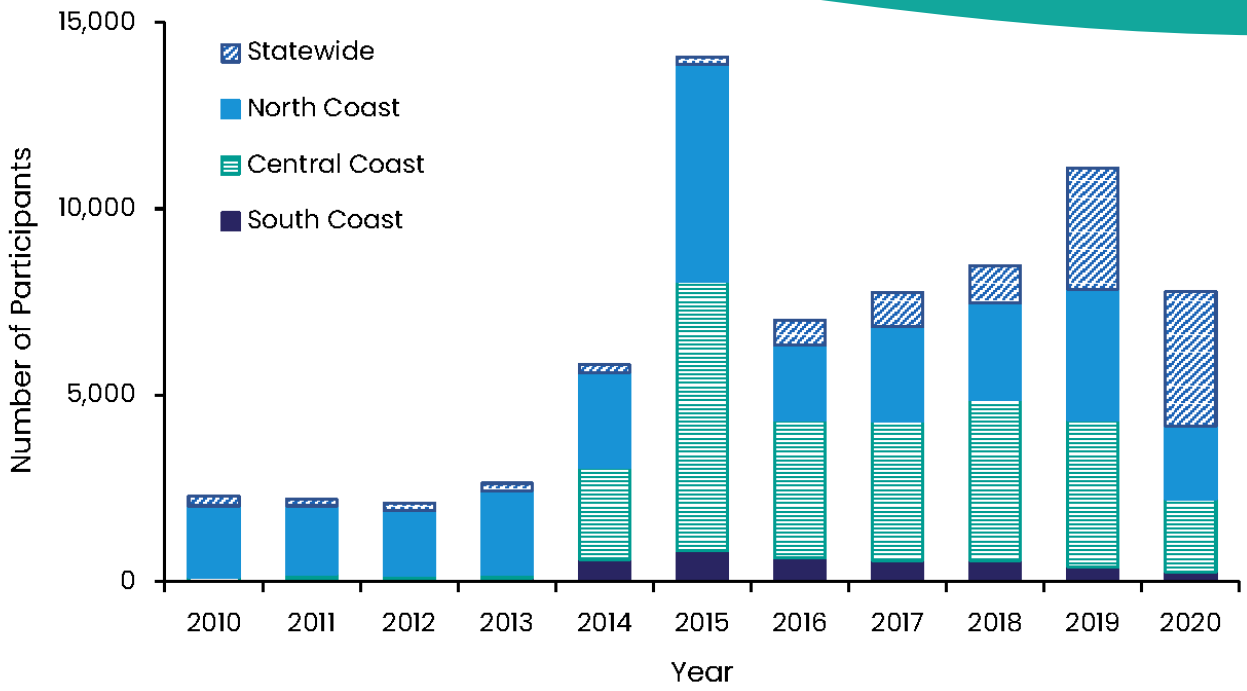
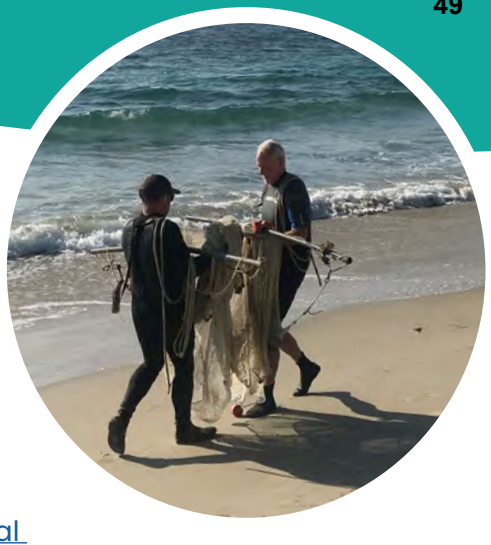


Figure 4.8 Number of participants involved in state-funded community science programs from 2010-2020 in each MPA bioregion or "Statewide" if data could not be parsed by region (adapted from Appendix D.6). Figure includes three monitoring projects on the north coast that are no longer active: surfperch-49 participants from 2011-2012, rocky reef fish-52 participants from 2014-2015, and seabirds-7 participants from 2014-2016.

COMMUNITY SCIENCE

Californians value healthy coastal ecosystems, and many are eager to help inform MPA management. Community science programs provide the general public with the opportunity to engage in scientific efforts. There are currently six active community science programs that regularly contribute to the MPA Management Program (Appendix D.6): CCFRP, Reef Check California, MPA Watch, Beach Watch, Long-term Monitoring Program and Experiential Training for Students (LiMPETS), and Snapshot Cal Coast. Between 2010 and 2020, more than 80,000 individuals participated in these programs, and overall participation has increased over time (Figure 4.8). Involvement in community science advances place-based stewardship, empowerment, and civic engagement while contributing to MPA monitoring efforts. While interest in expanding MPA community science programs has grown, more work is needed to better integrate community science with the broader MPA Monitoring Program.

Tolowa Dee-ni' Nation members measuring fish to inform MPA monitoring-Rosa Laucci. Quadrat with meter tape and banner in the rocky intertidal zone-Sara Worden CDFW.



KNOWLEDGE GAPS AND FUTURE DIRECTIONS

California's MPA Network is one of the most studied and widely monitored marine environments in the world, yet limitations that affect monitoring results still exist. Throughout the evolution of the MPA Monitoring Program, the state has had to balance fluctuating funding levels with monitoring priorities and capacity, leading to some knowledge gaps and compromises in monitoring approaches.

Some key habitats protected in MPAs have not been evenly or consistently monitored through time. Prior to the passage of the MLPA, several long-term monitoring groups already existed and operated statewide, such as the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and the Multi-Agency Rocky Intertidal Network (MARINe). These research groups primarily surveyed nearshore and intertidal rocky reef habitats and were prioritized for funding throughout baseline and long-term monitoring. Habitats such as sandy beaches and estuaries did not have consistent baseline data or statewide consortiums to coordinate uniform monitoring efforts. Some habitats, such as deep soft seafloors, have been left out of monitoring altogether due to inherent challenges in sampling large, remote geographic areas and highly mobile species that are less likely to benefit from MPA protection. Survey methods and sampling resolution vary between habitats depending on the targeted species, sampling logistics, and experimental design. Because of these inconsistencies and differences in time series and spatial coverage, integration and evaluation of datasets across habitats is challenging.

The Action Plan attempted to create a more cohesive approach to monitoring. However, funding levels are not unlimited and vary from year to year, so a three-tiered approach was utilized for prioritizing monitoring sites. Long-term monitoring partners were directed to focus on gathering more information at tier 1 MPAs for this first Review (CDFW and OPC 2018). Tier 1 sites contain more rocky reef habitats, meet many of the science design thresholds (i.e. size, level of protection, connectivity), and may have more consistent historical monitoring information available. Tier 1 sites are not more important to the functioning of the Network; rather, they are expected to provide the best return of information on investment. To some degree, targeting tier 1 sites limits the ability to answer several evaluation questions included in the Action Plan and the DEWG framework, so future long-term monitoring priorities may shift to address these outstanding questions.

Finally, large data gaps exist in the human domain of the social-ecological system that defines the MPA Network. There are few human-focused studies that evaluate information related to MPAs over as large a geographic area as the California coast. Research with a social-ecological focus has only recently come to the forefront of MPA science and evaluation and been prioritized by the state. Furthermore, integrating MPA effects on fisheries and the fishing community continues to be a challenge because most fishery-dependent data is collected at a much coarser spatial scale relative to the size of California's MPAs. California has the opportunity to be a leader in this field, and the next decadal management cycle will aim to more effectively balance the human and ecological domains.

The state is mandated and committed to continuing MPA Network monitoring into the future to inform adaptive management. The Action Plan is a living document, and as new information is discovered and management priorities shift, the state will update MPA monitoring strategies. This first Review has identified critical knowledge gaps that will be addressed as the state prepares an update to the Action Plan.

CALIFORNIA MARINE PROTECTED AREAS

Top: CDFW Senior Environmental Scientist Steve Wertz carrying a beach seine with a graduate student onshore of Laguna Beach SMR - Amanda Van Diggelen CDFW.

MPA DECADAL MANAGEMENT REVIEW

OUTREACH AND EDUCATION

KEY HIGHLIGHTS

- A wide variety of tools are employed in MPA outreach and education to build public awareness of MPAs and support compliance: signage, brochures, posters, coloring books, websites and blogs, CDFW's ocean sport fishing interactive web map, mobile apps, webinars and videos, virtual field trips, online training courses, social media, and in-person docents and interpreters.
- CDFW and OPC jointly support and coordinate numerous partner organizations to conduct MPA outreach and education and to ensure information accuracy and product consistency across different sources.
- Efforts to make MPA outreach and education resources available in Spanish and other commonly used languages in California facilitate the distribution of MPA information to wider audiences and promote justice, equity, diversity, and inclusion.
- Evaluating the effectiveness of outreach and education efforts will serve to inform an overall outreach strategy and generate data-backed recommendations moving forward.

Giant kelp-CDFW. OPC Jenn Eckerle with CCFRP scientist holding a lingcod-Stacy Hayden OPC.

MPA OUTREACH AND EDUCATION OVERVIEW

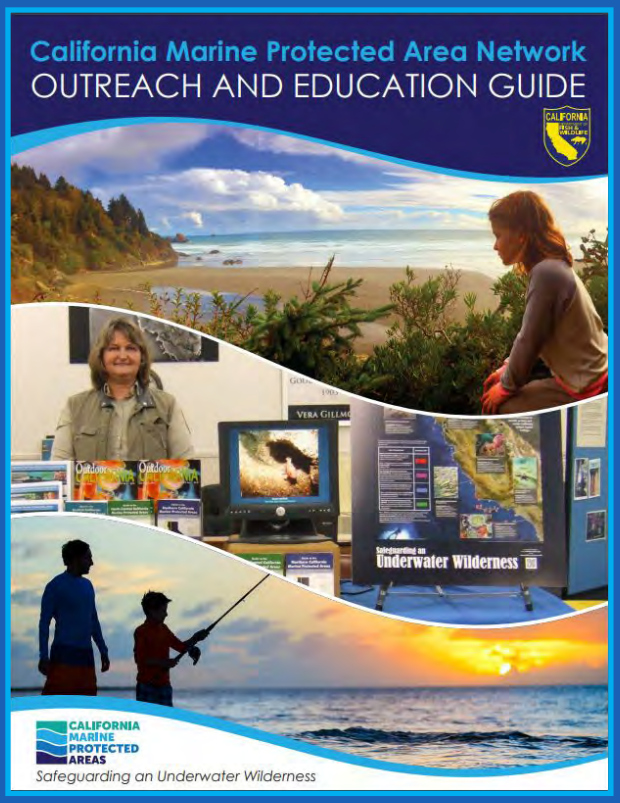
Outreach and education in the MPA Management Program focuses on building public awareness of MPAs and the Network to achieve compliance with MPA regulations. As secondary goals, the program encourages non-consumptive recreation and allowable take in some MPAs and communicates MPA research and monitoring results as well as other management updates. More broadly, MPA outreach and education fosters coastal stewardship and pride in California's marine resources. Recently, efforts have been launched to increase stakeholder engagement with the Review. By increasing public awareness and support for MPAs, outreach and education contributes to all MLPA goals. Outreach and education is specifically linked to improved educational opportunities (Goal 3), effective management measures (Goal 5), and management of MPAs as a cohesive network (Goal 6).

After MPA Network completion, the state prioritized and increased investment in outreach and education, with the understanding that MPA Network success depends on public compliance. CDFW developed and distributed outreach and education materials and acted as a point of contact for MPA inquiries statewide. CDFW also established and supported partnerships early on in order to build capacity and help meet the overwhelming need to publicize the newly implemented, yet invisible, MPA Network and its area-specific regulations. To date, nearly 500 signs have been installed at coastal access points to inform visitors about MPAs and MPA regulations (Appendix D.3). Additionally, from 2013 to 2021, CDFW distributed over 300,000 MPA brochures and guidebooks statewide, with efforts concentrated between 2014 and 2017. Posters, contact cards, and stickers were also created and distributed. Efforts were made to ship outreach materials to commercial fishermen, CPFV operators, ocean businesses, government agencies, NGOs, schools, and museums. In addition, CDFW staff delivered MPA presentations and participated in numerous public events, including scientific and resource management conferences, sport fishing shows, ocean-related public events, and other forums.

During the transition from baseline to long-term MPA monitoring, a concerted effort was made to create a more cohesive statewide outreach package. In 2018, a California MPAs logo was developed and used on a variety of new outreach materials, including brochures, California's marine habitats poster, stickers, and The California MPA Network: Safeguarding an Underwater Wilderness video. While CDFW supports a variety of partners to help conduct MPA outreach and education to boost communications, an ongoing challenge has been maintaining consistent and accurate information across various media and messengers. In 2019, CDFW released the California Marine Protected Area Network Outreach and Education Guide, which provides partners with guidance on approved MPA messaging and design standards. This framework helps to streamline the product review process and ensure that the public receives accurate, reliable, and consistent information about MPAs across different sources.

CALIFORNIA MARINE PROTECTED AREAS

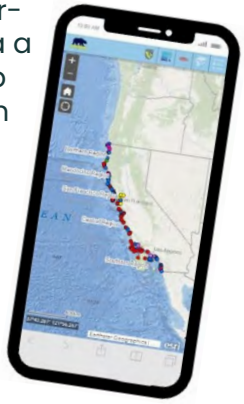
Top: Sea star-Alex Mutti CDFW.
Official MPA logo.



MPA outreach materials clockwise from top left: The Outreach and Education Guide, interpretive sign at Greyhound Rock SMCA, MPA sign at South Cape Mendocino SMR, MPA brochures for all MPA planning regions down the California coast, general MPA Network brochure and poster.

CDFW'S OCEAN SPORT FISHING INTERACTIVE WEB MAP

CDFW's ocean sport fishing interactive web map is an interactive map for referencing relevant ocean sport fishing information while on the go. Accessible via a web browser on a computer or mobile phone, this resource is designed to help users visualize sport fishing regulation boundaries, including MPAs and rockfish conservation area depth restrictions. Clicking on features of the map will bring up relevant fishing regulations. When on a location-enabled device and with user permission, the web map will also show user location in relation to regulatory boundaries, including MPAs. By popular demand, CDFW is working to upgrade this web page into a smartphone app for convenient use in coastal areas without cell phone or wireless coverage.



Despite the effort in 2018 to develop and print new MPA outreach materials, CDFW at the same time began to shift focus toward digital resources. CDFW's MPA website was completely updated in 2022 and hosts a plethora of information, including maps and regulations, brochures, individual MPA web pages, and MPA videos. CDFW also publishes educational blogs and announces Management Program updates on its Marine Management News blogsite. In 2019, CDFW released an ocean sport fishing interactive web map, which allows users to visualize their location relative to MPAs on a mobile device. This pivot toward online resources and tools reduces waste of printed materials following regulation changes and expedites the process of updating materials. Capitalizing on technology also allows CDFW to reach a larger audience and demonstrates an effort to keep up with broader communications trends.

DECADAL MANAGEMENT REVIEW OUTREACH AND ENGAGEMENT

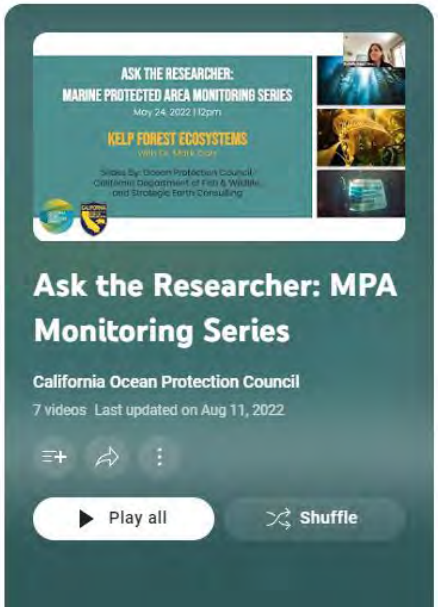
In preparation for the Review, additional outreach and engagement efforts were deployed. In 2021, CDFW launched a dedicated website informing the public about the Review, the information sources used, and ways to participate in the Review process. A new email address (MPAmanagementreview@wildlife.ca.gov) and contact form were also created to allow members of the public to submit questions, comments, and recommendations regarding the Review (Appendix F.3). The messages received were cataloged, and recommendations are captured in both Section 6 and Appendix A.

A consulting firm was contracted to provide additional expertise and resources to elevate outreach for and engagement with the Review. They helped convene a Steering Committee composed of representatives from key community groups, including tribal representatives, fishermen, NGOs, and resource managers, to advise on how to effectively engage and share information about the Review with their respective networks (Appendix F.1). Additionally, a second firm was contracted to develop marketing materials with cohesive design elements for the Management Program to help unify the California MPA brand and enhance public recognition.

Red sea urchin in Painted Cave SMCA. SeaKangaroo CC.

From 2021 to 2022, the state hosted two virtual engagement series to enhance stakeholder involvement with the Review. The first virtual engagement was a four-part series of community meetings to both share information about the Review and solicit input and comments from the public. The four meetings were held in fall 2021 and targeted various community groups: commercial fishermen, recreational fishermen, non-consumptive recreational users, and government agencies and NGOs. These meetings were a great opportunity to both disseminate information about the Review process and receive feedback from interested community members (Appendix F.2).

The second virtual engagement was developed in response to requests heard during the community meetings. All community groups voiced interest in hearing more about MPA science and monitoring. In early 2022, after the long-term monitoring reports were released, OPC distilled these dense technical reports into formats more accessible to public audiences. First, OPC developed two-page snapshot summaries in both English and Spanish to accompany each long-term monitoring technical report, which highlighted key results in a visually appealing format. Following the snapshot summaries, a webinar series was launched in summer 2022 to connect the public directly with MPA researchers. This webinar series, called "Ask the Researcher", featured eight 30-minute research presentations followed by 30-minute Q&A sessions. The Ask the Researcher webinar series was recorded and is available online (Appendix F.2). Lastly, following the public release of the Review and presentation at the CFGC meeting in February 2023, an MPA Review Forum is planned in March 2023. The Forum will provide a venue to highlight portions of the Review and celebrate partners' accomplishments.



Top: Young humpback whale-Dane McDermott CDFW. Screenshot of Ask the Researcher YouTube.
CDFW staff conduct outreach at the 2022 Shared Adventures event on the Santa Cruz Wharf.-Lisa Uttal NOAA.

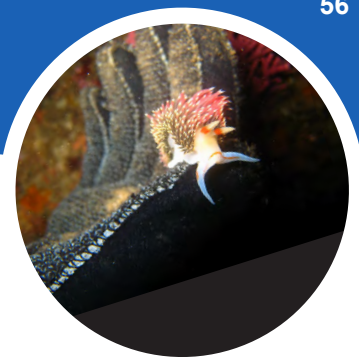
MPA DECADAL MANAGEMENT REVIEW COMMUNITY MEETINGS

Nearly 400 participants attended the MPA Decadal Management Review virtual community meetings in 2021. During the four-part meeting series, many different opinions and ideas were expressed, but some messages were consistent across stakeholder groups (commercial fishermen, recreational fishermen, non-consumptive recreational users, and government agencies and NGOs).

Participants from all stakeholder groups expressed an interest in more outreach and communication from the Management Program, as well as more coordination between agencies, organizations, and community groups. These community meetings were held just before the release of the MPA long-term monitoring reports, so many were interested in learning about MPA Network effectiveness and monitoring strategies. Participants from across the spectrum felt that the 10-year adaptive management cycle was not responsive enough to their needs, or changing ocean conditions. Without access to data, they were also concerned that enforcement efforts may be insufficient. Stakeholders shared a passion for ocean health and, frustrated by a perceived lack of transparency and action, many were interested in contributing their own time and efforts to MPA monitoring and restoration. Video recordings of the community meetings and a detailed summary of key themes are available online.

To address the concerns voiced at these community meetings, the Management Program offers recommendations in this report that propose increased coordination, outreach and communication, and data transparency, as well as strengthening the use of community science (Section 6).

Steve Wetrz presenting MPA information at the 2022 Western Society of Naturalists Meeting-Kara Gonzales CDFW.



CORE OUTREACH AND EDUCATION PARTNERSHIPS

MPA COLLABORATIVE NETWORK

The MPA Collaborative Network was created to bridge the gap between local communities and state-level MPA Management. After a successful pilot program in 2013, the MPA Collaborative Network became fully operational in 2014, composed of 14 member collaboratives representing all of California's coastal counties (Appendix D.11). Collaborative members come from many sectors, including government, NGOs, science and academia, the general public, tribes, the fishing community, ocean businesses, and more (Figure 4.9). CDFW staff participate in Collaborative meetings to provide MPA management updates, stay informed about local MPA issues, and build partnerships.

MPA Collaboratives provide area- and community-specific knowledge to inform outreach and education products and programs. The outreach materials they produce reflect the interests identified by local community members, as well as members' unique contributions. The state has funded locally relevant outreach products developed by the Collaboratives, including county-scale MPA brochures and videos, kids' coloring books and activity guides, lesson plans for teachers, an online MPA training course, and videos about California Native Americans' long history of coastal resource stewardship.

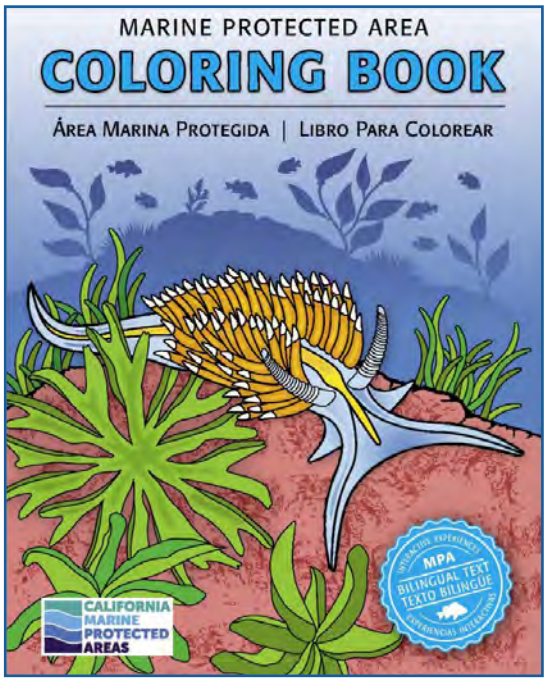
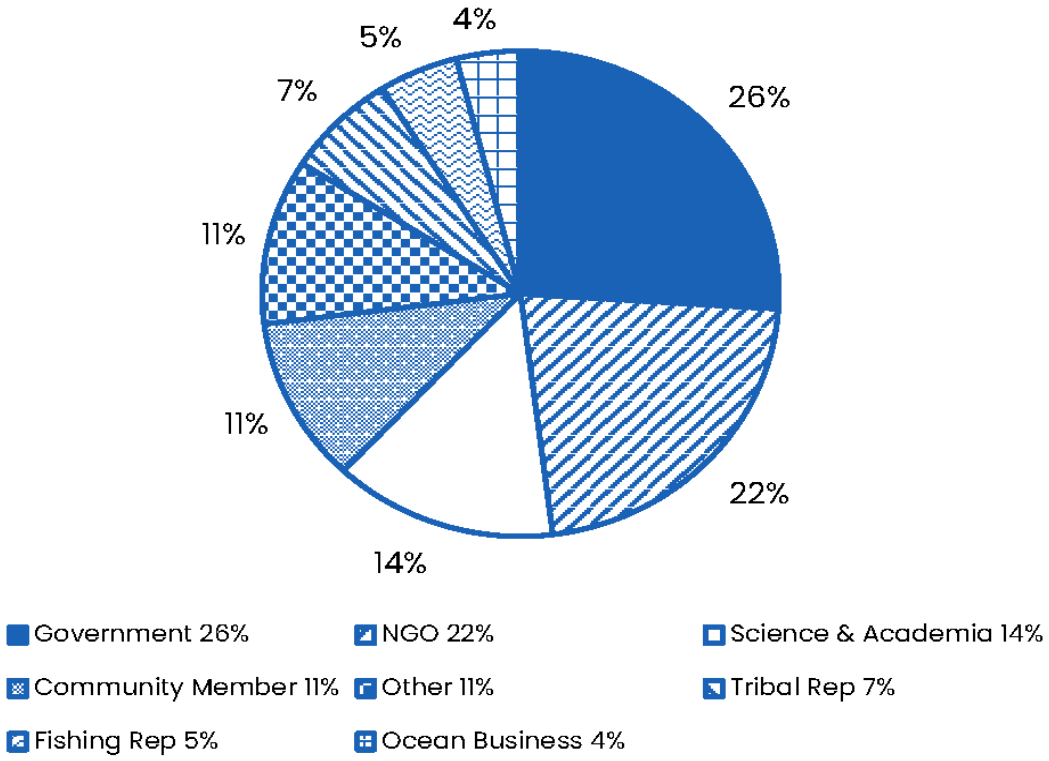


Figure 4.9 MPA Collaborative Network membership composition across sectors (adapted from Appendix D.11).



Hilton nudibranch on a dive glove-Derek Stein CDFW. Cover of the MPA coloring book.

The MPA Collaborative logos.

Figure 4.10 Examples of MPA outreach and education products developed by CMSF aimed at various audiences and locations (Appendix D.3).

CALIFORNIA MARINE SANCTUARY FOUNDATION

The California Marine Sanctuary Foundation (CMSF) was a major partner that helped promote awareness and stewardship of the MPA Network from the outset, beginning with regional MPA outreach and education in 2007 and eventually scaling up to statewide efforts. With funding from the state, CMSF created some of the first MPA Network outreach and education products and continues to build on the work of designing signs, brochures, exhibits, posters, training presentations, and web content (Figure 4.10). Currently, the state is supporting a collaboration between CMSF and the MPA Collaborative Network to inventory, assess, and update MPA signage across the state.

CMSF has also completed two state-funded MPA outreach and education assessments. The California MPA Education and Outreach Needs Assessment (2018) identified priority outreach needs, such as using audience-specific tools and approaches to disseminate locally relevant MPA information and ensuring that outreach materials continue to be distributed and replenished. The report also highlighted opportunities to reach specific audiences that may be important allies for outreach, such as recreational fishermen and docents.

The MPA Education and Outreach Tool Evaluation Report (2021) assessed the efficacy of three different types of outreach tools created by CMSF for increasing MPA awareness: regulatory brochures, scripted PowerPoint presentations, and a social media campaign. While non-consumptive ocean users found the brochure and presentation equally useful for increasing their understanding of MPAs, recreational anglers rated the presentations as more useful.

The social media campaign CMSF led on Facebook and Instagram using hashtags #CalifMPAs and #CaliforniaMPAs was widely successful in spreading MPA awareness. CMSF curated and shared content to partners, and about 400 hashtag users created over 3,000 posts, which reached more than 1.2 million unique users in about 18 months (Appendix D.3).

LED Lt. Michelle Budish at the LA Collaborative Honor the Ocean Event-Amanda Van Diggelen CDFW.

CALIFORNIA DEPARTMENT OF PARKS AND RECREATION

Leveraging the California Department of Parks and Recreation's (State Parks) infrastructure and interpretive expertise has been incredibly valuable for the MPA Management Program. There are 35 MPAs that are located adjacent to 42 coastal State Parks units (Figure 4.11). When adding MPAs and State Parks that are located nearby, the list grows to 69 MPAs located adjacent to or nearby 72 State Park units. Thus, more than half the MPAs in the Network are associated with a State Park. From 2014 to 2018, CDFW supported four part-time seasonal State Parks interpretive staff to design and deliver on-site MPA programming (Appendix D.2). From 2018-2022 with funding from OPC, State Parks' involvement in the Management Program grew to up to 18 seasonal and permanent interpretive staff.

In addition to delivering MPA messaging through in-person education programs, State Parks developed distance learning programs with MPA-focused curricula for K-12 students through PORTS: Parks Online Resources for Teachers and Students. What began as a pilot project in 2014 has since doubled in size from four to eight coastal State Parks districts. PORTS offers free, live, interactive virtual field trip experiences in MPAs led by State Parks interpreters. In 2018, PORTS began to include underwater "live dive" livestream programming. The expansion of PORTS was timely, as demand for these experiences surged during the COVID-19 pandemic while students sheltered in place and were forced into online learning. Through PORTS, MPA messaging now reaches far beyond California, engaging students across the country and around the world (Appendix D.2).

State Parks Interpreter with mobile cart at Natural Bridges SMR-CDFW. Below: Live Dive by State Parks at Point Lobos SMR- Lindsay Bonito OPC.

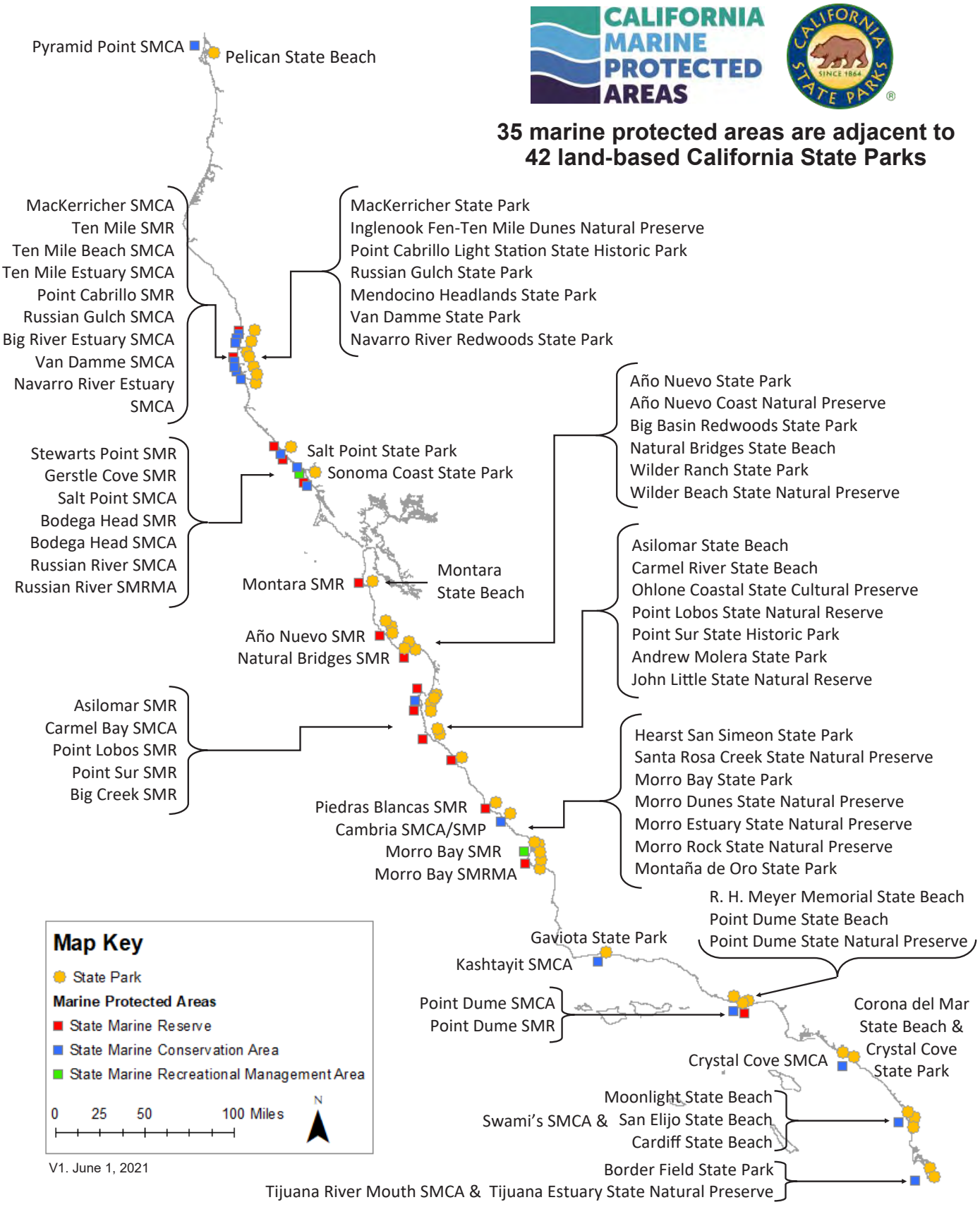


Figure 4.11 Map of 35 MPAs and 42 coastal State Parks units that are located adjacent to one another.

TRIBAL CONTRIBUTIONS TO MPA OUTREACH AND EDUCATION

The following information was provided directly by tribal representatives through a report delivered to CDFW to inform this Review. For a more comprehensive summary of tribal perspectives, please refer to the full report in Appendix C.

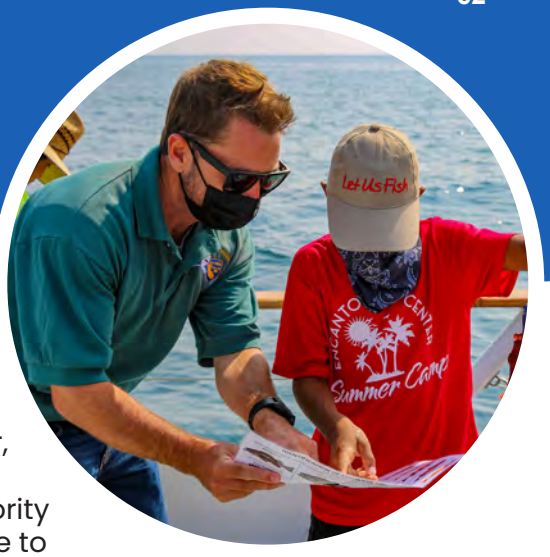
Education and outreach regarding healthy oceans is a shared interest among tribal and state governments. When in partnership, tribes and the state have an opportunity to reach and engage with larger and more diverse audiences than would be possible on their own.

One way tribal knowledge is celebrated and shared is through MPA signage targeted at members of the public. CMSF, the MPA Collaborative Network, and CDFW have collaborated to include tribal content in many of the MPA interpretative signs they install on the coast and are continuing this effort. So far, at least 18 unique signs about MPAs include cultural information from local tribes.

The Chumash Tribal Marine Protected Area (CTMPA) Education Program serves as a prime example of a successful tribal/state collaboration. In 2012, Wishtoyo Chumash Foundation, a Native-led non-profit, launched its CTMPA Education Program and taught the social importance of a healthy ocean environment to nearly 2,000 K-12 students in southern California, growing to 6,000 students by 2015. At least 78% of the programs were delivered to students from Latino, Chumash, and/or politically/economically marginalized communities. The scientific, policy, and regulatory content of the Chumash MPA programs was developed with CDFW, Channel Islands National Marine Sanctuary, and California State Parks Channel Coast District. CTMPA Education Programs instill a marine conservation ethic in thousands of youth and educate participants about marine conservation and the importance of MPAs. The programs also incorporate Chumash maritime art, traditions, culture, songs, dance, history, and stewardship.

Some tribal members have taken advantage of their local MPA Collaboratives to amplify tribal messages about ocean stewardship. In 2019, with funding from OPC, members of the Yurok Tribe, Trinidad Rancheria, and the Tolowa Dee-Ni' Nation led the development of a tribal MPA Curriculum (Unit 1 and Unit 2) through the Del Norte, Humboldt, and Mendocino Collaboratives. This teacher toolkit includes lesson plans focused on the intersection of MPAs, traditional knowledge, and tribal perspectives on stewardship. It also contains place-based cultural curriculum relevant to students in the north coast region and can serve as a template for adaptation by other California Native American Tribes.

Chumash paddling Tomol to Limuw (Santa Cruz Island)-Teresa Romero.



EMBRACING DIVERSITY AND INCREASING ACCESSIBILITY

California has the highest language diversity of any state in the nation, with 43% of the population aged five and older speaking a non-English language at home (Rumbaut and Massey 2013). However, many MPA outreach and education materials are only available in English, with a limited number of resources available in Spanish. A priority for MPA outreach and education is to make materials more accessible to non-English-speaking audiences. Starting in 2014, CDFW's website has offered a language translation utility for numerous languages, although the accuracy of these translations is reliant on Google Translate and not verified by the state. Another way that CDFW is increasing the accessibility of its communications is by employing the use of symbols and icons that are more universally understood. Additionally, in 2022, following partner requests for translated materials, CDFW began translating regional MPA brochures into Spanish, with Vietnamese, Tagalog, and both Simplified and Traditional Chinese to follow. Various partner organizations have also produced MPA outreach materials in Spanish, including CMSF, State Parks, Save Our Shores, the Bay Foundation, and the Monterey, San Luis Obispo, and Los Angeles MPA Collaboratives. While these efforts are a start, many opportunities remain for increasing the accessibility of MPA products.

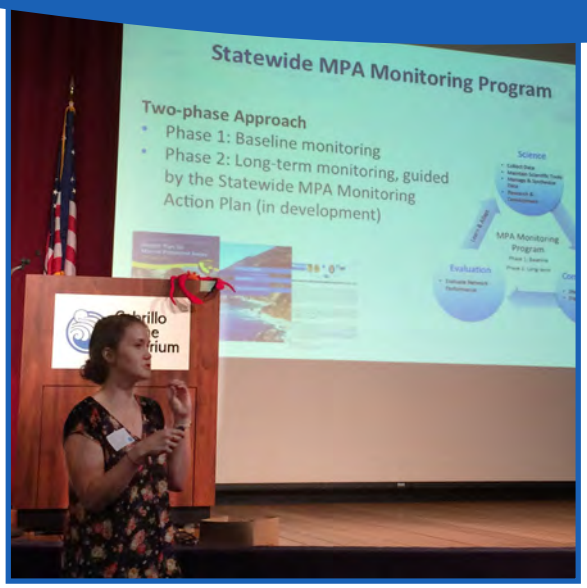
The MPA Management Program is considering other ways to make MPA information more accessible. Reaching underrepresented audiences requires targeted outreach efforts that go beyond language translations. Improving our understanding of barriers to MPA information, access, and benefits will help build momentum toward actions that promote equity and ensure that the benefits of California's MPA Network are shared more widely.

Top: Travis Buck explaining rockfish identification outside of an MPA on a Fish For Life trip-Carrie Wilson CDFW. MPA outreach brochure in Spanish. A young angler showing off their first fish (California sheephead) caught-Carrie Wilson CDFW.

KNOWLEDGE GAPS AND FUTURE DIRECTIONS

A fundamental knowledge gap is the effectiveness of MPA outreach and education activities. While the Management Program has improved on tracking the distribution of outreach materials, the level of public awareness about California's MPA Network is still limited, as well as the demographics of MPA users and those who engage with the Management Program. Without this basic information, it is difficult to gauge progress against MLPA goals and determine areas most needing improvement. The development of a human dimensions MPA research program can provide the necessary information for both assessing and improving the outcomes of outreach efforts. Understanding how the public effectively receives MPA information is critical for advancing MPA outreach and education.

To help address this knowledge gap, CDFW released a public awareness survey about California's MPA Network in 2022 (Appendix E.1). While this survey was a soft launch and only distributed to a limited number of stakeholders who have likely already heard of MPAs and/or the MPA Network, results will inform a revised survey planned for distribution to a more representative sample of Californians identified by a professional polling service. Nearly 100 individuals participated in the initial survey, which was posted online and solicited through emails by CDFW and partner organizations. More than half of the respondents expressed being very or extremely familiar with California's MPA Network but overwhelmingly agreed that the general public is not aware of the state's MPAs. While most



Clockwise from top: Amanda Van Diggelen giving an MPA presentation at the Cabrillo Aquarium-Steve Wertz CDFW. Conducting at the Cal Academy Ocean Prom MPA-Lindsay Bonito OPC. Imaginology MPA Video screening-Amanda Van Diggelen CDFW. Amanda Van Diggelen giving an MPA presentation for the Oceanside Senior Anglers - Wayne Kotow.

respondents expressed that any type of outreach would be helpful for learning about MPAs, CDFW's website, physical outreach materials (brochures, posters, regulation booklets), and visitor centers were believed to be the most useful (Figure 4.12). The results of this preliminary survey and future evaluations can be used to better align outreach and education efforts with perceived needs.

Management Program partners who specialize in MPA outreach and education advise more engagement with the fishing community, tribes, and traditionally underrepresented groups. While printed outreach materials, signage, and in-person interpretive programs are in high demand, digital tools and expanding partnerships can extend the reach of MPA messaging to larger and more diverse audiences. Furthermore, better linking outreach and education with enforcement and compliance information will help target efforts where they are most needed (Section 4, Rocky Intertidal Visitation During COVID).Conducting outreach to a state as large and diverse as California is an immense undertaking and will continue to require significant funding and the involvement of and coordination between multiple organizations. Ultimately, delivering accurate and consistent information about MPAs to all Californians will help ensure that MPAs are valued and safeguarded for future generations.

Top: Cooper's Aeolid in Blue Cavern Onshore SMCA-Leslie Harris CC. Interpretive sign overlooking Estero Americano SMRMA-Calla Allison MPA Collaborative Network.

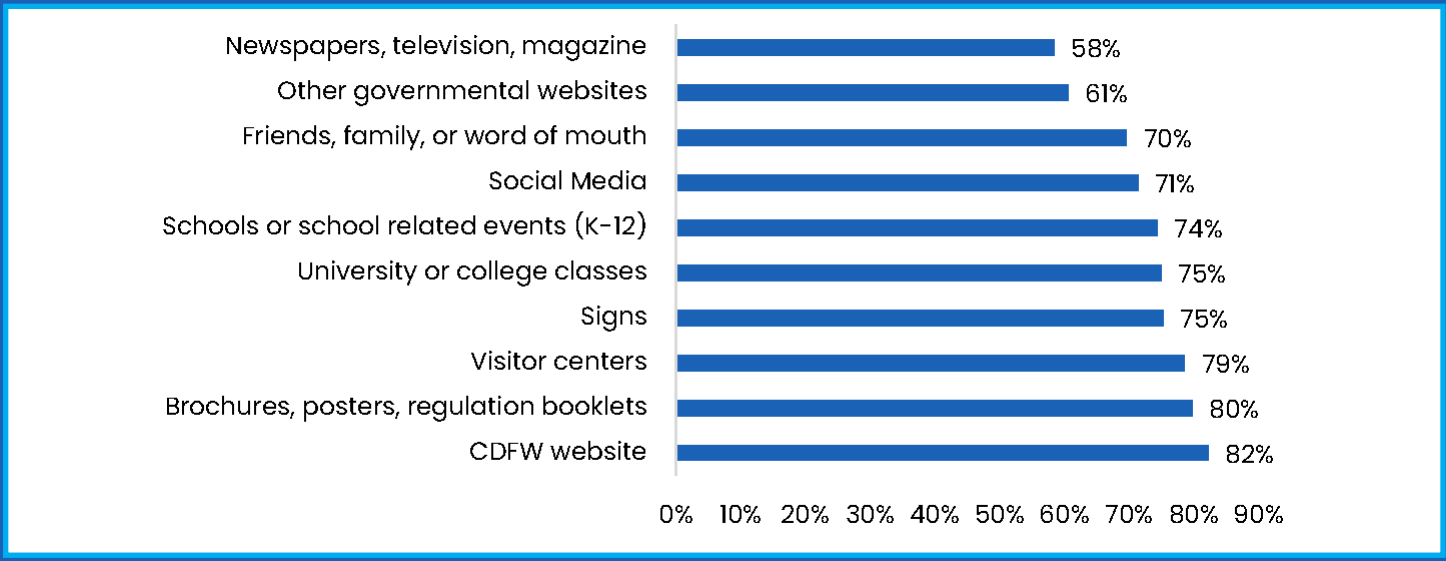


Figure 4.12. Percentage of survey respondents who believe the listed resource would be useful for learning about MPAs. Figure combines both "very useful" and "moderately useful" survey responses (adapted from Appendix E.1).

Clockwise from top left: Sara Worden conducting MPA outreach at the Fitzgerald Marine Reserve-Chenchen Shen CDFW. CDFW, OPC, State Parks, and MPA Collaborative Network staff conducting MPA outreach at the California Academy of Sciences-CDFW. Chenchen Shen presenting MPA information-Nicole Palma MPA Collaborative Network. OPC Mike Esgro on CCFRP trip-Stacy Hayden.

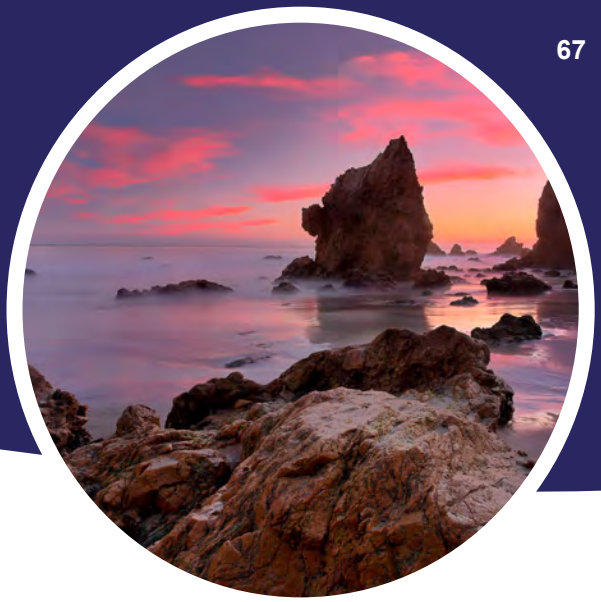
MPA DECADAL MANAGEMENT REPORT

POLICY AND PERMITTING

KEY HIGHLIGHTS

- Clarification and refinement of MPA policy and regulations, such as allowing tribal take and ensuring human health and safety, is an integral part of adaptive management.
- OPC receives mitigation payments from power plants to offset negative environmental impacts from once-through cooling, which it uses to fund MPA Management Program activities.
- CDFW's Scientific Collecting Permit Program regulates take in MPAs for research and education purposes to manage these uses in a manner consistent with protecting biodiversity.
- Key challenges for MPA policy and permitting include addressing stakeholder concerns about barriers to restoration in MPAs and setbacks to research caused by the Scientific Collecting Permit Program.

Giant kelp-CDFW. Bat star in Asilomar SMR-Chenchen Shen CDFW.



MPA POLICY AND PERMITTING OVERVIEW

MPA policy and permitting defines activities that are allowed or prohibited within MPAs, ensuring that California's MPAs have clearly defined objectives (Goal 5) that are consistent across the Network (Goal 6). While MPAs were established to reduce human impacts on ecosystems, limited take or disturbance to species and natural habitats may sometimes be warranted. These activities may be permitted either out of necessity or to advance broader science, education, conservation, and cultural objectives. Additionally, restoration and mitigation can potentially offset some damages caused by take, though scientific guidance for this in MPAs is lacking.

Similar to CDFW licenses used to regulate commercial and recreational take, CDFW issues scientific collecting permits (SCPs) for bona fide projects or activities that will result in the take of wildlife for education, research, or propagation purposes. After MPA Network implementation, the SCP Program was adapted to address take from within MPAs. This has helped CDFW encourage education and research within the MPA Network in a manner consistent with protecting biodiversity (Goal 3).

POLICY REFINEMENTS

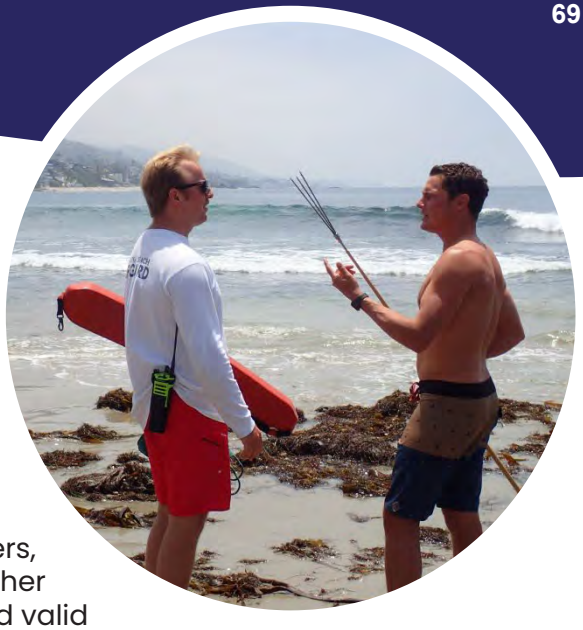
Over the years, MPA regulations have been improved and clarified through a number of policy refinements. Policy revisions addressing tribal take and human health and safety are highlighted in this section, but additional regulatory and legislative changes enacted as part of the adaptive management process are detailed in Section 3 and Appendix G.

Top: Sunset over El Matador State Beach, Point Dume SMCA-Pacheco CC. Elyse Goin, 2022 Sea Grant Fellow with OPC, presenting at OPC Meeting-Stacy Hayden OPC.

TRIBAL TAKE IN MPAS

Despite many of California's MPAs being in ancestral territories of California Native American Tribes, tribal engagement was limited in the early MPA design and implementation process. However, tribal involvement gradually increased through the MLPA planning process, resulting in tribal exemptions from some MPA take restrictions for 25 federally recognized California Native American Tribes. After the Network was completed, CFGC adopted regulations to add Cher-Ae Heights Indian Community of the Trinidad Rancheria and Resighini Rancheria to the list of tribes exempt from take regulations for Reading Rock SMCA. MPA regulations were also amended to honor a tribal name change from Smith River Rancheria to Tolowa Dee-Ni' Nation. Furthermore, the boundaries of Stewarts Point SMR and SMCA were modified to align the Stewarts Point SMCA with historical tribal lands acquired by the Kashia Band of Pomo Indians, thereby allowing tribal members direct access to culturally significant areas of the shoreline and marine resources for ceremonial, cultural, and subsistence purposes. Most recently, CFGC amended regulations to exempt the Santa Ynez Band of Chumash Indians from MPA take regulations from Kashtayit, Naples, Point Dume, and Anacapa Island SMCAs in southern California.

Top: Chumash Tomol crossing to Santa Rosa Island-R. Scwemmer NOAA. Traditional seaweed harvester Ruthie Maloney-Yurok. Little rockweed in Point Dume SMR-Claudia Makeyev CDFW.



HUMAN HEALTH AND SAFETY

While MPA regulations are critical for protecting California's marine resources, human health and safety are prioritized when in conflict with MPA regulations. Several regulatory amendments have been adopted to clarify policies when MPA regulations may compromise safety. For example, shortly after MPAs on the central coast were implemented, the city of Morro Bay noted the loss of their ability to perform harbor maintenance, including dredging. Since these activities are necessary for the safe transit of vessels and their passengers, CFGC adopted regulations in 2008 to allow for dredging and other harbor maintenance within Morro Bay SMRMA with required and valid permits and approvals. Following implementation of south coast MPAs, expansion of the pre-existing Catalina Marine Science Center Marine Life Refuge boundary resulted in the prohibition of anchoring or mooring within the entire Blue Cavern Onshore SMCA. This caused a public safety concern, especially for the diving community. In 2012, regulations were amended to allow for anchoring and mooring within Blue Cavern Onshore SMCA except within the former boundary of the Catalina Marine Science Center Marine Life Refuge. In 2014, regulations were amended to clarify that spearfishermen with or without catch are allowed to transit through MPAs while remaining at the surface with their speargun in an unloaded condition, since some safe access points for spearfishermen are located in MPAs.

Top: Lifeguard and spear fisherman discussing spear equipment-City of Laguna Beach. China rockfish and cup corals at Inner Pinnacles, Carmel Pinnacles SMR-Steve Lonhart NOAA MBNMS.

POWER PLANT ONCE-THROUGH COOLING INTERIM MITIGATION PROGRAM

In 2010, the Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling established the Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling. This policy requires power plants to stop using once-through cooling (OTC) technology or use the best technology available to protect aquatic life by greatly reducing impingement and entrainment from OTC water intakes. Until power plant owners and operators come into compliance with this policy, they are required to make mitigation payments to the state to support projects that will offset negative ecological effects and increase marine life associated with MPAs in the geographic area of the facilities.

OPC has received approximately $27 million in OTC mitigation payments (Appendix D.5). To guide OPC's investments of OTC funds, the OPC Science Advisory Team developed the "Ocean Restoration Methods: Scientific Guidance for Once-Through Cooling Mitigation Policy" in 2018. This report provides essential guidance on the scientific principles needed to identify restoration projects that meaningfully offset the impacts of once-through cooling. OPC's OTC Interim Mitigation Program directs mitigation payment investments through four critical components:

- Enforcement of MPA regulations statewide
- Outreach and education to improve compliance of MPA regulations statewide
- Research to establish and quantify the expected ecological benefits of the MPA Network and understand what additional mitigation may be required to offset OTC impacts
- Restoration that increases marine life in the geographic region of the facility

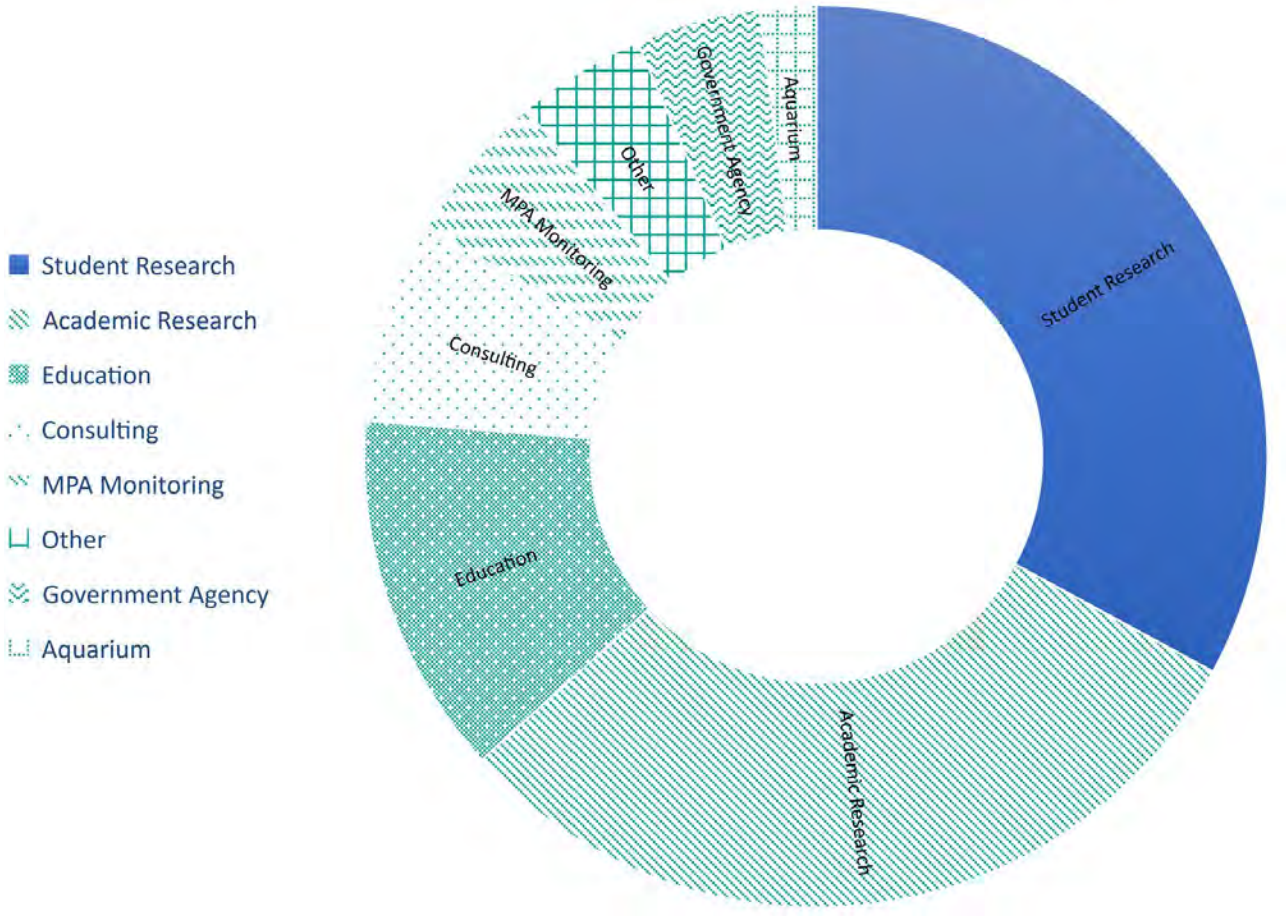
Top: Norris's top snail on giant kelp in Blue Cavern Onshore SMCA-Steve Lonhart NOAA MBNMS. Below: View of Morro Rock, Morro Bay SMRMA-Fred Moore CC.

SCIENTIFIC COLLECTING PERMIT PROGRAM

Scientific research permitted in MPAs is diverse and innovative. CDFW's SCP Program issues permits for an array of projects within and outside of California's MPAs. Broadly, projects focus on MPA monitoring as well as cutting-edge research and education efforts across many sectors. The majority of SCPs for work inside MPAs are issued to academic and student researchers (Figure 4.13). State-supported MPA monitoring projects make up only a small fraction of the total number of SCPs issued, but these projects must also undergo the SCP application review process. Research permitted inside MPAs includes surveys of marine habitats and the species that depend upon them, alternative energy sources, climate change effects, and species occurrence and biodiversity detected by eDNA.

About 98% of all marine SCP applications both inside and outside MPAs are approved, although applications may be modified to reduce impacts to marine resources while still allowing research activities to occur. From 2012 to November 1, 2022, a total of 2,345 SCPs were issued for marine and estuarine waters statewide; 907 were for activities within MPAs (Figure 4.14). In 2013, permit terms were extended from two to three years, which may explain the apparent decline in the number of SCPs issued through time. Almost half of all permits issued for projects inside MPAs take place in southern California (Figure 4.15), which may be due to a larger population and the concentration of research institutions in the area (Figure 5.6).

Figure 4.13. The proportion of SCPs issued for projects inside MPAs by sector from 2012 to November 1, 2022. The category labeled as "Other" is used to describe a wide range of unique projects such as training exercises, transportation of fish through state waters, and removal of abandoned fishing gear.



Top: Abalone survey in Sea Lion Cove SMCA-Chenchen Shen CDFW.

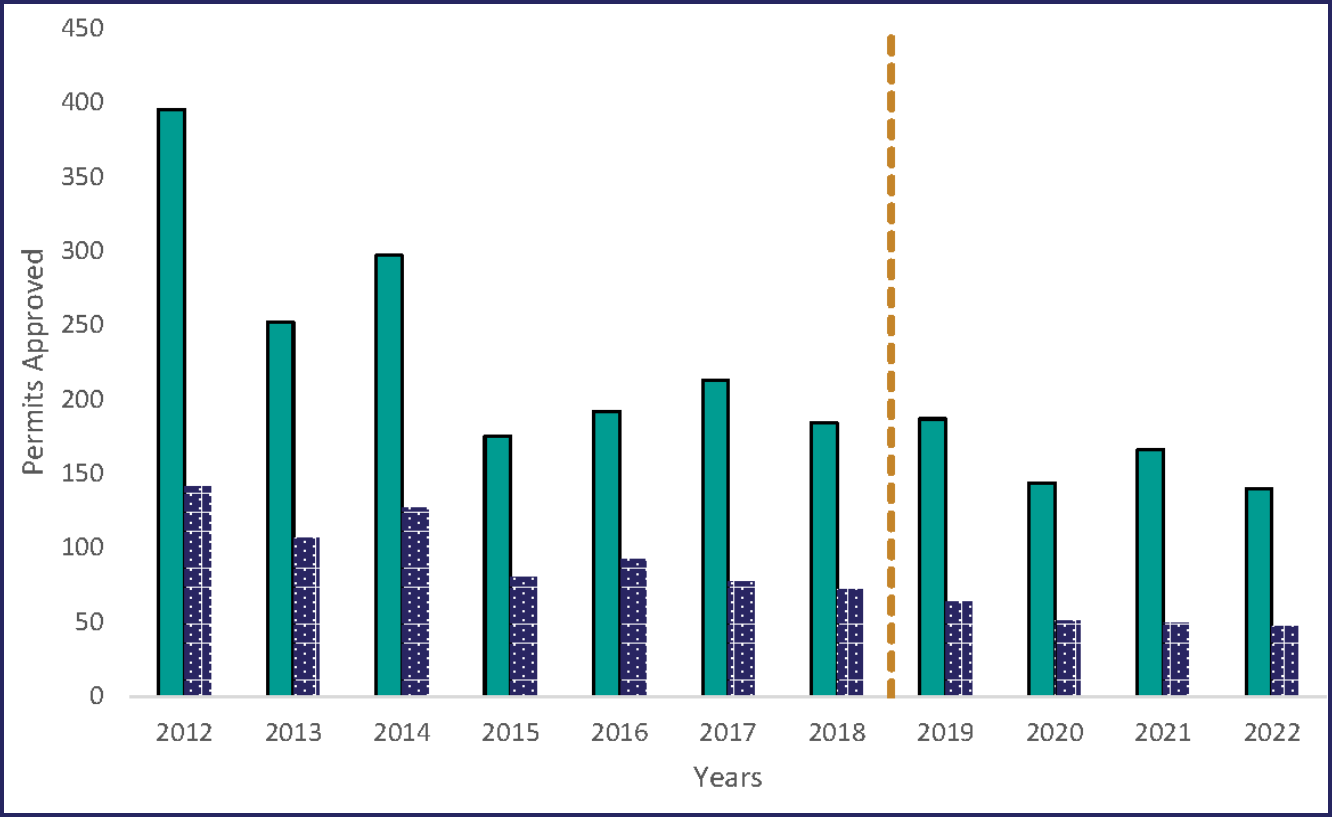


Figure 4.14 The total number of SCPs issued for work inside and outside the MPA Network from 2012 to November 1, 2022. The dashed line represents the creation of the SCP Portal.

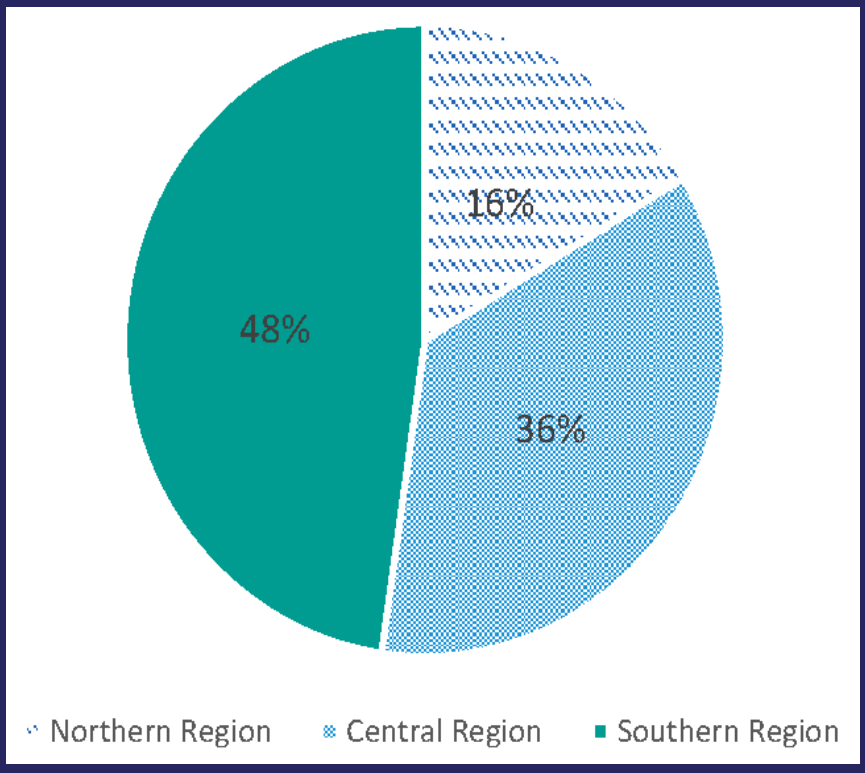


Figure 4.15 The percentage of SCPs issued for projects inside MPAs by bioregion from 2012 to November 1, 2022.

CDFW works collaboratively with other state and federal permitting agencies when reviewing SCP applications, including the National Marine Sanctuaries, California Coastal Commission, California State Lands Commission, and many other agencies. SCPs are conditioned with contact information for other permitting agencies and with language stating that the SCP is invalid unless the applicant has the necessary permits or approvals from other agencies. Coordination and cooperation with other permitting agencies are essential for concurrence on permit conditions. The creation of the MSLT has helped improve communication and coordination on more complex proposals. However, continued work to improve interagency coordination is recommended, particularly regarding activities occurring within MPAs and regulation changes.

In 2018, significant improvements were made to the SCP Program. First, the SCP Program was strengthened through amendments to California Code of Regulations Section 650. These changes expanded the types of activities requiring an SCP, enhanced the review process for SCPs, increased requirements for work conducted inside and outside MPAs, and created stricter guidance for permit holders to submit wildlife reports summarizing take resulting from their SCP. The SCP application process was also modernized through the creation of an SCP Portal (Portal), which allowed applications to be submitted online rather than by mail, though the Portal is currently under review for areas needing improvement. Another change to the SCP Program made in 2018 was the introduction of an ecological impact assessment (EIA) tool to objectively inform the review process for SCP applications (Saarman et al. 2018). Previously, CDFW used only a decision tree to evaluate whether work proposed within an MPA was essential to the research or if it could be conducted elsewhere. The EIA tool was added to assess ecological impacts in MPAs for projects involving lethal take in order to keep impacts from cumulative research activities below an acceptable threshold. As a result of these changes, oversight has improved for approving and tracking scientific collection within MPAs.

Top: Common Murre eating an anchovy in Soquel Canyon SMCA-Robin Gwen Agarwal CC. Diver Support Boat CDFW Dive Survey 2012 in Salt Point SMCA-Kevin Joe.

KNOWLEDGE GAPS AND FUTURE DIRECTIONS

CDFW's SCP Program is in urgent need of structural improvements to better serve the needs of researchers, students, educators, and other permit applicants. In particular, the online application Portal suffers from numerous deficiencies that create challenges for applicants and reviewers. While the Portal has facilitated permit processing and tracking and allows for better documentation and storage of wildlife reports, user experience with the system has been poor, and CDFW is investing in evaluating the platform for improvements. Difficulties with internal coordination can also cause SCP processing delays, reflecting a lack of capacity to address permits that require review across multiple programs. In addition, the EIA tool, while useful, suffers from some data gaps. The EIA tool is a series of models that incorporates data from MPA monitoring and SCP wildlife reports, but it requires continual updates to the base data to remain current, which is burdensome to maintain. In data-poor cases, CDFW may reconsider its functionality and application. Overall, the SCP Program requires additional attention and resources to improve program operations and increase accountability to stakeholders.

Some stakeholders are also frustrated with the lack of clear policy guidance regarding restoration in MPAs. Leadership is needed to clarify MPA policy as it relates to restoration and mitigation. While previous restoration efforts within SMRMAs have occurred, such as eelgrass restoration, these projects have not been reviewed under a standardized, science-based framework. The state is in the process of developing a policy to guide restoration and mitigation activities in coastal and ocean habitats, including general guidance for restoration in MPAs. Following the release of this general restoration policy, the state will prioritize development of a science-based framework to provide a consistent, standardized foundation for the evaluation and approval of appropriate restoration activities in MPAs with varying levels of protection.

Additional policy refinement is needed regarding the maintenance of structures such as piers, intake pipes, and seawalls that existed prior to MPA implementation in some locations where MPAs have now been designated. Maintenance of these pre-existing artificial structures often results in incidental take and may violate MPA regulations. Currently, artificial structure maintenance is only permitted in the case of a structural emergency and for health and safety considerations, unless specifically allowed in MPA regulations, e.g. no-take SMCAs. These MPA regulations conflict with historical State Lands Commission leases that permit placement and maintenance of artificial infrastructure. To address this discrepancy, CDFW is coordinating with the MSLT to develop draft regulations authorizing incidental take of marine resources associated with the repair, maintenance, removal, or replacement of pre-existing artificial structures located within the boundaries of an MPA. This proposed regulatory amendment will be presented to CFGC in 2023. The state will continue to pursue corrections and clarifications to MPA regulations to remove errors and ensure consistent policies among governing agencies.

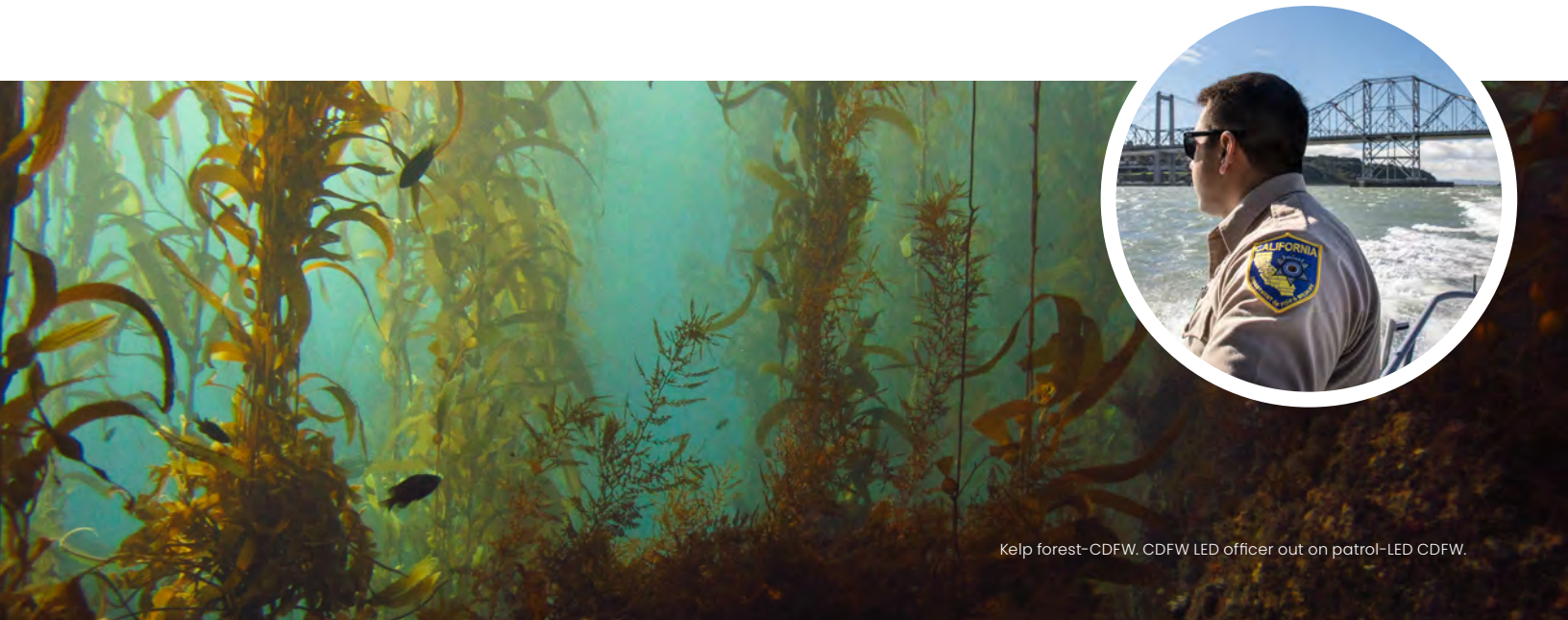
Garibaldi, purple sea urchins, and a warty sea cucumber in the Northern Channel Islands-Derek Stein CDFW.

MPA DECADAL MANAGEMENT REVIEW

ENFORCEMENT AND COMPLIANCE

KEY HIGHLIGHTS

- Approximately 50 wildlife officers and seven large offshore patrol boats are currently focused on enforcing marine laws and regulations, including those pertaining to MPAs.
- CDFW has implemented a digital enforcement records management system to track resource violations.
- Partners are eager to help with MPA enforcement and compliance, and CDFW offers assistance to allied agencies who request help or insight on conducting marine enforcement.
- Most violations occur in southern California; however, SMCA violations occur more frequently in the northern bioregion. Central and southern bioregions have higher proportions of violations occurring in no-take MPAs, and increased violations occur around more populated areas.



Kelp forest-CDFW. CDFW LED officer out on patrol-LED CDFW.

MPA ENFORCEMENT OVERVIEW

Effective management and success of MPAs relies upon compliance and proper enforcement of MPA laws and regulations. The MLPA emphasizes the importance of enforcement as a key goal (Goal 5) of the Management Program and identifies CDFW as the primary agency responsible for MPA enforcement. CDFW wildlife officers have law enforcement jurisdiction throughout the entire state of California, 200 miles out to sea, and have unique authority to inspect vessels and containers where fish or invertebrates may be held or stored. CDFW's Law Enforcement Division (LED) uses a variety of methods to monitor and enforce MPA regulations, including large patrol vessels, small patrol skiffs, and aircraft, vehicle, and foot patrols. In addition, allied agencies such as the National Oceanic and Atmospheric Administration, the National Park Service, State Parks, the United States Coast Guard, county sheriffs, and the California Highway Patrol can write citations for wildlife violations.

MPA CITATION DATA

Beginning in 2013, all 124 MPAs were, and continue to be, patrolled and enforced as a completed Network (Goal 6). While CDFW's citation records show how the number of violations has changed over time, complete citation records currently available begin in January 2016. From January 2016 to December 2021, approximately 16,634 citations were written for 21,059 marine-related violations, of which 2,792 citations were written for 3,468 violations occurring within MPAs (Figure 4.16). These violations occurred within 91 of the 124 MPAs, with most of the violations occurring in southern California at Catalina Island within Blue Caverns Onshore no-take SMCA and Long Point SMR, and South La Jolla SMR in San Diego County (Figure 4.17). SMCA violations occur more frequently in the northern bioregion, while central and southern bioregions have higher proportions of violations occurring in no-take MPAs (Figure 4.17). MPAs near large population centers tend to get more traffic than MPAs in less populated areas which may drive increased violations in the southern bioregion (Figure 4.17).

In preparation for this report, CDFW staff manually entered physical citations into a database for these years. While citations were also manually entered to prepare for the regional State of the Region reports (Table 4.1), citation data entry did not continue following those reporting periods, resulting in a knowledge gap on earlier citation trends. CDFW recommends entering data for citations prior to 2016, as well as citations from 2021 through May 2022. This may provide a more complete historical picture of citation records in the future. Data records for years will be easily accessible thanks to a new records management system protocol that was implemented to help identify marine and MPA-specific citations beginning in June 2022.

CDFW LED patrol boat Thresher-CDFW LED.

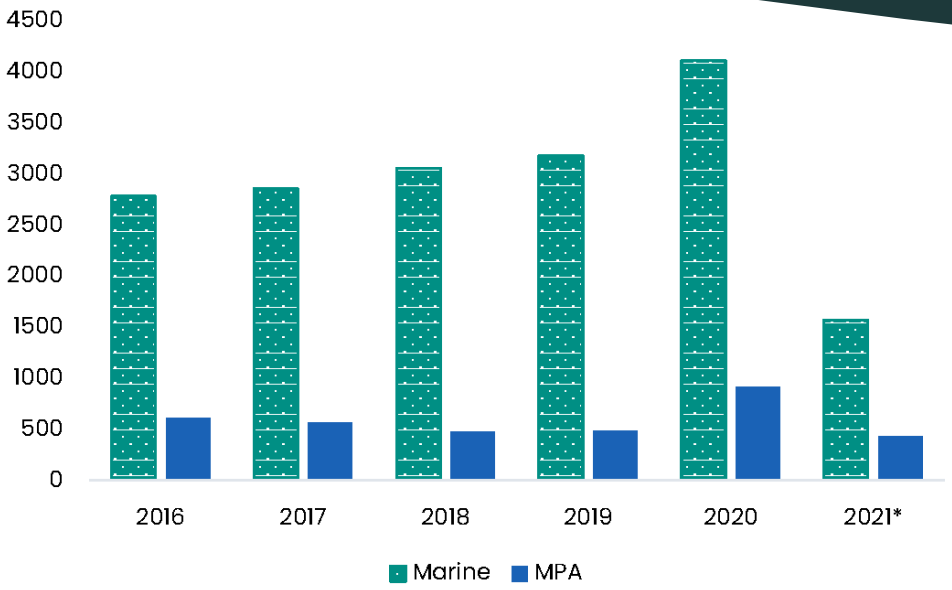
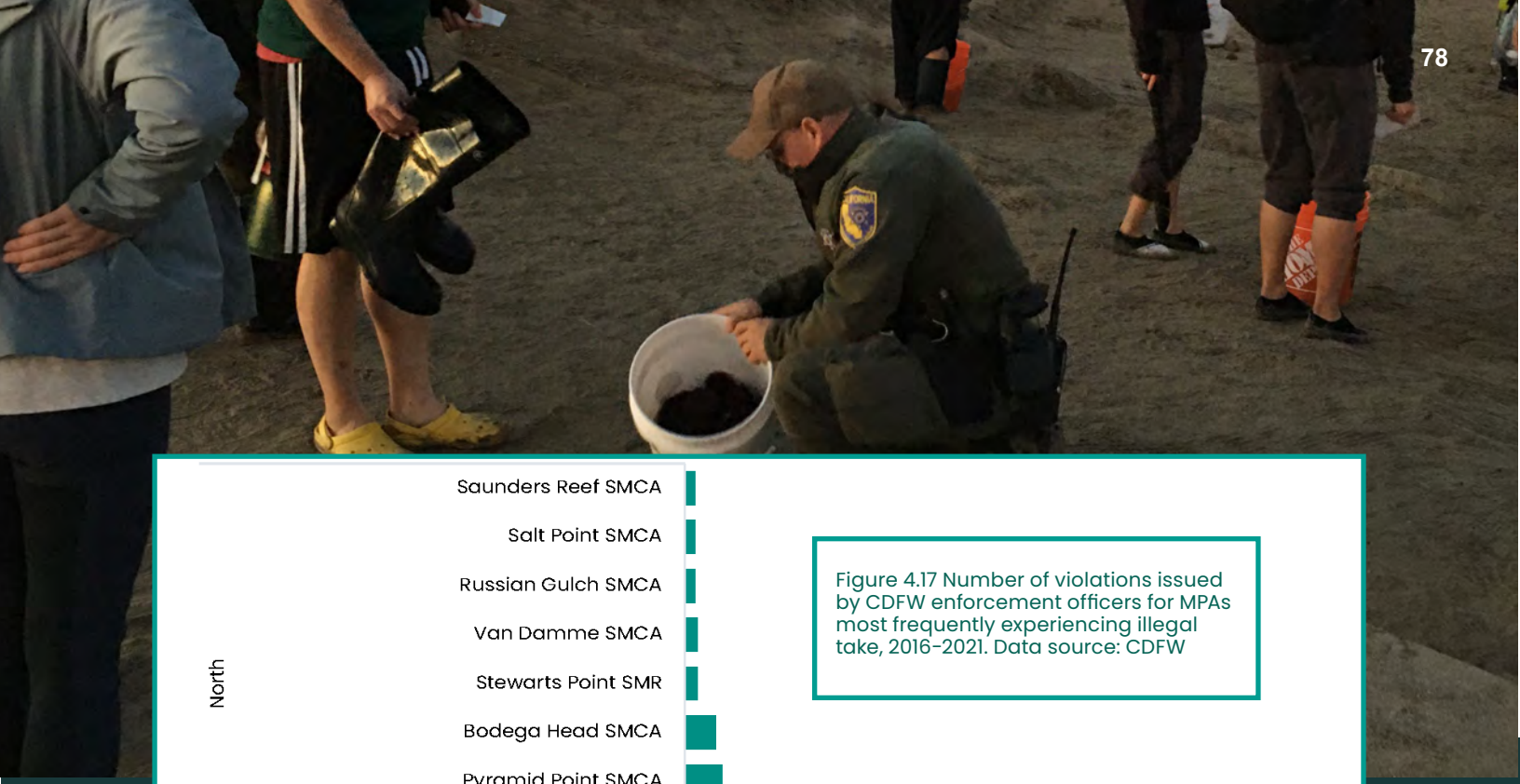


Figure 4.16 Marine and MPA specific violations issued by CDFW LED officers statewide, 2016-2021 (*2021 data is preliminary). Data source: CDFW.

CDFW ENFORCEMENT TRAINING

CDFW's more than 450 sworn wildlife officers, including the 50 within the Marine Enforcement District, attend an extensive 30-week Peace Officers Standards and Training accredited basic academy, and receive specialized training in fish, wildlife, and environmental law enforcement. In addition to Peace Officer and specialized wildlife enforcement training, CDFW's wildlife officers receive training on racial profiling, cultural diversity, and hate crimes, as well as implicit bias and LGBTQ+ education. CDFW has committed to diversity-focused outreach, engagement, and recruitment efforts and have worked to create and incorporate inclusivity-focused adjustments to the hiring and selection processes which aim to expand and enhance diversity in hiring and retention.

Top: Illegally harvested and confiscated gaper clams-CDFW LED.
CDFW adds graduates of the Wildlife Officer Academy to the ranks of its Law Enforcement Division-CDFW LED.



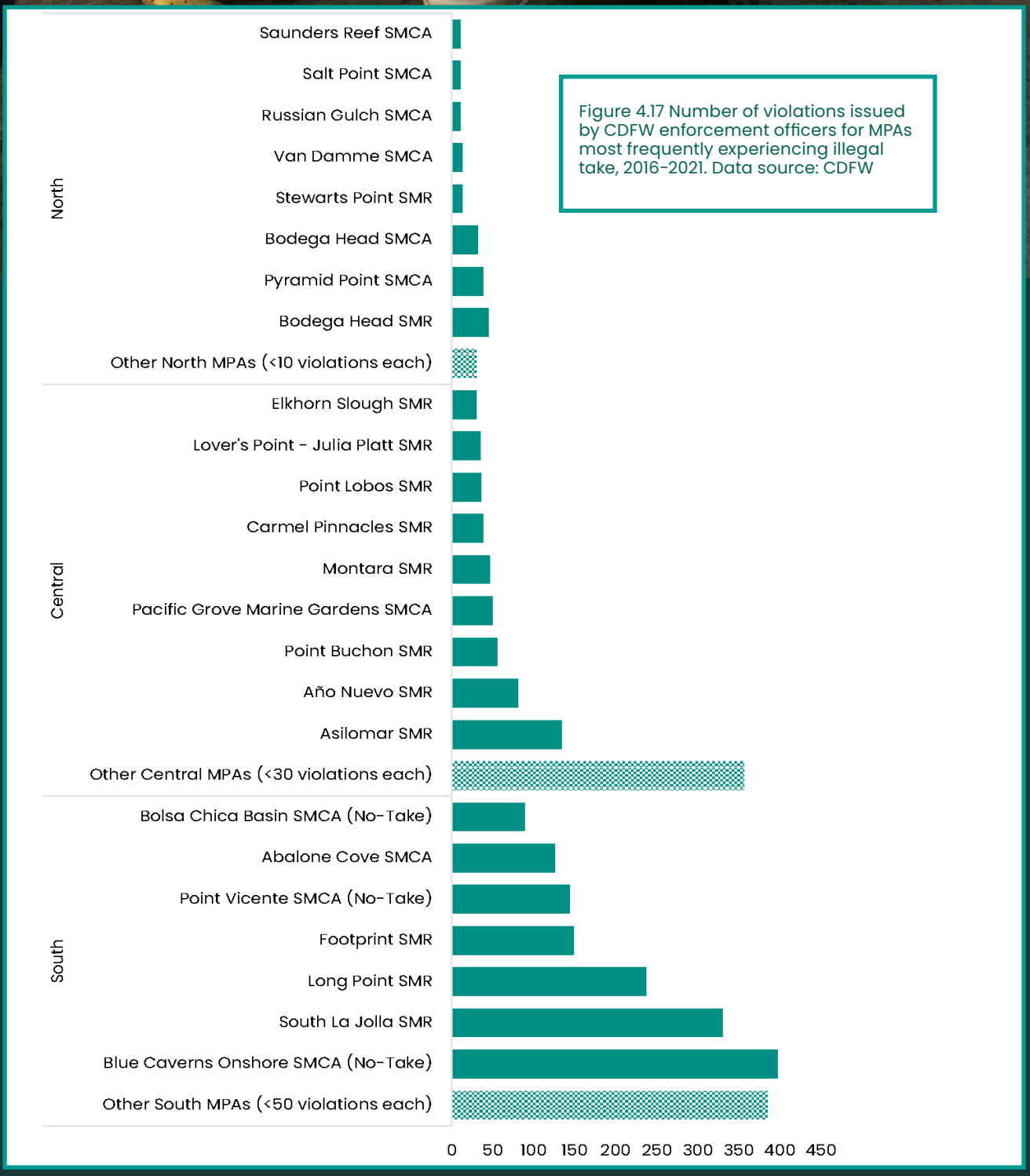


Figure 4.17 Number of violations issued by CDFW enforcement officers for MPAs most frequently experiencing illegal take, 2016-2021. Data source: CDFW

Top: CDFW wildlife officers checking tidepool harvesters for illegal take at Pillar Point in 2020-Chenchen Shen CDFW.

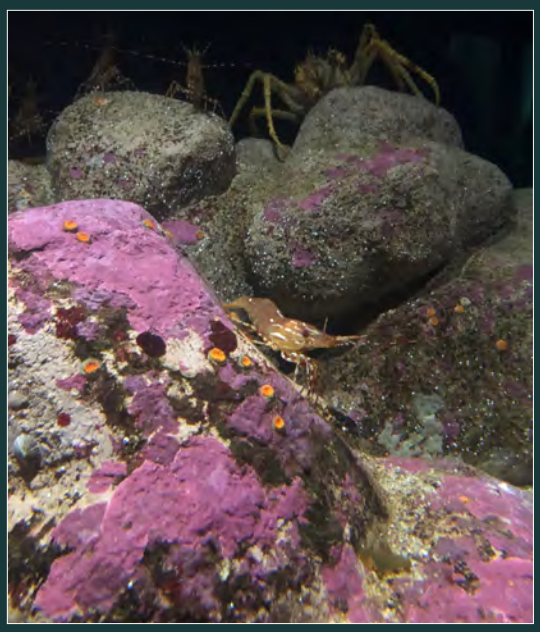
Top: Mussels, gooseneck barnacles, and owl limpets in a Morro Bay tidepool-Claudia Makeyev CDFW. Non-consumptive use of the tidepools in 2019-Chenchen Shen CDFW. Before and after photos of a rocky intertidal ledge following overharvesting and poaching in 2020. A rocky intertidal ledge before and after the start of the COVID-19 pandemic in 2020. In 2019, the rock ledge was full of life. In 2020, this rock was picked clean by overzealous tidepoolers. The pink dot denotes the same reference point on the rock-Cal State University Fullerton and Cal Poly Pomona MARINe Team.

ROCKY INTERTIDAL VISITATION DURING COVID

From San Francisco to San Diego, tidepools along California's coastline drew large consistent crowds during the first months of the COVID pandemic in 2020. While seasoned tidepoolers knew about regulations, closed businesses and social distancing guidelines brought a wave of new people to the beach, who weren't aware of collecting rules. Starting in late June 2020, CDFW began receiving reports of both increased and potentially illegal collecting of intertidal species. With a goal to educate the public, volunteers handed out regulatory flyers and information on MPAs, and informative tidepool signs were displayed at key beach entrances. Once most people learned they had inadvertently violated rules, they were eager to return the catch to the tidepools unharmed. However, for the people who were significantly violating the rules, CDFW was there to enforce regulations. Increased patrols of tidepool habitats led to an increased number of violations recorded in 2020 compared to other years (Figure 4.16). With the help of enforcement, education, and public awareness, tidepool awareness increased and these rocky habitats still remain a unique way to access California's ocean wilderness.

Tidepool regulation signage at Pillar Point-Rob Calla San Mateo County Parks.

NOTABLE ENFORCEMENT CASES



PORTUGUESE LEDGE SMCA

In December 2019, a crew of enforcement officers aboard the patrol boat Steelhead observed multiple commercial-type buoys within the Portuguese Ledge SMCA. Over the course of multiple days, three separate strings of 40 spot prawn traps were pulled from protected waters in depths around 800 feet. Using GPS technology, the marine enforcement officers determined that the fishing vessel Navigator was fishing illegally for spot prawn in the SMCA. Without admitting they were fishing in the SMCA, their counsel worked cooperatively to resolve this matter with the Monterey District Attorney's office without litigation. By pursuing civil prosecution, higher fines are typically issued, and in this case a settlement of $42,747 was reached ($25,000 in civil penalties, in addition to reimbursement of investigation costs) in a civil action filed in Monterey County Superior Court.

SWAMI'S SMCA

In December 2020, the CDFW patrol boat Thresher noticed the CPFV Electra on their radar within Swami's SMCA. As patrol boat Thresher approached the Electra, wildlife officers noticed passengers on the boat reeling in lines and keeping fish. After boarding the vessel for inspection, the officers clearly documented passengers fishing from the CPFV. The Swami's SMCA only allows fishing from shore, so the vessel's captain was cited for fishing in Swami's SMCA. The case was solidified with further documentation of the vessel's presence in the MPA via the shore-based radar M2 vessel tracking system. When prosecuted, this case was the first to use the recently implemented law (Fish and Game Code § 12012.5) which increased penalties for illegal commercial fishing in MPAs (Section 3, Legislative Amendments). The guilty verdict resulted in a fine of $5,000 and an order to stay out of Swami's SMCA for one year.

For more enforcement stories, please visit Appendix E.2.

Spot prawn - Claudia Makeyev CDFW. Officers in the field checking game bags-CDFW LED.

IMPROVEMENTS TO ENFORCEMENT CAPACITY

INTERNAL RESOURCES

An adequate capacity of law enforcement staff along with required patrol equipment (e.g., vessels, surveillance equipment, etc.) is necessary to effectively enforce wildlife laws and regulations. Prior to 2016, CDFW enforcement officers were responsible for both terrestrial and marine-based patrols. Since then, CDFW's Law Enforcement Division established a Marine Enforcement District, which includes 50 wildlife officers focused primarily on enforcing marine laws and regulations, including those pertaining to MPAs. Substantial OPC funding to support enforcement officers, and technology required for an effective presence on and off the water, has also helped increase CDFW enforcement capacity and intensity of patrolling of MPAs.

In 2019, an electronic records management system (RMS) was implemented to satisfy a statewide need to provide an accessible online database for enforcement reports, citations, and other records. In addition to fulfilling specific law enforcement needs, this RMS may be adapted to analyze violation trends and to strategically plan for effective enforcement efforts. Along with RMS, wildlife officers submit electronic daily activity reports (eDARs) which help track daily activities such as type of patrol, area patrolled, duration of patrol and number of contacts, and warnings and cites during said patrols. Implementation of these tools and future technologies can improve documentation and tracking of all marine-related citations including MPA-specific citation data into the future.

The CDFW Marine Enforcement District currently has seven large patrol boats in its fleet (Table 4.2). Five of the large patrol boats are similar in age and all built by the same builder between 1999 and 2003, and another large patrol boat has been in service for more than 30 years. In 2021, CDFW purchased patrol boat Chinook, a new 45-foot patrol boat stationed in the Fort Bragg area, to help expand offshore enforcement. Additionally, a new patrol boat was ordered in 2022 to replace an older vessel (patrol boat Steelhead) and is anticipated to begin service in 2024. To ensure CDFW enforcement staff have safe and reliable marine equipment to manage and protect California's marine resources, and to respond to any public safety event on the ocean or in our bays and harbors, it is recommended that this aging fleet of offshore patrol boats be replaced. New vessels will improve protection efforts of MPAs by allowing wildlife officers more days at sea and will help mitigate the ongoing maintenance costs of older vessels.

Top: CDFW K-9 on patrol–CDFW LED. The LED patrol boat Coho at Catalina Island–CDFW LED.

NAME	STATION	GENERAL PATROL AREA	APPROXIMATE LENGTH	YEAR AQUIRED
Chinook	Fort Bragg	Eureka to Bodega Bay	45 feet	2021
Marlin	Berkeley	Fort Bragg, to San Francisco Bay including Farallon Islands	60 feet	2001
Steelhead	Monterey	San Francisco to Monterey, including Farallon Islands	60 feet	2002
Bluefin	Morro Bay	Monterey to Point Conception, including Northern Channel Islands	65 feet	1992
Swordfish	Ventura	San Luis Obispo County to Los Angeles, including Channel Islands	60 feet	2002
Coho	Long Beach	Point Conception to California/Mexico border, including Channel Islands	60 feet	2002
Thresher	Dana Point	Ventura to California/Mexico border, including Channel Islands	60 feet	1999

Table 4.2 CDFW's seven patrol boats are tasked with patrolling California's 1100 miles of coastline, islands, state waters (0-3 nautical miles) and federal waters (3 to 200 nautical miles). The general patrol areas overlap with each other and boats can cover other areas or move temporarily as needed.

CDFW patrol boat-CDFW LED.

LEGISLATION

Changes to California Fish and Game Code have helped improve enforcement of both recreational and commercial MPA violations. More information about California State Assembly Bills 298 and 2369 can be found in Section 3, Legislative Amendments.

COMPLIANCE PARTNERSHIPS

From 2019 to 2022, the MPA Collaborative Network conducted an MPA Compliance Priorities Workshop and Enforcement Training for Allied Agency Officers throughout each of California's coastal counties (Appendix D.11). Funding for the training was made possible via OTC mitigation funds and private funding provided by RLF.

- The Compliance Workshops were held for each coastal county and brought together members of the public, local representatives, and enforcement agencies to discuss local MPA compliance issues. More than five hundred community members participated, resulting in over 2,200 compliance concerns with the top three concerns being: poaching in MPAs, trash and pollution, and wildlife disturbances. Multiple recommendations for addressing compliance solutions were proposed with the most recommended solution being increased signage (Figure 4.18).

- The Allied Agency Officer meeting included a consistent curriculum reviewed by CDFW enforcement officers and environmental scientists regarding the appropriate methods for citing infraction and misdemeanor level MPA violations for each county as well as the science of MPAs. These meetings also included recommendations from the District Attorney's office for what to include to help make a case more prosecutable and provided attendees with an MPA Officer Trainings and Reference Guide created by the MPA Collaborative Network.

The ultimate goal of these workshops and meetings was to learn ways to improve local enforcement understanding on the importance of enforcing MPA regulations and reporting observed violations. Additionally, a new MPA Prosecutors Task Force was launched in September 2021 to facilitate sharing of information and improving coordination related to prosecution of MPA cases statewide. In 2022 an overview video of California's Network of MPAs and enforcement efforts for judges, district attorneys, and enforcement officers was created by RLF and the MPA Collaborative Network in partnership with CDFW, through OTC funding provided by OPC.

ALLIED AGENCY OFFICER TRAINING

- **447+ enforcement partners attended**
- **80+ distinct agencies/departments trained**
- **50+ prosecutors and court officers in the MPA Task Force**
- **430 Officer Reference Guides distributed**

Top: CDFW patrol boat-CDFW LED . Outcomes and highlights from the MPA Compliance Priorities Workshop and Enforcement Meetings for Allied Agency Officers-MPA Collaborative Network.

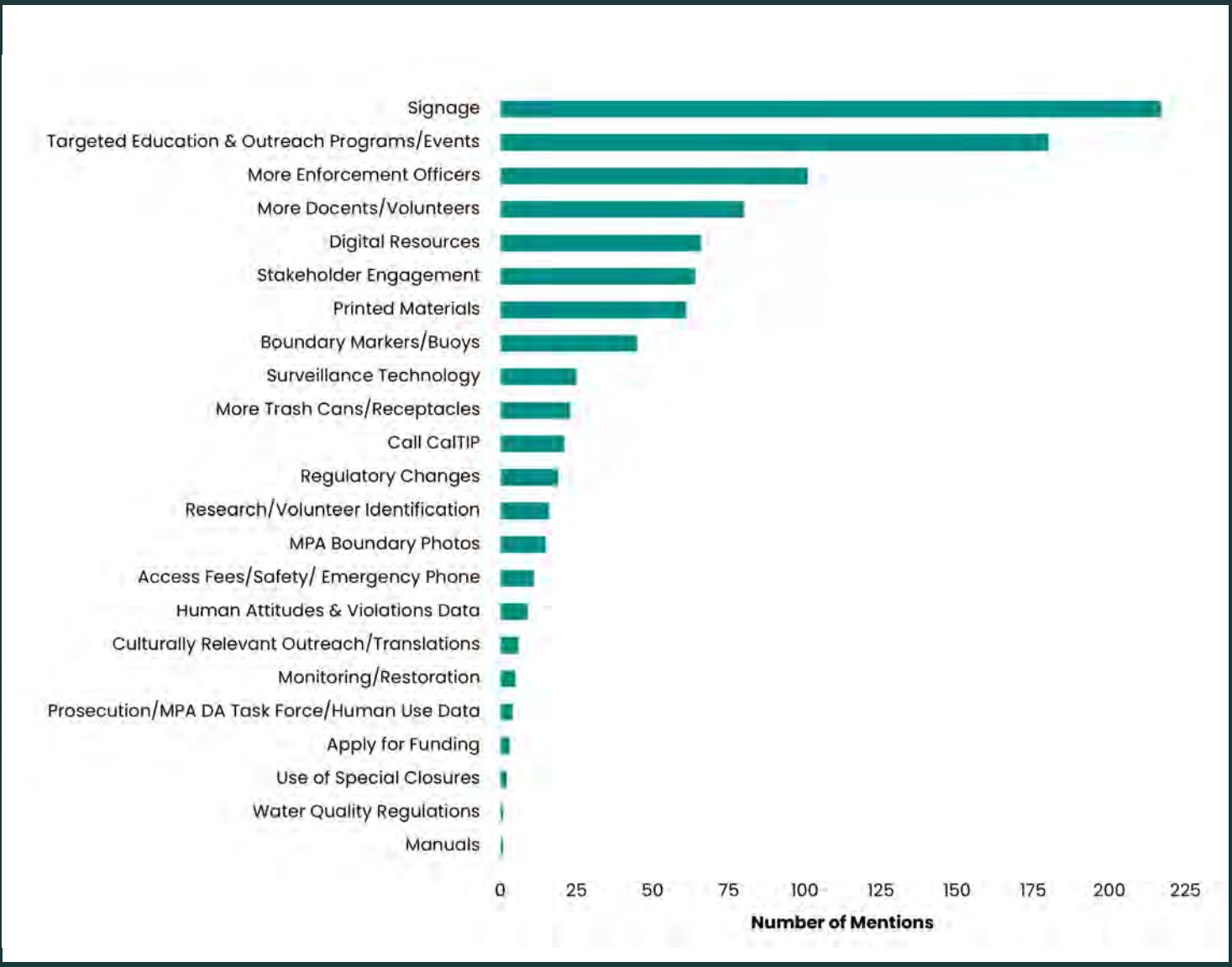


Figure 4.18 Number of times each MPA compliance solution was mentioned during a forum discussion, post-forum evaluation form, and survey (from Appendix D.11).

Green anemone in a tidepool-CDFW.

ENFORCEMENT TECHNOLOGIES

CDFW partners, including the NOAA's Channel Islands (CINMS) and Monterey Bay National Marine Sanctuaries, CMSF, RLF, and ProtectedSeas, support two new enforcement technologies known as the electronic Fisheries Information Network (eFINS) and Marine Monitor (M2).

Although these tools have some benefits, currently CDFW recommends use of these resources on an as-needed basis rather than a requirement. While eFINS can provide data in real time, it does not provide CDFW with a way to track sensitive information, and required use of eFINS places excess administrative duties on wildlife officers to record information they already enter into RMS and eDARs. The use of eFINS by CDFW officers is presently being researched and evaluated and more time is needed to determine if the system can be implemented on a larger scale. Additionally, M2 is an expensive tool to maintain, and while it has assisted in helping to make cases against MPA offenders, the judicial process still requires enforcement officers in the field to conduct investigations and collect on-scene evidence to satisfy the statutory elements required for a successful prosecution in a court setting.

M2

This shore-based radar, camera, and Automatic Identification System can detect and record offshore vessel activity day and night with an average coverage of 42 square miles depending upon ocean surface conditions and fog (Figure 4.19). Since 2015, M2 has been used to observe and analyze vessel data in nearshore areas along California's coast including: Piedras Blancas SMR/SMCA, Point Conception SMR, Naples SMCA, Campus Point SMCA, Carrington Point SMR, Skunk Point SMR, Swami's SMCA, San Diego-Scripps Coastal SMCA, Matlahuayl SMR, and South La Jolla SMR/SMCA. The technology may supplement enforcement officers' ability to differentiate between vessels that are potentially fishing and those that are transiting.

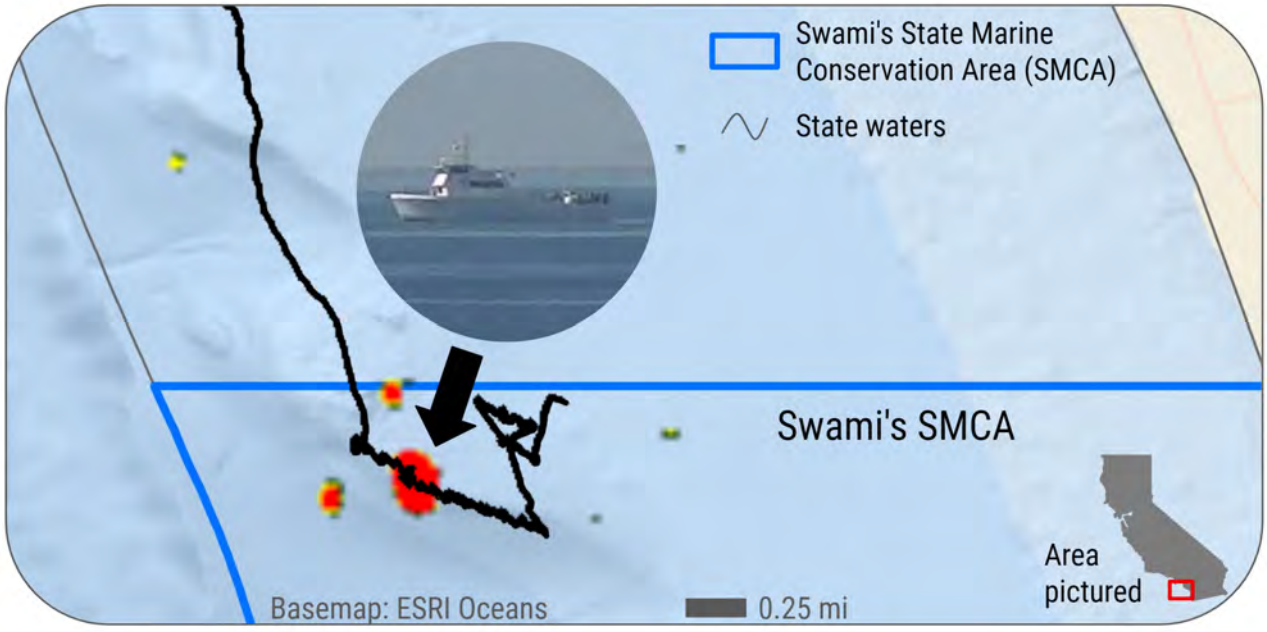


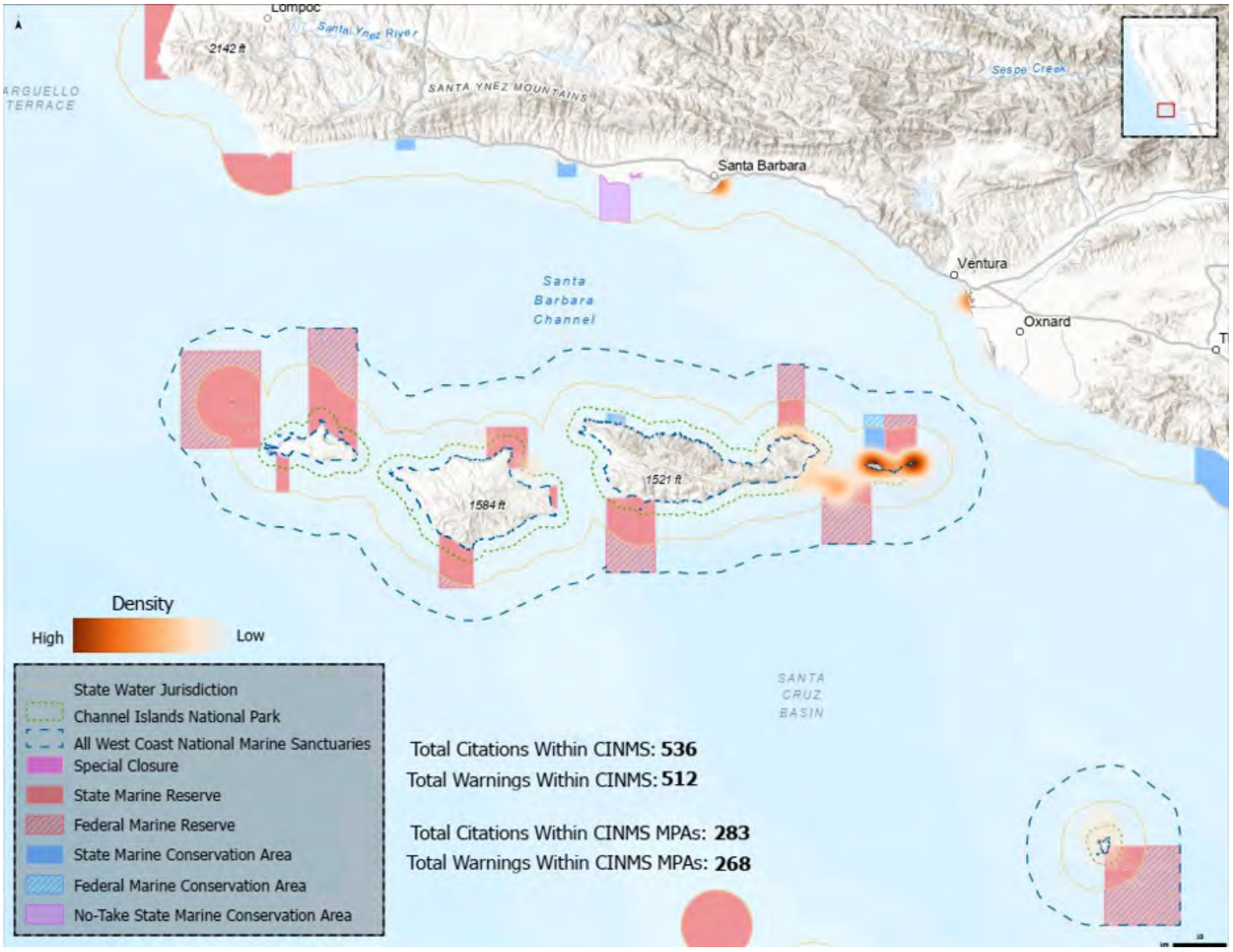
Figure 4.19 Track line of the CPFV Electra. Photos confirm the vessel's presence, and M2 radar imagery shows the vessel within the boundaries of Swami's SMCA (from Appendix D.16).

Top: CDFW LED vessels moored at Catalina Island-CDFW LED.

EFINS

This mobile data collection and sharing application allows enforcement agencies to electronically record, store, and reference citation and warning data collected during enforcement patrols. In 2017, data collection began in a limited capacity at the Northern Channel Islands and expanded in 2019 to be used on a voluntary and trial basis by CDFW marine wildlife officers. Since then, some CDFW marine wildlife officers and Channel Islands National Park marine rangers have been partnering and collecting field data as they perform compliance checks with commercial and recreational fishermen (Figure 4.20). These data and subsequent analyses from the eFINS system are shared between agencies to improve marine domain awareness on a trial basis.

Figure 4.20 Violation density of eFINS records entered by CDFW officers and Channel Islands National Park rangers in CINMS from 2017-2021. Map credit: California Marine Sanctuary Foundation/Anastasia Kunz.

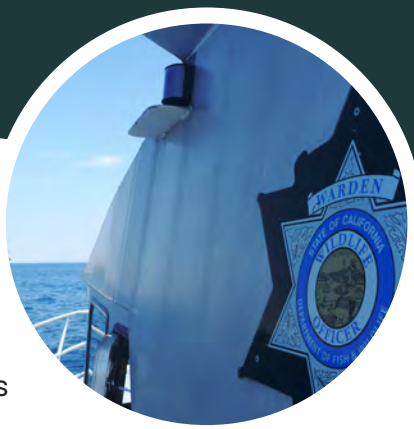


Top: Anacapa Island-John Ugoretz CDFW.

DISPOSITION STUDY: DEL NORTE COUNTY

A vital aspect of MPA enforcement is successful prosecution of violators of MPA regulations. To begin looking at citation disposition outcomes, CDFW conducted a case study looking into citation dispositions within Del Norte County. Public records accessed from the Del Norte County Superior Court online website were searched to obtain violation data from CDFW marine citations. Citations from January 2013 to December 2020 were recorded, and trends in the number of violations, types of violations, and dispositions were documented. MPA violations accounted for 15% of all reported violations in marine waters in Del Norte County. Of the 15% of MPA violations, 75% resulted in a conviction. This indicates that while MPA violations occur with less frequency than other marine fishing related violations, some courts are prepared to process them (Appendix E.3).

Laguna Beach Marine Enforcement quantifying illegal catch of sheephead-CDFW LED.



KNOWLEDGE GAPS AND FUTURE DIRECTIONS

Effective management and success of MPAs relies heavily on proper enforcement of, and public compliance with, MPA laws and regulations. While resources like CalTIP remain invaluable for the public to report potential poaching or pollution incidents, without boots on the ground, wildlife and MPA violations may go undetected. CDFW recommends increasing capacity through building/updating/replacing the fleet of enforcement vessels, and the continued collaboration with allied agency enforcement officers who have the appropriate authority to issue MPA citations when their jurisdiction and policy authorizes them to do so. For agencies who may not be able to cite violations, communication channels should be set up to ensure that personnel can report possible violations.

Additionally, continued coordination with the MPA Prosecutor Task Force will help further the cause and promote the importance of prosecuting wildlife crimes (Appendix D.11). In court, some wildlife crimes may be dismissed or reduced to a lesser charge or penalty when compared to other criminal cases. However, as prosecutors continue to work with enforcement officers and learn about the importance of prosecuting wildlife crimes, cases of poaching in MPAs will be prosecuted with the appropriate penalty, or potentially with a civil suit similar to the process used in the Portuguese Ledge SMCA poaching case.

Since implementation of the RMS and more recent improvements to the RMS database, researching marine and MPA-specific violation data can happen more quickly than in the past. However, a search for hard copies of citation data prior to 2016 still needs to be completed and data entered into the historical database for a complete picture of how enforcement efforts and compliance with MPA regulations have changed since completion of the Network.

Top: The wildlife officers star displayed on patrol boats.-CDFW LED. CDFW Enforcement partners logos.

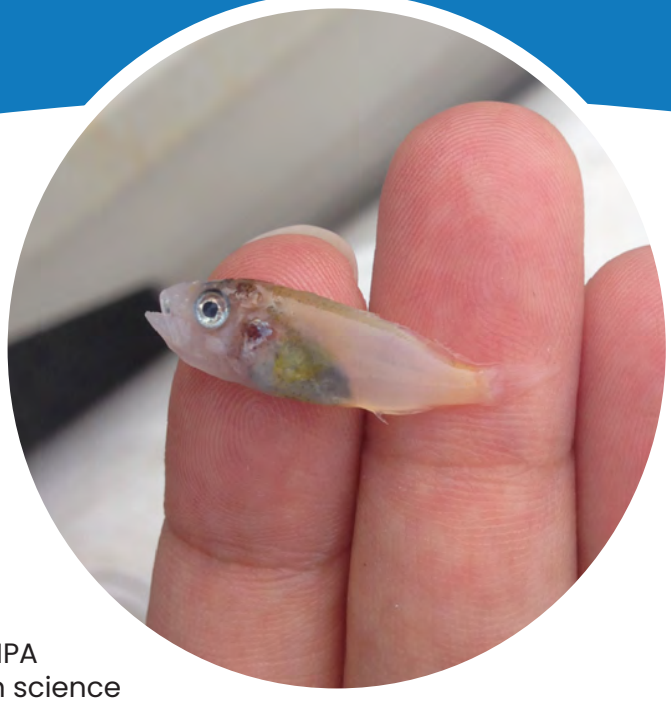
MPA DECADAL MANAGEMENT REVIEW

5. MPA NETWORK PERFORMANCE

CONNECTING HABITATS AND DOMAINS

California's MPA Network currently presents one of the only opportunities in the world to examine the ecological and social effects of a connected network of MPAs. While the highlights from each Management Program pillar provide important insights for examining individual MPA performance objectives and evaluation questions, a more holistic approach to achieve broader integration across habitats and the domains identified in the social-ecological framework (Figure 2.2) is critical. This Review presents a first attempt at integrative analyses across available datasets to provide the most comprehensive understanding of MPA Network performance to date.

Kelp forest-CDFW.



The state leveraged several sources to address the DEWG recommendation to evaluate MPA performance metrics and connections across habitats and domains. Some trends from the long-term monitoring projects showed similar species- and community-level responses to protection across habitats. After the long-term monitoring results and data became available, the state convened an NCEAS working group to conduct an integrated evaluation of MPA performance across key habitats against the goals of the MLPA. The NCEAS working group streamlined many of the priority DEWG evaluation questions into several core objectives to address broader MPA performance and climate resilience. Lastly, advancement in science since the planning phase has allowed for more high-resolution modeling of larval connectivity across the Network through the California Connectivity Population Model (Appendix B.8). While work on refining and improving the connectivity model is ongoing, current model outputs have already provided critical information about population connectivity on an individual MPA, bioregion, and Network-wide scale. These results combined reveal a broader understanding about MPA Network performance against the goals of the MLPA in both ecological and human domains.

ECOLOGICAL DOMAIN

MPA NETWORK DESIGN ATTRIBUTES

The MPA Network was designed to be ecologically connected and ensure effective protection of California's unique coastal ecosystems. During the design and planning phase, a science advisory team identified the key metrics needed to achieve this connectivity, including MPA size, spacing, and key habitat representation and replication (Saarman et al. 2013, CDFW 2008, 2016). Results from the long-term monitoring reports and the NCEAS working group shed light on how some of these metrics, such as MPA size and habitat representation, affect ecosystem and species responses to protection. Connectivity modeling incorporates oceanographic circulation patterns with high-resolution habitat area mapping to examine the movement of larvae between MPAs and the rest of the coast (Appendix B.8). Initial model results show that the design of the Network appears to be promoting ecosystem connectivity.

» **MPAs are more connected than areas outside of MPAs to each other and other parts of the coast (Appendix B.8).**

- Model outputs show that rocky intertidal, kelp forest, and mid-depth rocky reef habitats inside MPAs provide more larvae to each other, as well as areas outside MPAs, compared to non-MPA sites.
- The levels and patterns of connectivity across the Network vary by habitat type. Sites outside of MPAs appear to be important larval sources for rocky intertidal and mid-depth rocky reef habitats, but not for kelp forests.

Larval yelloweye rockfish-Neosha Kashef NOAA Fisheries SWFSC.

» **MPA placement and spacing may enhance ecological connectivity across the Network.**

- Ocean circulation patterns appear to be a main driver of higher connectivity between MPAs. This result suggests that the locations of MPAs within coastal circulation regimes promote higher population connectivity across the Network than expected based on habitat area alone (Appendix B.8).

» **MPA size affects species and habitat composition in various ways.**

- Overall, the response of fish biomass within regions was not linked to MPA size (Caselle and Nickols et al. 2022). While some individual species did respond positively in larger MPAs when compared to smaller MPAs, there are likely other factors influencing this result besides MPA size (Appendix B.4, B.5, Caselle and Nickols et al. 2022).
- MPA size does not appear to affect the variety of habitats protected within MPA borders. However, within each region, larger MPAs tended to contain greater amounts of deeper, soft bottom habitats (Caselle and Nickols et al. 2022).

» **Coastal habitat composition protected inside MPAs varies greatly between regions (Caselle and Nickols et al. 2022).**

- North coast MPAs protect comparable areas of soft and rocky habitats.
- Central coast MPAs boast more rocky reef and kelp forest habitat than sandy beaches and other soft bottom habitats.
- South coast MPAs, including around the Northern Channel Islands, protect more soft bottom habitat across depths. South coast mainland MPAs contain a lower proportion of rocky intertidal habitat than MPAs in other regions.

Top: plankton-CDFW. Yelloweye rockfish, warty sea cucumber, and red gorgonian-MARE.

SPECIES- AND COMMUNITY-LEVEL RESPONSES

Protection within MPAs is expected to provide both species- and community-level benefits, such as larger, more abundant marine species, and higher biodiversity. Other metrics, such as MPA age, can further affect ecological responses. Both the long-term monitoring results and NCEAS integrative analyses show how species and ecological communities are broadly responding to MPAs in California since Network completion.

» **Detecting the ecological benefits of MPAs for some species and habitats will take more time.**

- The oldest and most studied MPAs in the Network show the strongest MPA effects for most ecosystems and species (Appendix B.1-B.5, Caselle and Nickols et al. 2022).
- In some cases, MPA effects are detectable on both an ecosystem and species level. The ability to detect these effects is expected to increase over time (Appendix B.1-B.5).
- MPA age was strongly linked to an increase in the biomass of fished species. Older MPAs tended to contain larger fish (Appendix B.1, B.3, B.4, Caselle and Nickols et al. 2022).

» **Ecological performance of MPAs varies across and within bioregions, habitats, depths, species, and survey method (Figure 5.1).**

- Species- and community-level responses were strongest in the central and south coast regions in most habitats (Appendix B.1-B.5).
- Some species, such as lingcod and vermilion rockfish, experienced similar responses in abundance and biomass across survey methods and bioregions. Other species, such as blue rockfish and abalone, varied in their responses (Figure 5.1).

Top: Harbor seal on BRUV footage-Shoshana Lescht-Smith CDFW. Lingcod and vermillion rockfish-MARE.

» **The overall biomass of fished species is higher inside MPAs than areas outside across most of the state (Figure 5.2).**

- This response was most significant in the south coast bioregion, which is likely driving the combined statewide trends (Caselle and Nickols et al. 2022).
- Regionally, the magnitude of the response in some habitats was linked to MPA distance from port (Appendix B.3), although the combined habitat response did not correlate with this metric (Caselle and Nickols et al. 2022).
- Connectivity modeling shows that an increase in fish biomass inside MPAs may increase connectivity and enhance larval transport from MPAs to other areas of the coast (Appendix B.8).

» **Biodiversity responses of ecological communities varied across habitats and bioregions.**

- Although biodiversity of select marine species was higher inside MPAs in some habitats and bioregions (Appendix B.2-B.4), statewide and regional trends across habitats showed no difference in biodiversity inside compared to outside MPAs (Caselle and Nickols et al. 2022).

Top: Treefish-John Ugoretz CDFW. Sea palms-CDFW.

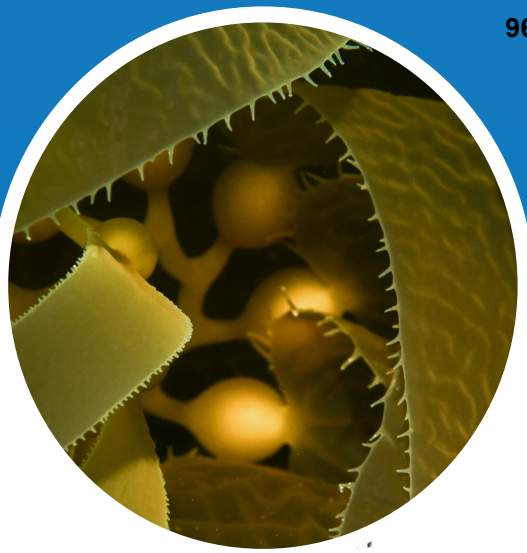
Fish	North			Central			South		
	SCUBA	Hook and Line	ROV	SCUBA	Hook and Line	ROV	SCUBA	Hook and Line	ROV
	15 - 65 ft	65 - 130 ft	65 - 330 ft	15 - 65 ft	65 - 130 ft	65 - 330 ft	15 - 65 ft	65 - 130 ft	65 - 330 ft
Quillback rockfish			↑ ↑						
Yelloweye rockfish			↑ =			= =			
Brown rockfish			↑ =			= =			
Black rockfish	* ↓	= ⇧	= =	* ↑	↓ ↓				
Canary rockfish		↑ ⇧	⇧ ↑		⇧ ⇧	= =			
Blue/deacon rockfish	* ↓	↑ ↑	= =	* ↑	↑ ↑	= ⇧		= ↓	= =
Gopher rockfish	* ↓	⇧ ↑	= ⇧	* ↑	↑ ↑	= =		↑ ↑	= =
Copper rockfish		↑ ⇧	↑ ↑		↑ ↑	= =		↑ ↑	↑ ↑
Vermilion rockfish		↑ ↑	↑ =		↑ ↑	= =		↑ ↑	= ↑
Kelp rockfish				* ↓			* ↑		
Cabezon				* ↓					
Lingcod	* ↑	↑ ↑	↑ =	* ↑	⇧ ⇧	↑ =			↑ =
Kelp greenling	* ↑		↑ =	* ↑		= =			= =
California sheephead							* ↑	↑ ↑	↑ *
Ocean whitefish								↑ ↑	= *
Kelp bass							* ↑	↑ ↑	
Blacksmith							* ↑		= *

Invertebrates	Intertidal	SCUBA	ROV	Intertidal	SCUBA	ROV	Intertidal	SCUBA	ROV
	0 - 6 ft	15 - 65 ft	65 - 330 ft	0 - 6 ft	15 - 65 ft	65 - 330 ft	0 - 6 ft	15 - 65 ft	65 - 330 ft
Red sea urchin		↓ ↓	↑ *		↓ ↑	↓ *		↓ ↑	↓ *
Purple sea urchin		↓ ↑			↑ ↑			↑ ↓	
Red abalone	↑ ↑	↑ ↑		↑ ↑	↑ ↓		↑ ↑	↓ =	
Black abalone	* ⇧			* ⇧			* ⇧		
All abalone		↑ ↑			↑ ↓			↓ =	
CA and warty sea cucumber								↑ ⇧	
CA sea cucumber			= =			= =			↑ *
Warty sea cucumber								↑ ↓	↑ *
Spiny lobster								↑ ↑	
Corals and gorgonians			↑ *			↑ *			↑ *
Sponges			↑ *			↑ *			↑ *

The left symbol in each cell applies to a response detected in abundance or density metrics and right symbol applies to size or biomass metrics.

↑	**Metric greater inside MPA than outside.**
⇧	**Metric greater inside MPA than outside but not statistically significant.**
↓	**Metric less inside MPA than outside.**
=	**Metric not statistically different inside or outside MPA.**
*	**Metric not measured or reported on.**

Figure 5.1 Summary of individual fish and invertebrate species responses reported in the four long-term monitoring projects in rocky reef habitats using different methods: intertidal, SCUBA, hook and line (CCFRP), and remotely operated vehicle (ROV) surveys. Results are reported in the long-term monitoring technical reports (Appendix B) and include data collected through the 2020 sampling season and may change as subsequent data are included in ongoing analyses.



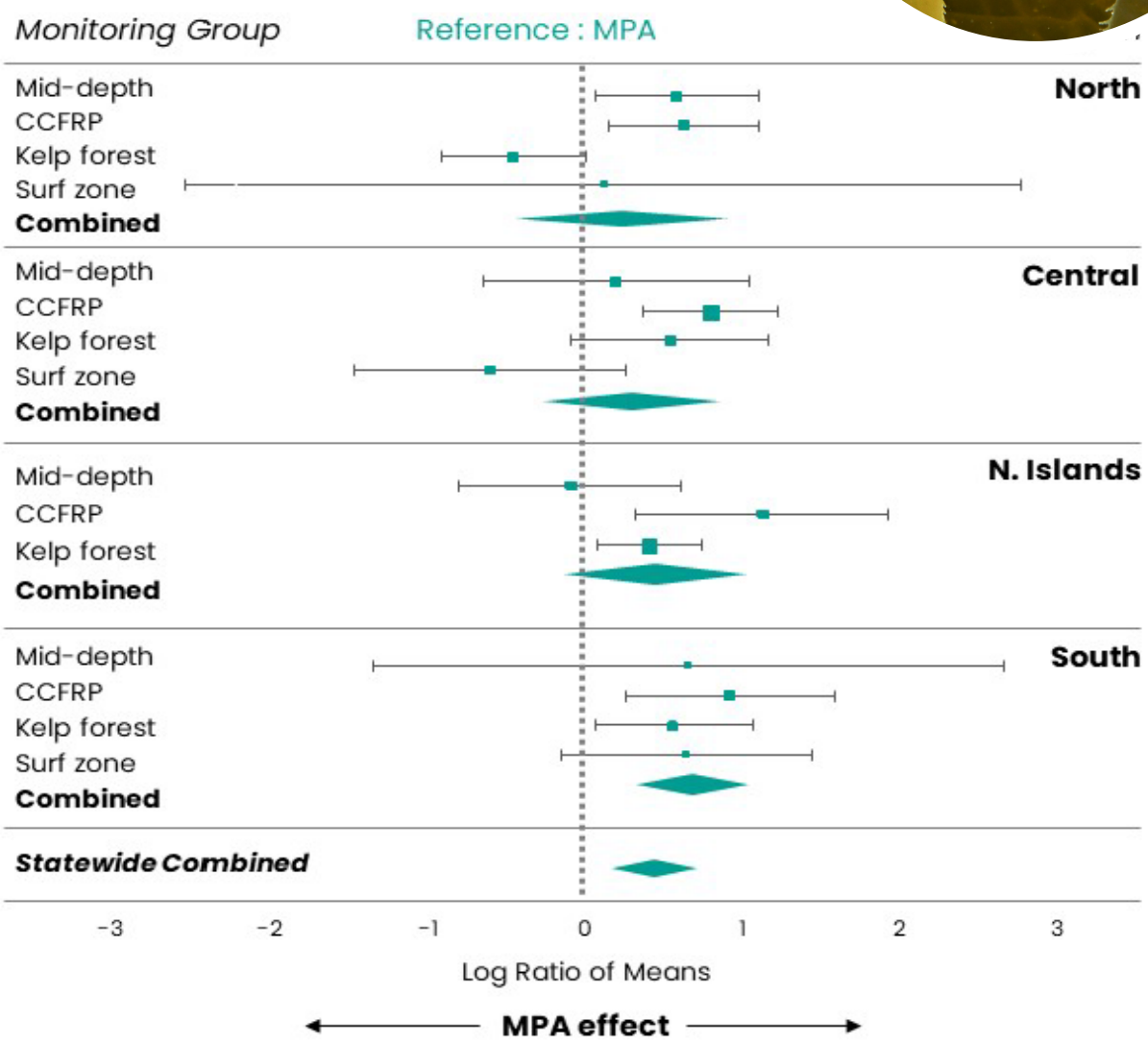
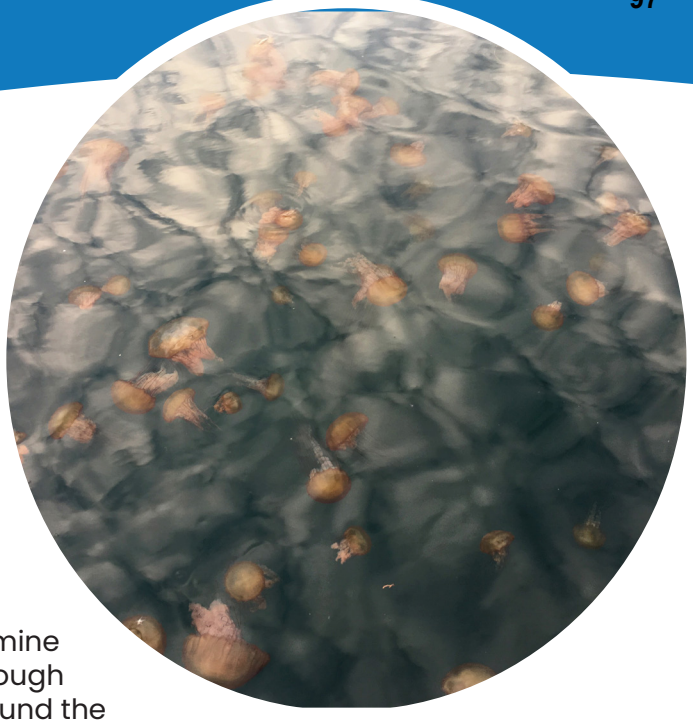


Figure 5.2 Comparison between MPAs and reference sites in the biomass of fished species statewide and by habitat monitoring group and bioregion, using the standardized mean difference and 95% confidence intervals for the 2019-20 sampling period. The dashed vertical line represents a mean difference of 0 (no difference) between MPAs and reference sites. Points to the right of the line indicate a higher mean biomass of fished species in MPAs relative to reference sites, representing a positive MPA effect. The size of the square indicates the mean effect size for that monitoring group and region. The larger the square, the more that habitat affects the regional combined response. Diamonds depict the combined effect size for each region and statewide. The Northern Channel Islands (N. Islands) were identified as a fourth bioregion for this analysis (adapted from Caselle and Nickols et al. 2022).

Giant kelp frond-CDFW.



CLIMATE CHANGE AND MPA RESILIENCY

While climate change was not at the forefront of conservation considerations when the MLPA was implemented into law over two decades ago, MLPA Goal 1 does call out the importance of promoting ecosystem resiliency. By reducing extraction and supporting more stable and diverse marine communities, MPAs in California may have the ability to promote resilience to climate change impacts and other disturbances (Hofmann et al. 2021).

Given the impacts that climate change will have on our coastal ecosystems and communities, it is critical to examine how climate change interacts with the MPA Network. Although long-term studies that link climate change and MPAs around the world are historically rare (Hofmann et al. 2021), MPA monitoring data collection in California coincided with a historic marine heatwave in 2014-2016, providing an opportunity to explore several priority questions about MPA resiliency and the general effects of climate change on California's coastal ecosystems. Most analyses focused on the central coast bioregion because it is the most comprehensively sampled region through space and time.

» **Habitats and species experienced dramatic changes due to the extreme conditions brought on by the 2014-16 marine heatwave (Figure 5.3).**

- Ecosystems both inside and outside MPAs experienced declines in biodiversity and species abundances due to the heatwave, although the magnitude of change varied within habitats (Appendix B.1-B.5, Caselle and Nickols et al. 2022).
- These changes were directly linked to shifts in oceanographic conditions. Ecological community structure pre-heatwave was strongly correlated with higher upwelling and lower sea surface temperature. Post-heatwave communities were defined by long-term regional ocean and atmospheric conditions and higher sea surface temperature (Caselle and Nickols et al. 2022).

» **MPAs did not appear to help mitigate against the initial effects of the marine heatwave, yet some ecological communities within MPAs appeared to be more resilient and showed signs of recovery after the heatwave.**

- Rocky intertidal ecosystems in central coast MPAs were more stable throughout the marine heatwave and began to recover more quickly after the disturbance (Figure 5.4).
- Diversity of nearshore rocky reef fish monitored by CCFRP began to recover more quickly in MPA sites than outside MPAs following the heatwave (Figure 5.5).
- Kelp species experienced large scale declines at certain locations along the coast during the marine heatwave, yet overall, kelp canopy was more stable and appeared to be more resilient inside MPAs (Appendix B.3).

These results show the potential for MPAs to act as an important conservation tool for safeguarding a resilient coast for many habitats, but more research and continued monitoring is needed to further investigate the role MPAs will play in promoting a resilient coast (Hofmann et al. 2021).

Pacific sea nettle-Katie Grady CDFW.

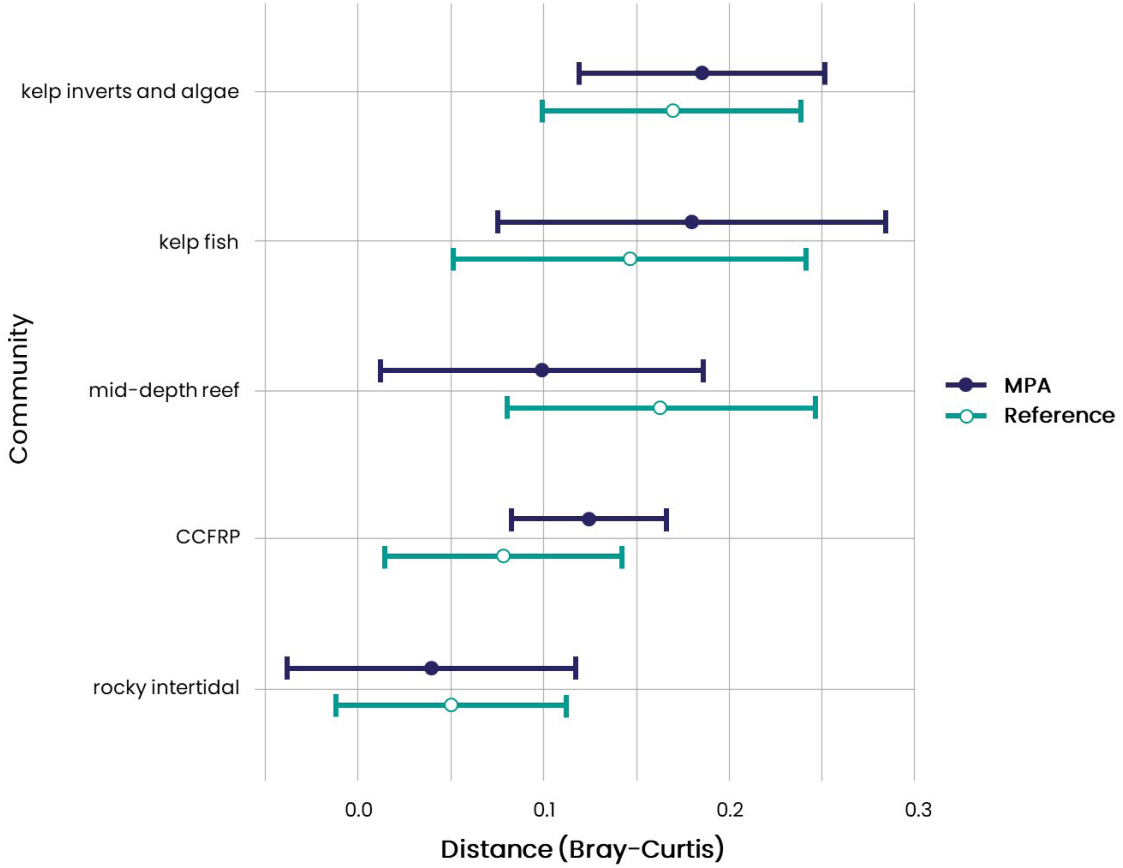


Figure 5.3 Differences in community structure pre- and post-heatwave for each monitoring group inside and outside MPAs on the central coast. Points with greater distance values indicate more difference between pre- and post- heatwave community structure within each habitat. Error bars are pooled standard error and distance values were calculated using Bray-Curtis dissimilarity (adapted from Caselle and Nickols et al. 2022).

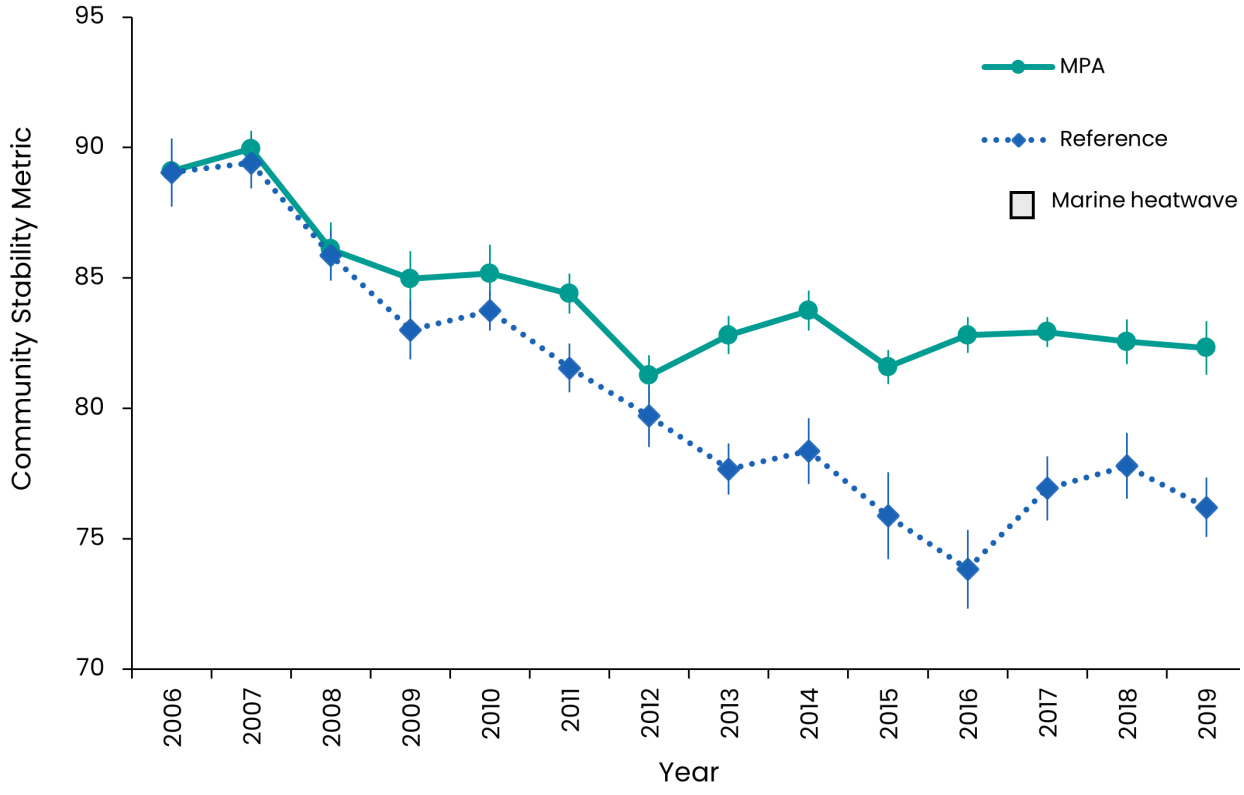


Figure 5.4 Community stability in rocky intertidal habitats inside and outside central coast MPAs from before, during, and after the 2014-2016 marine heatwave (adapted from Appendix B.2).

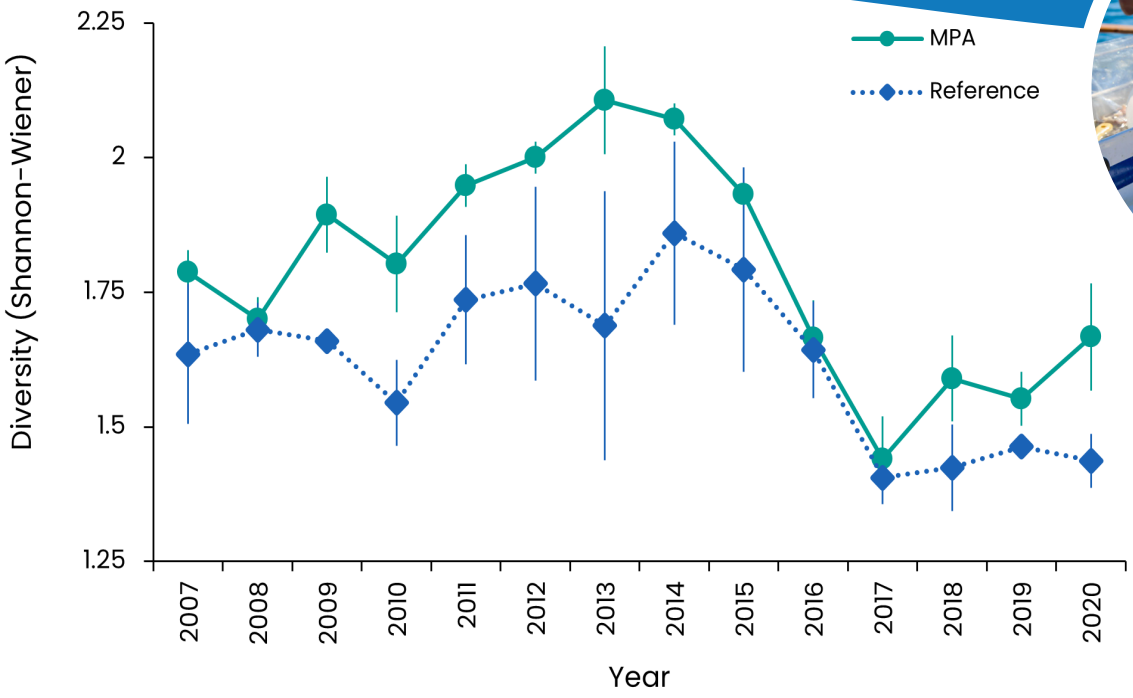


Figure 5.5 Changes in fish diversity caught in CCFRP surveys inside and outside central coast MPAs before, during, and after the 2014-2016 marine heat-wave (adapted from Appendix B.4).

HUMAN DOMAIN

Although the DEWG identified many gaps to fill within the human domain, there is still a wealth of information available in California to help examine human interactions with the coast, including MPAs. Using datasets from several ongoing statewide community science programs, CDFW's SCP Program, and CDFW LED's MPA citations, the NCEAS working group developed a human use scorecard that depicts the level of engagement of each indicator for all 124 MPAs in the Network (Figure 5.6, Caselle and Nickols et al. 2022).

» **For most MPAs, level and type of engagement correlates with population density.**

- Humans primarily engage with MPAs closest to larger population centers.
- In general, law enforcement citation frequency was positively correlated with higher local human population density and MPA engagement.
- MPAs with low human engagement tend to be hard to access, such as the Northern Channel Islands and Big Sur Coast MPAs.

» **Certain site characteristics expand human engagement in more remote MPAs.**

- MPAs that are affiliated with State Parks or National Marine Sanctuaries and protect sandy beaches or estuaries tend to have higher human visitation relative to population density.
- MPAs that allow some level of take and have nearby infrastructure, such as easily accessible parking lots, attract more human uses.

» **Scientific monitoring and research is the most evenly dispersed human use indicator studied.**

- Every MPA across the Network has received some type of scientific attention.

Expanded results, descriptions of methods and analyses, and more discussion of the limitations in integrating across different datasets are in the full NCEAS working group synthesis report, released concurrently with this Review. Even with some limitations, the results presented here are an immense first step at understanding the impacts of implementing a cohesive Network of MPAs in California and will help inform the next decade of MPA Network management and monitoring.

A child holding squid bait on a fishing trip-Carrie Wilson CDFW.

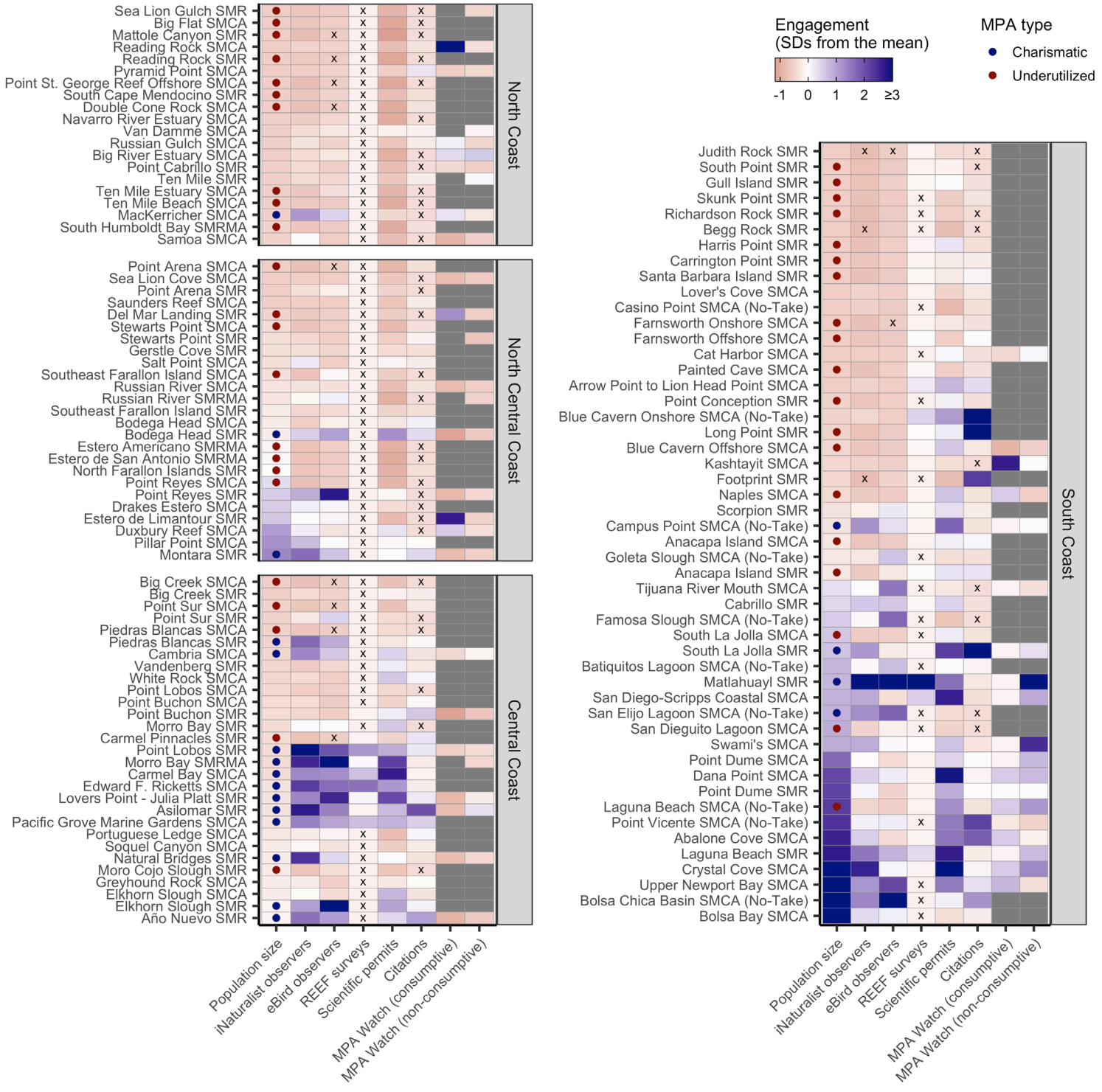


Figure 5.6 A synthesis of human use indicators within California's state MPAs. MPAs are organized by region and are sorted by population density within 31 miles (50 km; first column of each plot). Human use indicators are centered and scaled to ease comparison across indicators. Purple shades indicate MPAs with above average engagement and red shades indicate MPAs with below average engagement. Gray boxes indicate MPAs without data for any given indicator and x's indicate MPAs with true zeros. MPAs with greater ("charismatic") and less ("underutilized") engagement than expected based on surrounding population density are marked in the population size column (from Caselle and Nickols et al. 2022).

MPA DECADAL MANAGEMENT REVIEW

6. A PATH FORWARD

INFORMING OCEAN MANAGEMENT DECISIONS

This report represents the first 10-year management review of California's groundbreaking MPA Network. Guided by the principles of adaptive management, it is an opportunity to evaluate progress to date, celebrate accomplishments, provide lessons learned, and identify recommendations to strengthen the MPA Network and Management Program going forward. The ultimate purpose of this report is to assess the progress of the Network and Management Program towards meeting the six goals of the MLPA (Figure 1.2), California's founding MPA legislation, and to inform the development of recommendations to improve the Network and Management Program. Information from the ecological, human, and governance domains inform a suite of recommendations to improve Network performance and forge a path forward for the next decade of adaptive management.

GOAL 1: PROTECT THE NATURAL DIVERSITY AND ABUNDANCE OF MARINE LIFE, AND THE STRUCTURE, FUNCTION, AND INTEGRITY OF MARINE ECOSYSTEMS.

Long-term monitoring and integrative analyses conducted thus far indicate that species inside MPAs have generally increased in size, number, and biomass relative to those in reference sites outside MPAs. Even where species size or abundance increased both inside and outside MPAs, the rate of increase was often higher inside MPAs, indicating that California's MPA Network is already conferring benefits to many economically and ecologically important species. Results demonstrate that MPA protection has had a larger effect on increasing individual species biomass and abundance than species diversity. Community-level changes such as species diversity may take more time to reach detectable levels than species-level changes such as biomass and abundance. However, both species- and community-level responses to MPA protection vary by region, habitat, species, survey method, analysis method, and evaluation metric.

While areas both inside and outside MPAs experience similar ocean conditions within the same bioregion (Appendix B.6), MPAs in California have the potential to provide resiliency to stressful environmental conditions such as marine heatwaves (Hofmann et al. 2021). Although the MLPA did not specifically address climate change concerns, the Network was designed with ecological connectivity principles in mind. These design principles, such as habitat representation and replication, larval connectivity, and a large statewide geographic span that encompasses high genetic, demographic, and oceanographic diversity, are thought to boost Network resiliency. Additional benefits derived from

MPA protection and the subsequent reduction in fishing pressure, such as the support of marine populations with a wider size and age structure and the protection of potential climate refugia, are also expected to help mitigate the effects of climate change and other disturbances. The 2014-2016 marine heatwave affected the entire west coast in unprecedented ways, and ongoing MPA monitoring offered a real-world opportunity to investigate the effects of MPAs on the ability of ecological communities to either resist or recover from the heatwave. Ecological communities in some habitats were more stable or recovered more quickly from the changes induced by the heatwave inside MPAs relative to reference sites (Appendix B.2-B.4). However, analysis across habitats in the central coast did not reveal overall differences in community recovery between MPAs and reference sites outside MPAs in response to the marine heatwave (Caselle and Nickols et al. 2022). While these early results lack consistency, the expectation is that ecosystem resilience in MPAs will strengthen as ecological benefits from MPA protection have time to build.

Some benefits of MPA protection on species- and community-level metrics have already been detected using existing monitoring designs and methodologies, but there is still room for improvement. Questions remain about why effects are seen for some MPAs, habitats, regions, and species, but not others. While integrating across diverse data sets can clarify assorted individual results by providing a general overview of responses, analyses can be limited. Challenges to integrative analyses are difficult to overcome because of inherent differences in data sets across the various habitat studies, such as time range and spatial coverage (Caselle and Nickols et al. 2022). The state is committed to updating the Action Plan and working with partners to explore more efficient and cost-effective solutions to long-term monitoring. Furthermore, in order to improve our ability to interpret MPA results moving forward, the DEWG framework stresses the importance of expanding data collection on influencing factors, such as fishing pressure, habitat quality, connectivity, and environmental variability. An overarching influencing factor is climate change, and the resilience capacity of the MPA Network is an emerging topic of research that requires continued coordination. As a start, OPC has committed funding for 2023-2025 to support projects that advance our understanding of the role of the MPA Network in the context of climate change. As disturbances from climate change are expected to grow in frequency and severity, it is imperative that the Network continues to provide ecosystem benefits, while the Management Program gathers the information needed to assess the strengths and vulnerabilities of the Network both regionally and statewide.

Top: CDFW MPA surveyors Chenchen Shen and Sara Worden-MARINe. Bat stars in Asilomar SMR-Chenchen Shen CDFW.

GOAL 2: HELP SUSTAIN, CONSERVE, AND PROTECT MARINE LIFE POPULATIONS, INCLUDING THOSE OF ECONOMIC VALUE, AND REBUILD THOSE THAT ARE DEPLETED.

The strongest positive responses to MPA protection thus far have been linked to current and former levels of fishing pressure, such that the relative abundance and biomass of fished species inside MPAs compared to outside MPAs was larger where fishing pressure was heavier (Appendix B.3-B.4; Ziegler et al. 2022). Since MPAs protect older, larger, and more fecund individuals, these enhancements to economically important species inside MPAs can translate into benefits to fisheries through spillover. For example, substantial increases in lobster biomass and abundance were recorded not only within the boundaries of two of the Network's oldest MPAs, located in the Northern Channel Islands, but also just outside of them (Lenihan et al. 2022). While information on the contribution of the Network to fisheries spillover is limited, fine-scale spatial estimates of fisheries catch and effort can help determine whether spatial shifts in fishing activity following MPA implementation reveal patterns such as fishing the line, which would suggest spillover benefits to fisheries.

Ecosystem-based management and fisheries management work in tandem to conserve California's marine life. It is difficult to isolate the effects of one approach versus the other. For example, fish abundance in mid-depth and deep reef habitats increased statewide both inside and outside MPAs, likely due to the complementary effects of MPA protection and other management strategies like rockfish conservation areas. The feedbacks between MPA management and traditional fisheries management frameworks can be strengthened by increasing data and information sharing between programs to further integrate the two approaches to marine resources management.

A critical gap identified by the DEWG is an assessment of the economic impacts caused by California's MPA Network, especially pertaining to the state's fisheries. Preliminary analyses of CDFW's commercial market receipt and CPFV logbook data have not shown a persistent decrease in catch following MPA implementation. Despite these findings, commercial fishermen and CPFV operators generally believe that MPAs have had a negative effect on their livelihoods and well-being, and many have a negative opinion of the MPA Network and Management Program. Although coastal recreation businesses had a more favorable opinion of California's MPAs than the fishing community at large, still a greater share of ocean businesses believed that MPAs have had a negative effect on their business than a positive effect. While opinions about MPAs in both fishing and business communities may improve through increased communication and engagement with the Management Program, a human dimensions-focused MPA research agenda is needed to provide a more complete portrait of the economic effects of California's MPAs.

Top: Commercial fishing boats-Christy Juhasz CDFW. Bait ball and striped marlin-CDFW.

GOAL 3: IMPROVE RECREATIONAL, EDUCATIONAL, AND STUDY OPPORTUNITIES PROVIDED BY MARINE ECOSYSTEMS THAT ARE SUBJECT TO MINIMAL HUMAN DISTURBANCE, AND TO MANAGE THESE USES IN A MANNER CONSISTENT WITH PROTECTING BIODIVERSITY.

Though much focus is on their ecological utility, MPAs are designed and intended to provide direct benefits to humans as well. The Management Program must adaptively manage the Network to ensure that it is meeting the needs of people as well as the environment. Changes to MPA regulations over the last decade have strived to accommodate for some human uses and needs. Advancing our understanding of MPA use, socioeconomic impacts, ecosystem services, and human behavior relative to MPAs will boost management effectiveness. While there is a need to shed light on the ways in which MPAs may or may not be meeting current societal needs, it is also crucial to consider how those needs will be affected by climate change.

MPAs are living laboratories, providing researchers with access to minimally disturbed marine ecosystems. Implementation of the Network greatly expanded research opportunities, as evidenced by the growing number of MPA-related publications and projects over the last decade. Some level of scientific research has occurred in every MPA across the Network. Participation in community science activities in MPAs has also increased over time. Going forward, improvements to the SCP Program are needed to better meet the needs of researchers while ensuring minimal human disturbance. Communications with the public about the MPA Monitoring Program should also be prioritized. Though the state strives to make MPA science transparent and accessible through tools like the California MPA Monitoring Data Portal on DataONE and the 'Ask the Researcher' webinar series, stakeholders have requested more frequent research updates through their respective preferred communication channels.

Educational and recreational use of MPAs has also grown over time. New student curricula have been developed around the MPA Network, with some incorporating both western and indigenous ecological knowledge. State Parks has expanded interpretive programs in park units co-located with MPAs, and the PORTS program has doubled its offerings to K-12 students in California and beyond. Visitation at MPAs is directly related to nearby population density, though 'charismatic' MPAs receive higher levels of visitation and use than would be predicted by population density alone. MPAs with proximity to a State Park or National Marine Sanctuary, presence of sandy beach or estuary habitat, and/or well-developed infrastructure for visitors tend to receive higher levels of human engagement. These findings have direct implications for both MPA outreach and enforcement.

Top: Human use in the Cayucos tidepools-Claudia Makeyev CDFW.
MPA banner in the kelp forest-Amanda Van Diggelen CDFW.

GOAL 4: PROTECT MARINE NATURAL HERITAGE, INCLUDING PROTECTION OF REPRESENTATIVE AND UNIQUE MARINE LIFE HABITATS IN CALIFORNIA WATERS FOR THEIR INTRINSIC VALUE.

The passage of the MLPA was a direct action to recognize California's deep affiliation with the ocean and protect the coastal state's cultural identity that has been shaped by its shared boundary with the sea. Thirty-five of the Network's MPAs are located adjacent to 42 coastal State Parks units, strengthening the protection of natural heritage across the land-sea boundary.

California has some of the most diverse and unique coastal ecosystems in the world, and the Network was partly designed to protect these places for their intrinsic value. Existing monitoring data and high-resolution habitat mapping indicate that the key habitats identified during the MPA planning and design phase as critical ecosystems in California's nearshore waters are well-protected across the Network. The MPA Monitoring Program is structured around several habitat research groups, ensuring dedicated research attention and data collection within each habitat. Models also suggest that, compared with the rest of state waters, the MPA Network protects more habitats that could serve as climate refugia (Appendix B.6).

MPAs also have positive effects on culturally significant species like surf smelt and endangered species like black abalone. These promote nature-based activities and coastal tourism, and sustain tribal cultural and harvesting practices. Special closures, while not considered MPAs, benefit marine mammals and seabirds by prohibiting human access and reducing disturbance around critical haul out and breeding sites (Appendix D.19). Further investigation into how MPA design attributes contribute to the protection of unique species and habitats across the Network will help identify strengths and weaknesses of the MPA Network in protecting marine natural heritage.

Top: Caught surf smelt-Chuck Valle CDFW.
Black abaone in a protected tidepool-Claudia Makeyev CDFW.

GOAL 5: ENSURE CALIFORNIA'S MPAS HAVE CLEARLY DEFINED OBJECTIVES, EFFECTIVE MANAGEMENT MEASURES, AND ADEQUATE ENFORCEMENT, AND ARE BASED ON SOUND SCIENTIFIC GUIDELINES.

Since its first iteration outlined in the 2008 Master Plan, the Management Program has evolved into its current organization around the four pillars of research and monitoring, outreach and education, policy and permitting, and enforcement and compliance. Guiding documents, such as the Master Plan, Partnership Plan, and Action Plan, provide a comprehensive foundation for effective management of the statewide Network. MPA management is a collaborative, partnership-based effort that continues to develop through adaptive action.

In 2016, enforcement of marine coastal waters was enhanced through establishment of a Marine Enforcement District, a dedicated squad of CDFW wildlife officers supporting enforcement of and compliance with MPA regulations. The introduction of RMS in 2019 has provided an electronic database for enforcement records that facilitates the analysis of violation trends and equips officers with more information to strategically plan for effective enforcement efforts. Statewide, the number of violations is correlated with nearby human population density, and more MPA-related violations occur in southern California. However, more investigation is needed regarding changes in compliance over time and the reasons for non-compliance. Participants in a series of compliance workshops organized by the MPA Collaborative Network statewide have identified priority concerns, namely poaching in MPAs, trash and pollution, and wildlife disturbance. To maintain adequate enforcement in the future, additional funding, patrol boats, outreach, and partnerships are necessary, and the adoption of new enforcement technologies may also be considered.

The design of the MPA Network was underpinned by the best available scientific principles at the time, with guidelines for size, spacing, and habitat representation and replication to promote ecological connectivity. The Management Program continues to utilize rigorous science guidance derived from monitoring results and scientific working groups to inform adaptive management decisions. Following this Review, long-term monitoring approaches and the Action Plan will be reevaluated to ensure that priority questions regarding Network performance are addressed and that future data collection more easily lends itself to analyses across multiple habitats, species, and domains statewide.

The MLPA goals defined the objectives for the MPA Network in 1999. Now, over two decades later, it is time to expand this vision. The MLPA goals are broad in scope and were developed ahead of emerging scientific guidelines. While efforts have been made to address each goal, they lack the structure and specificity needed to serve as a program evaluation tool. Although some of these limitations were addressed by the Action Plan and the DEWG, the next step is to develop targets for measuring the degree of progress toward each goal against an expectation. An objective, well-defined evaluation tool, similar to the National Marine Sanctuaries' Condition Reports, would provide a Network and Management Program status report centered around the MLPA goals and more clearly inform adaptive management.

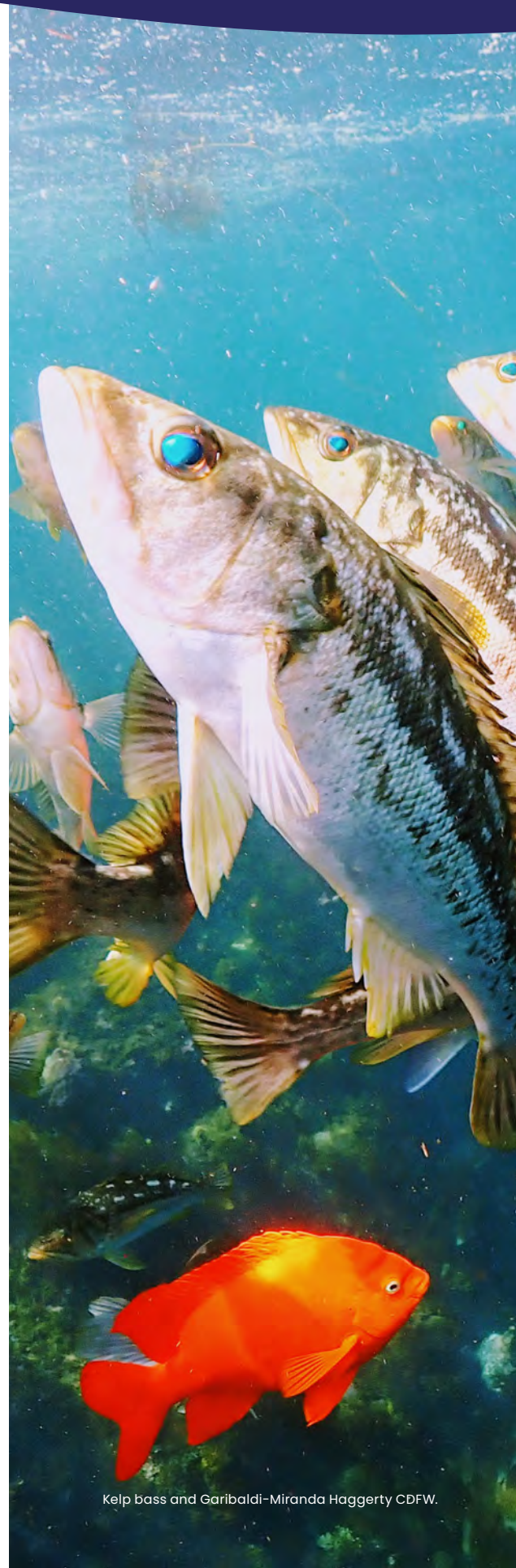
Gorgonian coral and a sea star-MARE.

GOAL 6: ENSURE THE STATE'S MPAS ARE DESIGNED AND MANAGED, TO THE EXTENT POSSIBLE, AS A NETWORK.

California's MPAs are remarkable partly because they were designed as an ecologically-connected network and are managed as a statewide network through the Management Program's four pillars. MPAs in the Network appear to be better connected to each other and to other parts of the coast than non-MPA sites through larval supply and transfer. Work on the California Connectivity Population Model is ongoing, and continued advancements in monitoring and modeling will improve our understanding of the effects of Network design and MPA placement in relation to ecological connectivity. Further exploration of MPA Network connectivity to truly understand if a network of MPAs is greater than the sum of its parts is the next frontier in MPA science.

Since completion of the Network in 2012, the Management Program has operated on a statewide scale while also meeting ecological and stakeholder needs at more local and regional scales. For example, large research consortiums are necessary to monitor the Network at a statewide scale, but emerging results indicating strong regional patterns suggest that further research may benefit from additional regional-scale analyses. At the same time, more robust integrative analyses across habitats, species, and domains will improve our understanding of MPA Network performance. Outreach and education efforts have benefitted from the successful creation of numerous partnerships, both statewide and at more local levels. Standardized branding and style elements, combined with the California MPA Network Outreach and Education Guide, promote consistency of outreach materials across Management Program partners. Policy and permitting decisions are applied consistently across the Network and continue to be improved through increased coordination across programs and agencies statewide. Finally, all 124 MPAs are patrolled through CDFW's statewide Marine Enforcement District, supported by numerous allied enforcement agencies at various jurisdiction levels.

The MPA Network was created to help safeguard California's diverse marine resources, but this mission requires broad coordination across sectors and scales. Besides strategic MPA research in both ecological and human domains, MPA governance and progress toward the MLPA goals can be improved through enhanced coordination on tribal engagement, fisheries management, water quality management, marine spatial planning, and climate change adaptation. These integration efforts are still in their infancy but hold vast potential for leveraging the assets of the MPA Network and Management Program and increasing their relevance and value.



Kelp bass and Garibaldi-Miranda Haggerty CDFW.

RECOMMENDATIONS

To guide adaptive management actions regarding the state's MPA Network and Management Program following this Review, CDFW developed a comprehensive list of recommendations in Appendix A from a wide range of sources, including tribes, core partners, the fishing community, the public, and existing reports. Based on this wealth of input and the knowledge gaps identified in this Review, CDFW has streamlined and elevated a suite of recommendations to prioritize for the next decade of the adaptive management cycle (Table 6.1). These recommendations are the culmination of priority needs to advance and improve MPA governance and partnership coordination, program activities under each pillar, and more effective evaluation of MPA Network performance moving into the future.

The CDFW MPA team Sara Worden, Amanda Van Diggelen, Steve Wertz, Michael Prall, Chenchen Shen, and Becky Ota on Catalina Island in 2019-CDFW.

Table 6.1 Adaptive management recommendations and actions to prioritize for the next decade of the adaptive management cycle. Recommendations 1-3 were provided directly by tribes through a report delivered to CDFW to inform this Review (Appendix C).

MPA Governance	Recommendation	Management Actions
Tribal Coordination	**1. Improve state agencies' tribal engagement and relationship building efforts.**	a. Engage in early and frequent communication with California Native American Tribes. b. Have an understanding and respect for tribal decision-making processes. c. Ensure a transparent and accountable process that provides clarity on agency decision-making and the potential for tribes to affect the final decision.
Tribal Coordination	**2. Create a clear pathway to tribal MPA management.**	a. Recognize tribal people as scientific and cultural practitioners and rightful, equal partners in the development, implementation, and management of MPAs. b. Work with tribes to develop and support co-management programs that can enrich tribal cultural practices and renew traditional values. c. Work with tribes to include and integrate traditional knowledge in MPA management, specifically coastal and marine science.
Tribal Coordination	**3. Build tribal capacity to participate in MPA management activities.**	a. Provide tribes with adequate resources to participate in changes to the MPA Network and management. b. Better incorporate tribal-led ecological monitoring into the broader MPA Monitoring Program and adaptation of the MPA Monitoring Action Plan.

MPA Governance	Recommendation	Management Actions
Regulatory and Review Framework	**4. Apply what is learned from the first Decadal Management Review to support proposed changes to the MPA Network and Management Program.**	a. Coordinate with CFGC to evaluate current and future proposed changes to Network design, individual MPAs, and current MPA Management Program priorities and policies in a manner consistent with the findings of this Review (see Appendix A for comprehensive recommendations list and Appendix G for outstanding petitions). b. Identify and utilize best science-based approaches to inform potential changes to the MPA Network in order to enhance Network performance. c. Coordinate with CDFW's legislative office to remove obsolete sections of the Fish and Game Code concerning Marine Life and Fish Refuges to better align with updated designations in the Marine Managed Areas Improvement Act (MMAIA).
Regulatory and Review Framework	**5. Establish targets for meeting the goals of the MLPA and how the Management Program and Network will evolve as targets are met.**	a. Use results and resources from this first Review, ongoing monitoring, and continued coordination with management partners to develop interim MPA status reports to guide future evaluations.
Justice, Equity, Diversity, and Inclusion	**6. Include and fund more diverse researchers and stakeholders in research and monitoring projects that directly contribute to the MPA Monitoring Program.**	a. Develop and implement a strategic plan informed by underrepresented and diverse user groups to increase the diversity of community science participants. b. Expand coordination between core monitoring programs and other partners to build trust and merge different types of knowledge with science-based information. c. Explore innovative approaches to engage the fishing industry in MPA research and management.
Justice, Equity, Diversity, and Inclusion	**7. Expand targeted outreach and education materials and events to underrepresented user groups.**	a. Conduct a language assessment of census blocks within 10 miles of each MPA to translate MPA outreach materials into the top three to five languages used in a household and work on finding new approaches to effectively engage underrepresented audiences. b. Utilize MPA Program partners to target and engage underrepresented user groups in marine conservation. c. Solicit input on customized/targeted outreach materials from members of diverse user groups.

MPA Governance	Recommendation	Management Actions
Justice, Equity, Diversity, and Inclusion	**8. Evaluate the accessibility of MPAs to various community groups.**	a. Promote novel projects and utilize existing human use datasets to evaluate accessibility of MPAs to different user groups.
MPA Statewide Leadership Team and Partner Coordination	**9. Continue to coordinate and collaborate with OPC and other agencies on California's ocean and coastal priorities to enhance coastal biodiversity, climate resiliency, human access and use, and a sustainable blue economy.**	a. Support OPC and partners on the MSLT to prioritize relevant OPC Strategic Plan and MSLT Work Plan objectives. Assess feasibility of current timeframes for taking action and adjust if needed. b. Review and synthesize MPA-focused recommendations and actions outlined in existing state action plans, such as CDFW's State Wildlife Action Plan, and reports that focus on ocean issues, such as ocean acidification, water quality, and sea level rise.
MPA Statewide Leadership Team and Partner Coordination	**10. Improve partnership coordination across the four pillars of the MPA Management Program.**	a. Develop and implement a workflow for enhanced coordination between CDFW's Scientific Collecting Permit Program and other agencies' permitting requirements. b. Develop strategic plan to strengthen communications between MPA Monitoring Program partners, tribes, and agencies that have overlapping jurisdiction at monitoring sites. c. Strengthen connections and communication between CDFW's Law Enforcement Division and allied agencies. d. Strengthen cross-border MPA management with West Coast states, Mexico, and Canada. e. Continue to add representatives to the MSLT as partnerships expand. f. Provide partners with consistent MPA messaging and branding for outreach and education activities to support compliance with MPAs.

MPA Management Program	Recommendation	Management Actions
Research and Monitoring	**11. Update the MPA Monitoring Action Plan framework to improve and sustain a cost-effective long-term monitoring program, including guidelines to ensure monitoring consistency and sustainable funding.**	a. Revisit the MPA site-tiering system and identify more efficient data collection and analysis methods to maximize use of available funding and efficiency without sacrificing scientific rigor. b. Explore more localized and bioregion-specific monitoring strategies. c. Explore CDFW capacity to participate in MPA monitoring to increase long-term program stability.
Research and Monitoring	**12. Invest in improving understanding of the human dimensions of MPAs and develop a human dimensions working group and research agenda.**	a. Improve collection of demographic data of ocean users and visitors to the California coast. b. Collect participant demographics in volunteer community science and outreach programs and assess participant benefits, motivations, and engagement patterns. c. Conduct more robust studies about compliance with MPA regulations and the impact of outreach and enforcement efforts. d. Conduct a broad economic assessment of the MPA Network on California's coastal communities. e. Continue to conduct and refine CDFW ocean businesses and public awareness surveys.
Research and Monitoring	**13. Explore the use of innovative technologies such as remote sensing, drones, and eDNA, to enhance and streamline traditional monitoring projects.**	a. Develop and fund pilot projects to explore novel data collection methods to scale up to regional and statewide monitoring. b. Augment existing monitoring programs to explore new and improved survey methods.

MPA Management Program	Recommendation	Management Actions
Research and Monitoring	**14. Develop a comprehensive community science strategy for MPAs and better utilize community science to supplement core monitoring programs.**	a. Evaluate the effectiveness and applicability of current community science programs involved in MPA monitoring. b. Create clear frameworks on regional and statewide scales for the intended use of community science from project onset. c. Invest in more centralized data management for community science programs. d. Improve coordination between existing community science programs and identify opportunities for new programs.
Outreach and Education	**15. Evaluate outreach needs, assess effectiveness of resources, and identify and pursue the most impactful and cost-efficient outreach tools for increasing MPA awareness and compliance.**	a. Conduct gap analysis on CDFW and core partner MPA outreach materials, including multi-lingual products, to identify whether initial objectives are being met and how to improve outreach projects and materials. b. Leverage partnerships to develop projects targeted at closing knowledge gaps in outreach needs. c. Expand the use of mobile apps, digital technologies, and social media to reach wider audiences. d. Improve CDFW website interface to increase accessibility to public information regarding MPAs.
Outreach and Education	**16. Conduct more targeted outreach to specific audiences to connect stakeholders with coastal resources and to encourage stewardship and compliance with regulations.**	a. Work closely with fishing communities to identify the most effective communication channels and outreach materials for these audiences. b. Increase opportunities for ongoing MPA researcher engagement with the public in forums, science advisory groups, and public presentations. c. Tailor outreach to better serve specific audiences, such as increasing the availability of waterproof materials, pocket-sized MPA maps, digital and online tools, and regionally tailored teacher toolkits. d. Organize an annual public webinar to provide MPA Management Program updates and receive public input. e. Create more regionally focused and culturally informed MPA outreach materials and weave MPA messaging into general ocean content produced by other partners.

MPA Management Program	Recommendation	Management Actions
Policy and Permitting	**17. Improve the application and approval process for scientific collecting permits.**	a. Improve the SCP online application portal. b. Establish a scientific steering committee to guide improvements to CDFW's environmental impact assessment tool for issuing SCPs within MPAs. c. Increase transparency and communication in the SCP review and issuance process.
Policy and Permitting	**18. Develop a framework to evaluate and approve appropriate restoration and mitigation actions within MPAs and marine managed areas.**	a. Work with a broad range of partners including state and federal agencies, tribes, the fishing community, and other ocean users to tailor restoration and mitigation projects to regional needs consistent with a statewide restoration and mitigation framework. b. Use statewide policy guidance and best available science to inform restoration and mitigation actions and decisions in MPAs and marine managed areas, such as permitting the removal of invasive species.
Enforcement and Compliance	**19. Create and implement a cohesive and actionable MPA Enforcement Plan.**	a. Create a standard operating procedure and citing blueprint/authority for use by CDFW's Law Enforcement Division and allied agencies. b. Provide guidance on confirming validity of a SCP for collections occurring in the field and improve communications between patrolling officers and field researchers. c. Identify ways to determine if an MPA requires heightened enforcement efforts using existing RMS data. d. Identify outreach materials enforcement officers most need when contacting individuals in the field. e. Identify potential alternative deterrents to MPA poaching for misdemeanor offenses and/or repeat offenders (example: possible MPA school prior to license renewal).

MPA Management Program	Recommendation	Management Actions
Enforcement and Compliance	**20. Increase enforcement capacity.**	a. Continue MPA-focused training for CDFW Wildlife Officers and allied agency partners. b. Assess needs for new equipment, such as replacing older patrol boats, and increased patrols in violation hotspots and across the coast. c. Explore utilizing technologies that could assist with enforcement cases and evidence-gathering in more remote locations.
Enforcement and Compliance	**21. Enhance MPA citation record keeping and data management.**	a. Identify enforcement gaps and violation hotspots for inclusion in enforcement plan and finalize manual data entry of any citations not yet entered into the database from before 2016, as well as citations from 2021 through May 2022. b. Track MPA patrol hours alongside the number of contacts, warnings, and citations in one database. c. Identify efficient ways to track repeat offenders when out in the field. d. Use enforcement data to inform outreach and education efforts, and better link enforcement data with human dimensions and ecological monitoring data. e. Develop a standardized MPA compliance report card to share with the public and decision makers.
Enforcement and Compliance	**22. Increase information gathering regarding MPA violation prosecutions and judicial outcomes.**	a. Track prosecution outcomes to better understand how fines may vary by county for similar offenses. b. Encourage MPA and marine resource outreach to district attorneys and judges to highlight importance of resource prosecution.

MPA Network Performance	Recommendation	Management Actions
MPA Network Design	**23. Expand and target monitoring and research efforts to examine the design attributes of the MPA Network more effectively.**	a. Tailor data collection and analyses to address the effects of specific MPA attributes such as size, spacing, and levels of protection on monitored species, habitats, and human communities. b. Continue to utilize and refine network connectivity models to assess MPA contributions to ecosystems, populations, and fisheries. c. Prioritize studies and data analyses that continue to address the benefits of implementing a connected network of MPAs on ecological and human communities in California.
MPA Network Design	**24. Work with CFGC and partners to better incorporate marine cultural heritage into the design of the MPA Network.**	a. Develop a process to incorporate state marine cultural preservation areas (MMAIA section 36700(6)(d)) into existing MPAs and new locations across the Network. b. Define metrics for identifying culturally important objects and sites to recommend for potential protection.
Climate Resilience and Adaptation	**25. Develop and implement climate change research and monitoring priorities and metrics for California's MPA Network.**	a. Develop models for climate change risk on shorter timescales and for both nearshore and deep-water marine species and habitats. Better incorporate tribal-led ecological monitoring into the broader MPA Monitoring Program and adaptation of the MPA Monitoring Action Plan. b. Investigate resilience conferred by MPAs by adding new climate resilience monitoring metrics to the MPA Monitoring Action Plan. c. Work with CDFW Science Institute's Climate Change Focus Team to better incorporate climate-focused MPA monitoring into broader state climate change targets.
Climate Resilience and Adaptation	**26. Consider climate change impacts from the outset of planning for monitoring MPA human dimensions.**	a. Leverage planned OPC Science Advisory Team human dimensions working group to identify social and economic service provision of MPAs and intersections with climate change. b. Assess equity issues around MPAs in a changing climate.

MPA Network Performance	Recommendation	Management Actions
Fisheries Integration and Other Influencing Factors	**27. Improve understanding of MPA Network effects on fisheries and fish stock sustainability and further integrate MPA monitoring data into fisheries management.**	a. Improve data sharing and integration between MPA and fisheries-focused management programs. b. Explore tools to capture spatially explicit metrics of fishing catch and effort that are more appropriate for MPAs in California.
Fisheries Integration and Other Influencing Factors	**28. Further integrate influencing factors into ecological and human study designs and interpretations of MPA performance.**	a. Improve estimates of other anthropogenic metrics such as visitation, enforcement presence, other regulatory management actions, and water quality.

MPA DECADAL MANAGEMENT REVIEW

7. CONCLUSION

California's MPA Network is unique and globally significant. It is one of the largest ecologically connected networks of MPAs in the world (Van Diggelen et al. 2022). While a common criticism of MPAs globally is that they can be "paper parks" that provide little actual protection (Halpern 2014), California's MPA Network is actively managed and has strongly enforced regulations. The resources invested in implementing, enforcing, monitoring, and managing California's MPA Network are unparalleled (Gleason et al. 2013, Murray and Hee 2019). Its implementation and management blends both science and community engagement, spurring curiosity and action among researchers, resource managers, tribes, fishermen, educators, students, and community scientists.

Bottom: Overlooking a breedng colony of California sea lions in San Miguel Special Closure-Sharon Melin NOAA Fisheries West Coast CC.

Over the last decade, great strides have been made toward fulfilling the goals that inspired the creation of California's MPAs (Figure 1.2). MPAs in California were expanded, redesigned, and managed as a statewide Network (Goal 6). The MPA Network was designed to protect California's representative and unique marine life habitats, with attention to size, spacing, and replication of kelp forest, rocky intertidal, sandy beach, mid-depth rocky reef, deep reef, and estuarine habitats (Goal 4). Regulations limiting the take and disturbance of marine resources within habitat-centered MPAs contribute to protecting marine life populations and marine ecosystems (Goals 1 and 2). Since MPA designations do not restrict public access, non-consumptive recreational experiences may be improved through better wildlife viewing opportunities (Goal 3). The expansion of MPAs in California has also created educational opportunities and facilitated the proliferation of MPA research, which, through the SCP Program, is balanced with the mandate to manage these uses in a manner consistent with protecting biodiversity (Goal 3). CDFW's enforcement of MPA regulations has improved and is supported by allied enforcement agencies (Goal 5). Effective management of the MPA Network is also ensured through several guidance documents that provide a framework for various aspects of management, including regional implementation (2008 Master Plan), program management (2016 Master Plan), collaborative governance (Partnership Plan), scientific monitoring (Action Plan), and scientific evaluation (DEWG Report) (Goal 5). Through partnerships with statewide habitat monitoring consortiums, OPC's Science Advisory Team, and for this Review, NCEAS, MPA management has been informed by the best available science from leading experts in their respective fields (Goal 5).

MPA NETWORK RECOGNITIONS

California's MPA Network is a candidate for listing under the International Union for Conservation of Nature (IUCN) Green List of Protected and Conserved Areas. The IUCN Green List provides a global standard for certification of effectively managed and fairly governed protected and conserved areas. Not only is California's MPA Network the first candidate for listing in the United States, but it is also the first MPA network in the world under consideration (Van Diggelen et al. 2022).

A portion of the MPA Network in southern California, the state and federal Northern Channel Islands MPAs, has been recognized by the Marine Conservation Institute. In 2019, the Northern Channel Islands received a platinum Blue Park Award, the highest distinction bestowed by the organization for MPAs that effectively conserve biodiversity.

Top: Opalescens nudibranch - Derek Stein CDFW.
Left to right: Dr. Lance Morgan Marine Conservation Institute, Christopher Mobley CINMS, Ethan McKinley CINP, John Ugoretz CDFW, and Becky Ota CDFW accepting the Blue Park award-CDFW.

The benefits of California's MPA Network are wide-ranging. MPA research and monitoring supports long-term ecological datasets that have broad applications. MPA monitoring data has helped inform threatened and endangered species listings, fisheries stock assessments, oil spill damage assessments, invasive species management, water quality protections, climate change assessments, and detection of marine infectious diseases such as sea star wasting disease. MPA management has also prompted a level of multi-agency and stakeholder coordination that has enhanced marine resources governance and adaptive capacity throughout the state. Continued investment will further foster collaboration across organizations and increase the value of MPA monitoring data in a wide variety of ways.

California has reached an important milestone with this first decadal evaluation of the state's MPA Network, not only for its own Management Program but also as a model for MPAs around the world. In synthesizing the information gathered over the last 10 years of management, California has demonstrated significant achievements while also identifying priority areas for improvement. Despite operating on a 10-year review cycle, with adaptive management as a guiding principle, the Management Program is continuously learning and cultivating itself to better serve the resources of the state and the intentions set forth by the MLPA. The recommendations presented in this Review will usher in the next decade of progress for California's MPA Network and solidify California's reputation as a global leader in marine conservation and resource management.

CALIFORNIA MARINE PROTECTED AREAS

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

Blue rockfish swimming in a kelp forest-Michael Alyono MBNMS.

MPA DECADAL MANAGEMENT REVIEW

GLOSSARY

- **Abundance**: The total number of individual organisms, quantity of biomass, or amount (usually percentage) of covered substratum present in a given area.
- **Adaptive management**: With regard to the marine protected areas, adaptive management is a management policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by changing it based on lessons learned. Actions shall be designed so that, even if they fail, they will provide useful information for future actions, and monitoring and evaluation shall be emphasized so that the interaction of different elements within marine systems may be better understood.
- **Biodiversity**: A component and measure of ecosystem health and function. It is the number and genetic richness of different individuals within a population of a species, of populations found within a species range, of different species found within a natural community or ecosystem, and of different communities and ecosystems found within a region. Humans are also an integral part of biodiversity and derive ecosystem services including sustenance and physical and psychological well being.
- **Biomass**: The total mass of organisms in a specified area. Measured as weight.
- **Community science**: Engagement by members of the public, often in partnership with professional scientists, to conduct research-based investigations, monitoring activities, or data collection and interpretation, which can inform natural resource management or basic research.
- **Community structure**: The types and number of species present in a community, which is influenced by interactions between species and other environmental factors.
- **Connectivity**: Linking of places or populations through movement of organisms. It can include: exchange of offspring between populations through larval dispersal; recruitment of juveniles and survival of these juveniles to reproductive age; any large-scale movement of juveniles and adults between locations.
- **Consumptive use**: Activities that result in removal of resources such as recreational and commercial fishing, seaweed harvesting, shell collecting.
- **Density**: The number of individual organisms per unit area or volume in a specified area.
- **Disturbance:** A discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system.

- **Diverse:** The range of similarities and differences in individual and organizational characteristics that shape a workplace. These include, but are not limited to, national origin, language, race, color, disability, ethnicity, gender, age, religion, sexual orientation, gender identity, socioeconomic status, veteran status, and family structure. The concept also encompasses other differences among people, including geographic differences and, importantly, diversity of thought and life experiences.
- **Ecosystem**: The physical and climatic features and all the living and dead organisms in an area that are interrelated in the transfer of energy and material, which together produce and maintain a characteristic type of biological community. Marine ecosystems can be particularly complex due to the vastness of the marine environment, the large number of organisms, and the intricacies of the physical, chemical, biological, and social processes involved.
- **Ecosystem service**: Ecosystem services are the benefits (physical and psychological well being) people obtain from ecosystems. These include provisioning services, such as food and water; regulating services, such as flood and disease control; cultural services, such as spiritual and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (Blackhart et al. 2005).
- **eDNA**: Environmental DNA (eDNA) is organismal DNA material that can be found in the environment. Environmental DNA originates from cellular material shed by organisms (via skin, excrement, etc.) into aquatic environments that can be sampled and monitored from water samples.
- **Error bar**: Typically represented on a graph or figure by a line through a point or bar that represents the variation or uncertainty around a data point or dataset. Common measures of uncertainty include standard error, standard deviation, and 95% confidence intervals.
- **Fishing effort/pressure**: The amount of time and fishing power to harvest fish, invertebrates, or plants, whether by individuals or vessels. For vessels, fishing power includes gear size, boat size, and horsepower. Used to calculate catch per unit effort.
- **Habitat**: The living place of an organism or community characterized by the resources and conditions present, including the physical, chemical and biological properties.
- **Habitat diversity**: The range of habitats present in a region.
- **Habitat quality (oceanographic, geologic, biogenic)**: The ability of the environment to provide conditions appropriate for individual and population persistence (Krausman 1999).
- **Human dimensions:** Physical, cultural, economic and social environments as it relates to the sphere of human activity.
- **Metric**: A calculated or composite measure or quantitative indicator.
- **MPA response/effect**: A positive or negative change over time in species abundance, biomass or other metric, inside an MPA compared to areas outside of an MPA.
- **Non-consumptive use**: Activities that do not include removal of resources such as photography, whale watching, diving, surfing, etc.
- **Non-targeted species**: A species of fish, invertebrate, or algae that is not targeted by recreational or commercial fishing or harvesting.
- **Population**: All the individuals of a species living within a specific area (informed by Clark et al. 2018).
- **Recovery:** Sustained increase in the attributes of the system that provide lasting ecological and social value. At a minimum, recovery entails the return of population viability and ecological function (Ingeman et al. 2019).

- **Reference site:** A sampling site outside of a MPA that is used to compare metrics to evaluate consequences of the MPA. Reference sites preferably differ only in the level of a regulated activity (e.g., some form of fishing) and are otherwise very similar in all other respects (e.g., habitat and other environmental conditions).
- **Representative marine life habitats:** Marine habitats found in California's state waters, and the ecosystems they support. Identified for protection in the MLPA planning process (e.g., rocky intertidal, sandy beach, shallow and deeper rocky reef).
- **Resilience:** The capacity of an ecosystem to absorb recurrent disturbances or shocks and adapt to change while retaining essentially the same function and structure (McClanahan et al. 2012, CDFW 2018). The ability of a coupled social-ecological-economic system and its components to absorb stressors and disturbance through resistance and/or recovery of core function, structure, and provision of services (Hofmann et al. 2021).
- **Species composition:** The number of species present in a given area and how well each of those species is represented in that area by the proportion of individuals for each species.
- **Species divesity:** The number of different species in a particular area (species richness) weighted by some measure of abundance such as number of individuals or biomass (Bynum 2009).
- **Spillover (adult):** Two types of spillover from MPAs can exist: ecological spillover and fishery spillover. Ecological spillover is the net movement of fish biomass from non-fished areas into fished areas. This may happen when a species exhibits density-independent movement such as home range behavior, ontogenetic shifts with increasing age, or when high densities inside MPAs lead to competition for scarce proportion of fish biomass available to a fishery given existing regulations and access constraints. This is most likely to occur when the rate of emigration from MPAs is low enough that MPAs provide some refuge from fishing, but high enough that a certain proportion of the population exit the MPA into fishable areas.
- **Stability:** For the purposes of this review, ecosystem stability is a measure of ecosystem response over time. A "stable" ecosystem does not experience large changes in community structure and function due to disturbances or effects of other abiotic and biotic factors. Population stability applies to a single species, and refers to changes to a population's abundance and biomass over time (McCann 2000, Worm et al. 2006, Stachowicz et al. 2007).
- **Take (including incidental take):** Hunt, pursue, catch, capture, kill, or attempt to hunt, pursue, catch, capture, or kill, as well as collecting, handling, marking, manipulating, or conducting other procedures on wildlife, whether wildlife are released or retained in possession.
- **Targeted Species:** A species of fish, invertebrate, or algae that is targeted by recreational or commercial fishing or harvesting.
- **Traditional ecological knowledge (TEK) or Indigenous traditional knowledge (ITK):** While no single definition of TEK/ITK is universally accepted, it has been described as 'a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (Berkes 2008, CDFW 2016).
- **Underrepresented:** Groups who have been provided with insufficient or inadequate representation, denied access, and/or suffered past institutional discrimination in the United States. According to the Census and other federal measuring tools, includes African Americans, Asian Americans, Hispanics or Chicanos/Latinos, and Native Americans.
- **Wrack:** Organic material such as kelp and sea grass that is cast up onto the beach by surf, tides, and wind.

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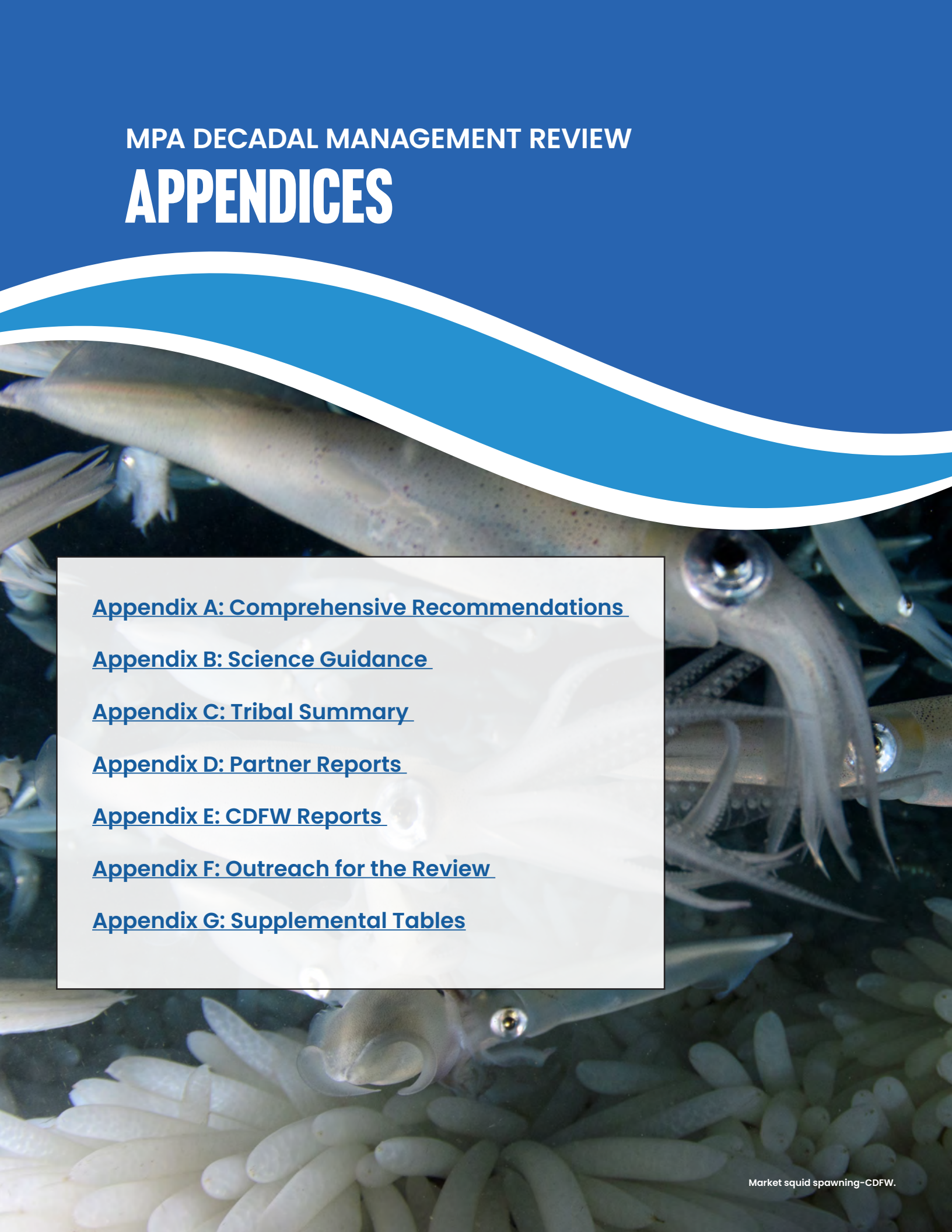
APPENDICES



Market squid spawning-CDFW.