

STATE OF THE

# California North Coast



Summary of Findings from Baseline Monitoring of Marine Protected Areas, 2013–2017



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## ABOUT THIS REPORT

This State of the Region report provides a synopsis of the ecological, biological, oceanographic, and socioeconomic conditions in the North Coast near the time of marine protected area (MPA) implementation in December 2012. The key findings presented here are from North Coast MPA baseline monitoring projects, and other assessments in the region from 2013 to 2017. Each baseline project included two to three years of data collection.

The California Department of Fish and Wildlife (DFW), California Ocean Science Trust (OST), California Ocean Protection Council (OPC), and California Sea Grant coordinated and collaborated in the implementation of North Coast MPA baseline monitoring, which was funded by OPC. This report was produced by DFW working in partnership with OST and OPC.

We acknowledge and are deeply appreciative of the work and input from our many partners and collaborators in the region who conducted the work upon which this report is built. We thank everyone for their expertise, dedication, and generous time given to this project.

This report will be provided to: 1) the California Fish and Game Commission (FGC) to inform the five-year management review of the regional MPAs; 2) relevant state agencies and entities, including the MPA Statewide Leadership Team, to help inform the MPA Management Program; and 3) the broader North Coast ocean community through a series of community gatherings and other meetings.

### LEARN MORE

Throughout the report, you will find “Learn More” boxes that contain links to additional resources with numbered references within each section.

Also, check the back cover for a full list of common and scientific names of species mentioned in this report.

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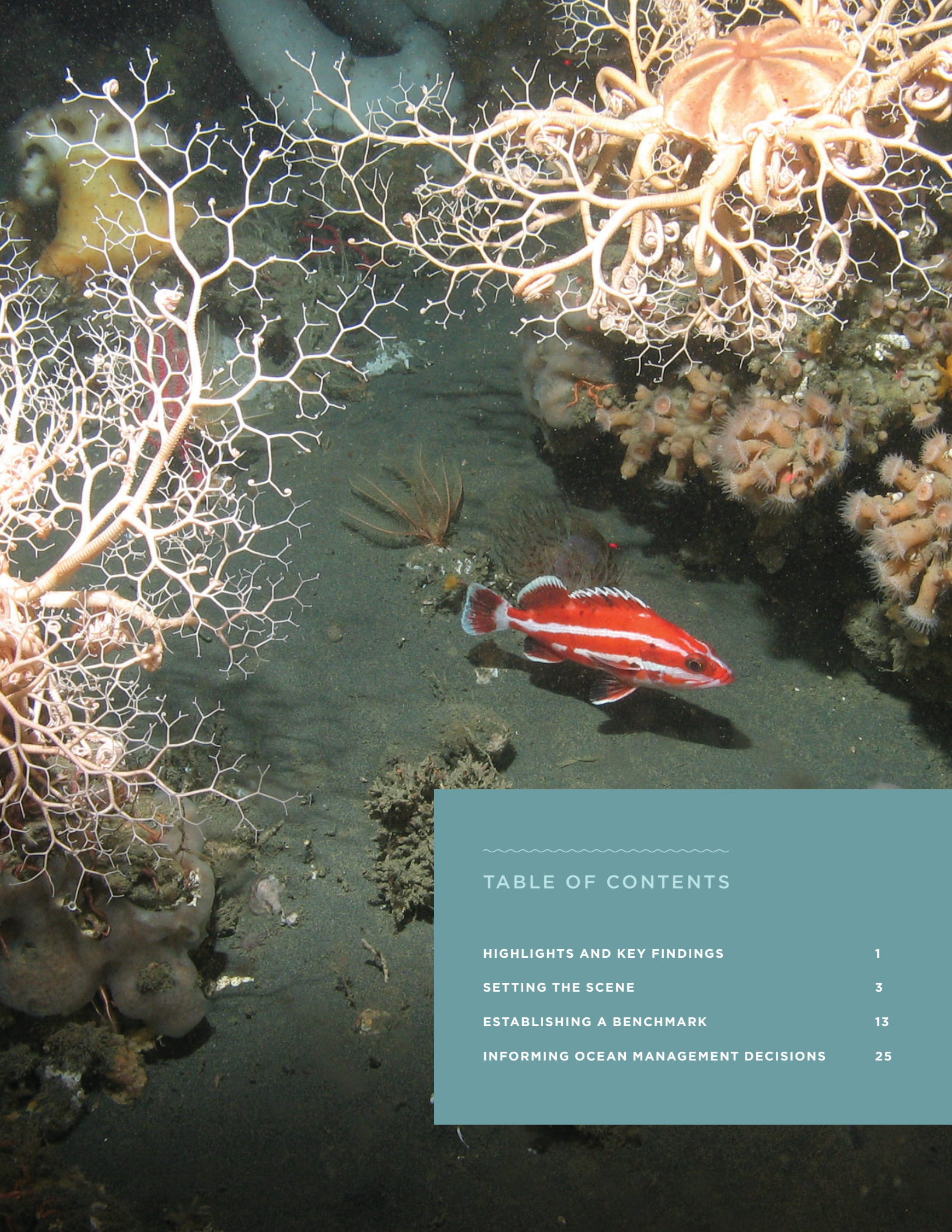
### OCEANSPACES: THE ONLINE COMMUNITY TRACKING CALIFORNIA'S OCEAN HEALTH

Everything in this report can be explored in more depth on **OceanSpaces.org**, which is home to baseline data packages and technical reports. Explore the State of the California North Coast page on OceanSpaces.org for the full portfolio of scientific reports, synthesis products, and analyses from MPA monitoring in the region.

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### SUPPORT FOR THIS REPORT PROVIDED BY





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# HIGHLIGHTS AND KEY FINDINGS

## Network of MPAs

With the passage of the Marine Life Protection Act (MLPA) in 1999, California became the first state in the nation to require a statewide network of marine protected areas (MPAs) to protect and conserve marine wildlife, habitats, and ecosystems. The MLPA also highlights the value of this network as a living laboratory for understanding and supporting ocean health, and exploring the effects of existing and emerging stressors.

In 2012, 20 MPAs and seven special closures were implemented in the North Coast, completing the statewide network. Scientists, commercial and recreational fishermen, Native American Tribes in California, non-governmental organizations (NGOs), managers, and others participated in a unique, collaborative, and science-based public planning process that resulted in a final unified proposal adopted by the FGC. This extensive effort set the stage for an informed community of participants and stewards interested in engaging in the implementation, scientific monitoring, and adaptive management of MPAs in the region and throughout the network.

## A Comprehensive Benchmark

Long-term scientific monitoring is essential to evaluate the effects of MPAs and inform ocean management. California's MPA Monitoring Program takes a two-phase approach: regional baseline monitoring (Phase 1) and statewide long-term monitoring (Phase 2). The goal

of baseline monitoring is to establish a benchmark of ecological and socioeconomic conditions inside and outside MPAs around the time of MPA implementation, against which future changes can be measured.

The North Coast is subject to variable oceanographic conditions that can influence the structure and function of the local marine communities. During baseline monitoring, an unprecedented marine heatwave occurred in the north Pacific producing conditions atypical for the region. The data gathered and analyses conducted during baseline monitoring are considered alongside these oceanographic conditions, and are coupled with available historical data to provide a detailed picture of regional ocean conditions. These data provide the foundation for rigorous, science-informed decision-making for our coast and ocean.

## Growing Capacity and Collaboration

Implementing, monitoring, and managing the MPA network requires coordination and collaboration. Since 2012, academic institutions, state and federal agencies, Native American Tribes in California, non-profit organizations, fishermen, citizen science groups, and many others, have collaborated to deepen our knowledge of the North Coast. This broad community involvement has created effective stewardship and strong partnerships necessary for a successful MPA network.

## Science to Support Management

### UNDERSTANDING AND RESPONDING TO UNEXPECTED EVENTS

Researchers observed several unique ecological events on the North Coast during baseline surveys:

- Throughout the North Coast, from rocky intertidal and shallow rocky reefs to deep offshore habitats, sea stars died off in massive numbers due to “sea star wasting syndrome”. Continued data collection in subsequent years has shown recruitment of juvenile sea stars of several species, a promising sign that some populations could recover.
- Baseline surveys of shallow reef habitats found extremely sparse kelp forests as well as increased sea urchin densities. Researchers are examining the potential role of the North Pacific Marine Heatwave in decreasing kelp and driving hidden urchins out into the open to search for kelp to eat. The loss of urchin predators, such as sunflower sea stars, due to sea star wasting syndrome may also play a role.

### LINKING MPAS AND OTHER MARINE MANAGEMENT EFFORTS

Monitoring can inform ocean management beyond adaptive management of MPAs. For example, water quality information provides important context for understanding the drivers of ecosystem condition and for interpreting trends. MPA Statewide Leadership Team partners (see page 6) are working to identify opportunities to align monitoring programs for MPAs, water quality, and water quality protected areas to leverage resources, capacity, and expertise.

## A Comprehensive View of the North Coast

### EXPANDING OUR UNDERSTANDING

Through baseline monitoring, researchers were able to:

- Explore and characterize new locations in rarely monitored North Coast deep canyon, estuarine, and sandy beach ecosystems.
- Incorporate Traditional Ecological Knowledge (TEK), encompassed by the project researchers’ preferred term of Tribal or Indigenous Traditional Knowledge (T/ITK), in the first tribal-led baseline monitoring project in the MPA Monitoring Program.

### HUMAN DIMENSIONS

Commercial and recreational fisheries play a vital role in the North Coast economy:

- Compared to other North Coast MPA region commercial fisheries operating in state waters, Dungeness crab reported the highest commercial landings and ex-vessel revenue. Recreational fishermen aboard commercial passenger fishing vessels (CPFVs) or “party boats” typically targeted and caught rockfish and lingcod.
- Reported commercial landings and ex-vessel revenue fluctuated throughout the study period (1992-2014).

### CONNECTED ECOSYSTEMS

Baseline monitoring illuminated the many ways that coastal and marine ecosystems in the North Coast are connected:

- Kelp, other algae, and seagrasses from nearby habitats, wash onto sandy beaches, forming wrack that supports abundant and diverse populations of macroinvertebrates and shorebirds.
- Estuarine and pelagic seabirds rely on different ecosystems—including estuaries, beaches, kelp forests, and nearshore pelagic—for activities such as breeding, feeding, and roosting.

### OLDER MPAS SHOW POSITIVE TRENDS

Many years of data may be needed to see MPA effects and understand regional trends. However, data from areas with pre-existing, long-established MPAs in the region can provide a glimpse of possible expected changes:

- Biomass and abundance of targeted fish species in kelp and shallow rock ecosystems in Point Cabrillo State Marine Reserve (initially established as a state marine conservation area in 1975) is almost double that of surrounding areas (see page 24).

## Looking Forward – Leveraging Existing Capacity

- As the state transitions from baseline to long-term monitoring, preparation of the Statewide MPA Monitoring Action Plan (Action Plan) is underway. The Action Plan will guide monitoring and research, and identify cost-effective strategies for long-term evaluation of the MPA network.
- The North Coast Monitoring Survey provides a detailed picture of the current regional monitoring capacity. Results from the survey identify the geographic and temporal coverage of monitoring activities, and the alignment of those activities with the State’s MPA monitoring priorities. Results of the survey are publicly available on the interactive California Coastal Monitoring Dashboard.
- A new open source information management system will become the central place for MPA data and information access, and is expected to be available in 2018. The powerful system will aggregate baseline data sources across disciplines and geographic areas to provide a comprehensive picture of marine ecosystems across California.

## Strategic Investments Build Long-Term Durability

Baseline monitoring generated novel scientific findings, strengthened partnerships, and developed new tools and approaches. Together, we are using this foundation to build scientifically rigorous, partnership-based long-term monitoring statewide.



## SETTING THE SCENE

### California's MPA Network

Taking a network-based approach to MPA design and implementation is one of many tools available for marine resource management. While individual MPAs function to protect organisms and ecosystems within a specific area, a network of MPAs can sustain marine life at multiple scales that cross ecosystem boundaries and span long distances. An MPA network includes individual MPAs of different sizes and degrees of protection, which could potentially serve as a tool to complement fisheries management to maintain and improve ocean health.

The California Marine Life Protection Act (MLPA, Chapter 10.5 of the California Fish and Game Code, §2850-2863) was passed by the California legislature in 1999 and directed the state to reevaluate and redesign California's existing system of MPAs. To implement the MLPA, California's 1,100 miles of coastline was divided into four coastal regions.

Through a collaborative, multi-year, and public MPA network design and siting process, California implemented the new network of MPAs iteratively across the four coastal regions. In September 2007, the Central Coast became the first region to implement redesigned MPAs, followed by the North Central Coast in May 2010, the South Coast in January 2012, and the North Coast in December 2012, completing the statewide network.<sup>1</sup>

### GOALS OF THE MARINE LIFE PROTECTION ACT

(1999, Chapter 10.5 of the California Fish and Game Code §2850-2863)

1. Protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
2. Help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.
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.
4. Protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic values.
5. Ensure California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement and are based on sound scientific guidelines.
6. Ensure the state's MPAs are designed and managed, to the extent possible, as a network.

To help achieve these goals, the MLPA also required the DFW to develop, and the FGC to adopt, a "master plan" to guide the design implementation and management of the network. A draft Master Plan (2008 Master Plan) was adopted by the FGC in 2008 and guided the process for designing and siting MPAs through a regional approach. In August 2016, the FGC adopted the final Master Plan (2016 Master Plan) that sets a statewide foundation for the MPA Management Program to help ensure the MPA network meets the goals of the MLPA.<sup>2</sup>

## The North Coast Region

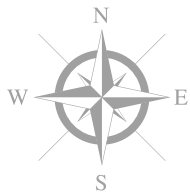
The North Coast region covers a straight-line distance of approximately 225 miles of the California coastline with about 517 miles (832 km) of actual shoreline, encompassing state waters (0-3 nautical miles from shore and offshore rocks) from the California-Oregon border south to Alder Creek, near Point Arena in Mendocino County. The region covers approximately 1,027 square miles (2,660 square kilometers) of state waters that extend from the mean high tide line to a maximum depth of 1,667 feet (508 meters), and includes prominent offshore rocks, such as Reading Rock. The North Coast encompasses a broad array of habitats from sandy beaches and rocky headlands, to kelp forests and submarine canyons.<sup>1</sup>

The North Coast has high productivity and exceptional biodiversity, due in large part to its position within the California Current Large Marine Ecosystem (CCLME). The CCLME is well known for persistent upwelling that brings cold, nutrient-rich waters to the surface, which support

blooms of phytoplankton that form the foundation of a diverse and complex food web. Extensive kelp forests, dominated by bull kelp, grow off rocky headlands and support rockfish, greenlings, lingcod, crab, abalone, and many more species of fishes and invertebrates. Further offshore, stretches of soft sandy bottoms and submarine canyons provide habitat and foraging areas for fish, marine mammals, and invertebrates, including deepwater corals. Onshore, regional estuaries are important for harboring eelgrass, and provide a vital role as foraging areas, breeding grounds, nurseries, and more.

Coastal communities depend on the region's rich waters for productive fisheries, recreational activities, and tourism. Major commercial fisheries in the region include Dungeness crab, salmon, nearshore finfish (primarily rockfish), and sea urchins. Recreational opportunities abound, from fishing for rockfish and salmon, to abalone diving, kayaking, wildlife watching, and beach walking.









## The North Coast

The North Coast region extends from the California-Oregon border south to Alder Creek, just north of Point Arena (Mendocino County).

The 20 protected areas in this region (19 MPAs and one SMRMA) cover approximately 13% of the region's State waters, and are managed together with the seven special closures. MPAs in the region differ in their classifications, allowed activities, and degree of protection.

 California State Waters

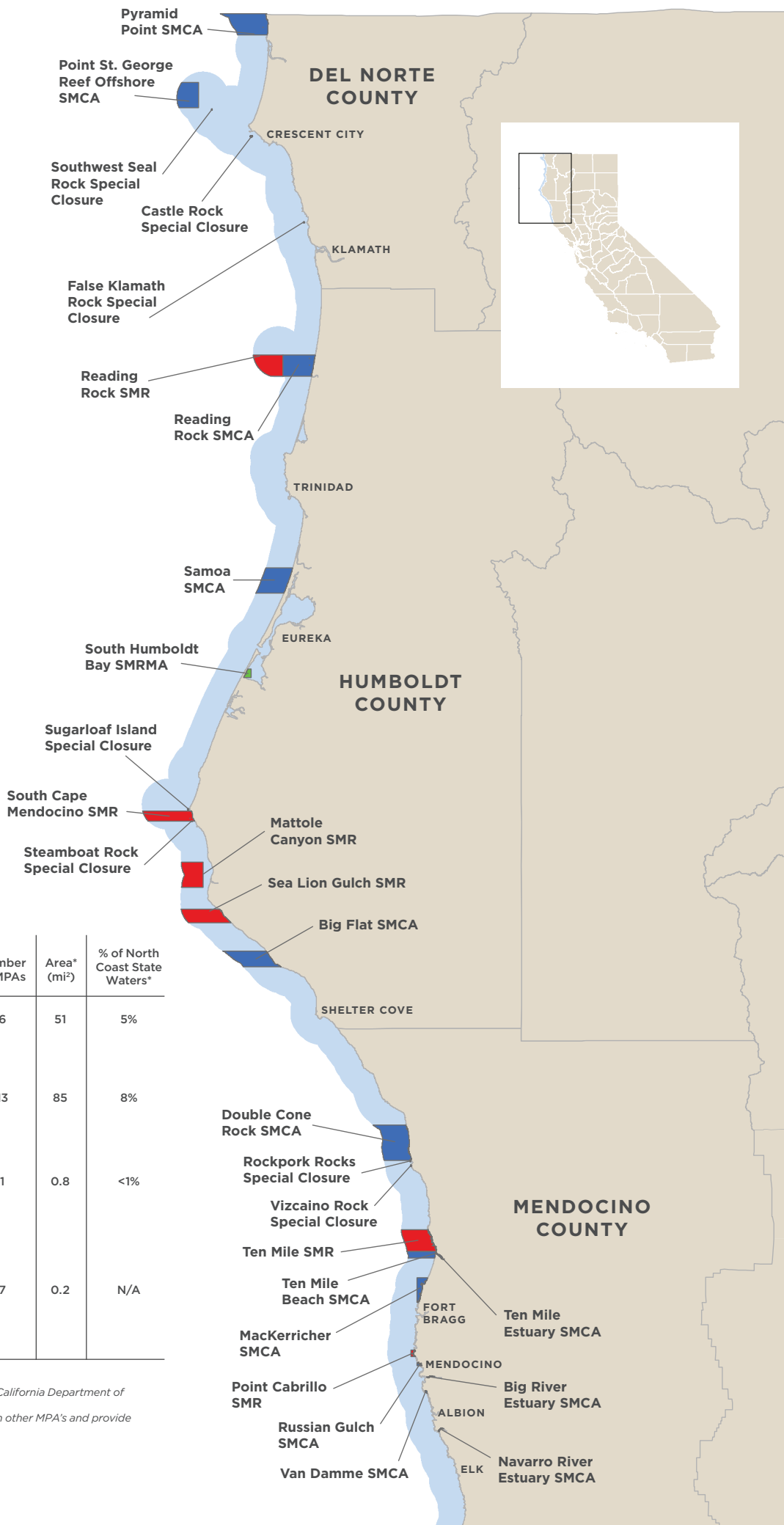
### MPA CLASSIFICATIONS IN THE NORTH COAST REGION

	Number of MPAs	Area* (mi <sup>2</sup> )	% of North Coast State Waters*
 <b>State Marine Reserve (SMR)</b> <i>An area where all commercial and recreational take of living, geologic, or cultural resources is prohibited. Scientific research and non-consumptive uses may be allowed.**</i>	6	51	5%
 <b>State Marine Conservation Area (SMCA)</b> <i>An area where select recreational and/or commercial take activities are allowed to continue. Scientific research and non-consumptive uses may be allowed.**</i>	13	85	8%
 <b>State Marine Recreational Management Area (SMRMA)</b> <i>A marine or estuarine area designated to provide for recreational hunting opportunities to continue while providing MPA-like protections subtidally. Scientific research and non-consumptive uses may be allowed.**</i>	1	0.8	<1%
 <b>Special Closure</b> <i>An area adjacent to seabird rookeries or marine mammal haul-out sites, where access or boating activities are restricted.***</i>	7	0.2	N/A

\* Numbers for area and percent represent rounded values.

\*\* Research within MPAs is allowed pursuant to obtaining a California Department of Fish and Wildlife issued Scientific Collecting Permit.

\*\*\* These small closures (300' and 1,000') often overlap with other MPA's and provide additional protection in sensitive areas.





## TRADITIONAL AND CULTURAL CONNECTIONS

Since time immemorial, Native American Tribes in California have stewarded and utilized marine and coastal resources in the region. The foundation of their management is a collective storehouse of knowledge about the natural world, acquired through direct experience and contact with the environment, and gained through many generations of learning passed down by elders about practical as well as spiritual practices. This knowledge, which is the product of keen observation, patience, experimentation, and long-term relationships with the resources, today is commonly called TEK. While no single definition of TEK 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.” Traditional Knowledge (TK) encompasses TEK, science, and other relevant information from tribes.<sup>2</sup>

Many Native American Tribes in California continue to regularly harvest marine resources within their ancestral territories and maintain relationships with the coast for ongoing customary uses. Today, California’s inhabitants and visitors continue to gain significant benefits from the state’s coastal waters, including economic, nutritional, recreational, cultural, spiritual, and educational, as well as climate regulation and protection from coastal hazards.



## MPA Management Program

California’s MPA network is managed collaboratively through the MPA Management Program, which includes four focal areas: outreach and education, enforcement and compliance, research and monitoring, and policy and permitting. The focus of this report is on research and monitoring, but the following pages provide an overview of the other three focal areas.

The California Department of Fish and Wildlife, California Ocean Protection Council, California Ocean Science Trust, and the Fish and Game Commission lead the MPA Management Program.

- The FGC is the decision-making authority for California’s MPA regulations. The FGC adopted the MPA Management Program (known as the Marine Life Protection Program in the MLPA), and the 2016 Master Plan for MPAs (see page 3).
- DFW is the lead managing agency for California’s MPA network. DFW implements and enforces the regulations set by the FGC, and their work spans all four focal areas of the MPA Management Program.<sup>3</sup>
- OPC is the policy lead for California’s MPAs and implementation of MLPA activities.
- OST is an independent, non-profit partner organization that supports science-informed decision-making for California’s coast and ocean.

## A Partnership-Based Approach

The Collaborative Approach: Marine Protected Areas Partnership Plan (Partnership Plan),<sup>4</sup> was adopted by OPC in 2014, and the Master Plan was adopted by the FGC in 2016 (see page 3). Both recognize that implementing and managing California’s MPA network requires collaboration. For example, in April 2014, the MPA Statewide Leadership Team (Leadership Team) was convened by OPC as a standing body to ensure communication, collaboration, and coordination among entities that have significant authority, mandates, or interests that relate to California’s MPA network. The founding members of the Leadership Team include state and federal agencies, departments, boards, and commissions with jurisdiction or management interests regarding California’s MPAs. In addition to OPC, core members include the FGC, DFW, and OST. OPC is currently working with tribes to include tribal representation on the Leadership Team.

MPA monitoring in a region as unique as the North Coast, with its often-inaccessible coastline typified by rocky cliffs and temperamental seas, as well as its relatively isolated coastal communities, relies on collaboration and partnerships for success. The work summarized in this report represents partnerships among academic institutions, state and federal agencies, Native American Tribes in California, non-profit organizations, fishing groups, and community and citizen science groups.

## Outreach and Education

Public outreach and education efforts continue to focus on encouraging compliance with MPA regulations, and fostering an understanding of the statewide MPA network. Since the North Coast regional MPA implementation in 2012, DFW has distributed over 35,000 North Coast regulatory guidebooks and 24,000 informative brochures. DFW outreach materials, including these widely distributed guidebooks and brochures, as well as MPA overview sheets that provide details on the size, location, and regulations of a specific MPA, are available on the DFW website.<sup>1</sup>

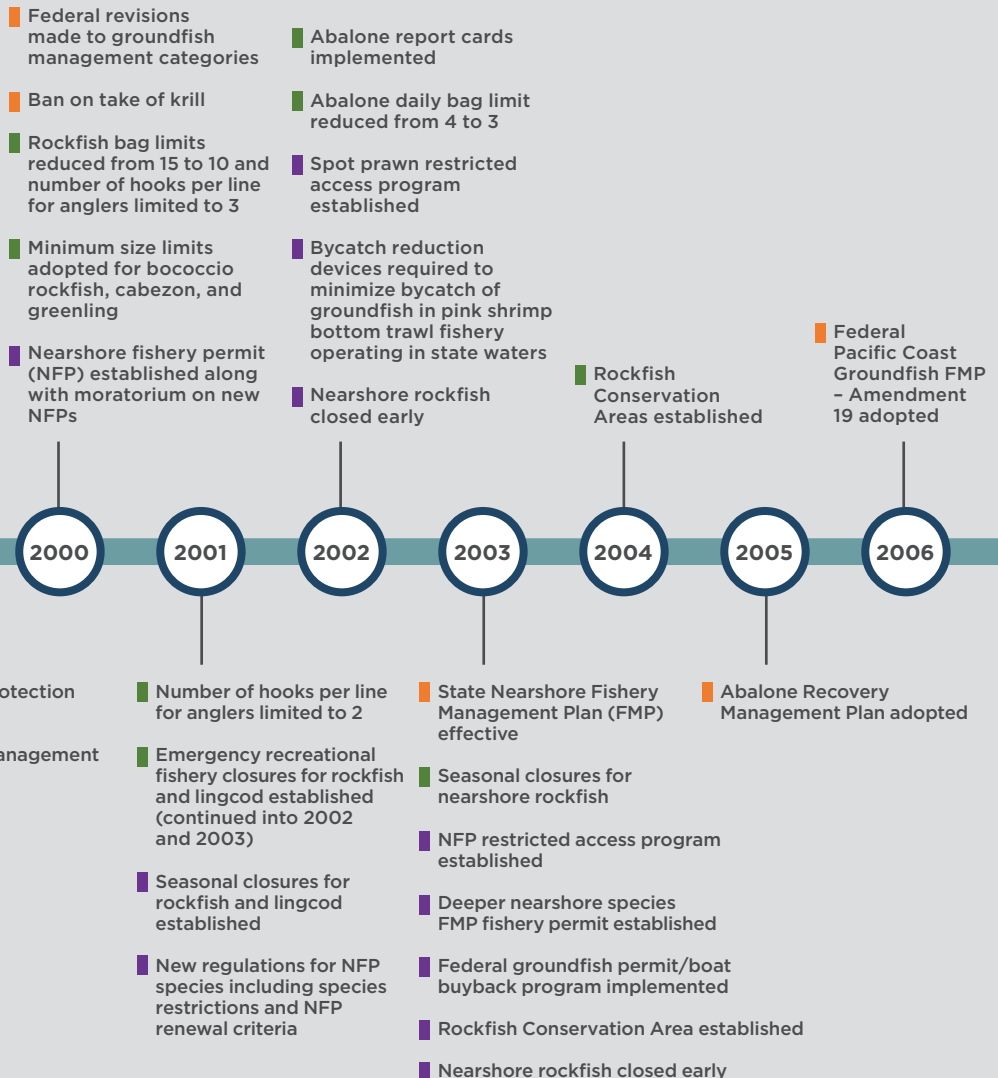
Partnerships help increase DFW's capacity to inform the public through a wide range of multimedia outreach tools and products. DFW continues to work with partner organizations such as the California Marine Sanctuary Foundation (CMSF), MPA Collaborative Network, and regional ports and harbors. DFW reviews partner outreach materials to help ensure accuracy and consistency in MPA information and messaging. Major partner-based projects completed in the North Coast since 2013 include:

- Development and installation of 38 MPA signs (11 of which include tribal information from collaboration with Tolowa Dee-ni' Nation, Trinidad Rancheria, and InterTribal Sinkyone Wilderness Council).
- Development and distribution of waterproof regulatory brochures for Crescent City, Ocean Cove, Timber Cove, and Humboldt Bay harbors.
- Installation of an informational kiosk in Crescent City to provide information on MPAs, fisheries, and fish identification.
- Development of three MPA videos, each with a different focus, including one that highlights the Tolowa Dee-ni' Nation's history and environmental stewardship.
- Using State Parks Online Resources for Teachers and Students (PORTS),<sup>5</sup> to link interpreters with classrooms via live video conferencing, focusing on Pyramid Point SMCA.

DFW will continue to work with partners to promote public knowledge about MPAs and encourage regulatory compliance.

## SELECT MANAGEMENT ACTIONS AFFECTING OCEAN RESOURCES IN THE NORTH COAST

- GENERAL REGULATIONS
- RECREATIONAL FISHING
- COMMERCIAL FISHING

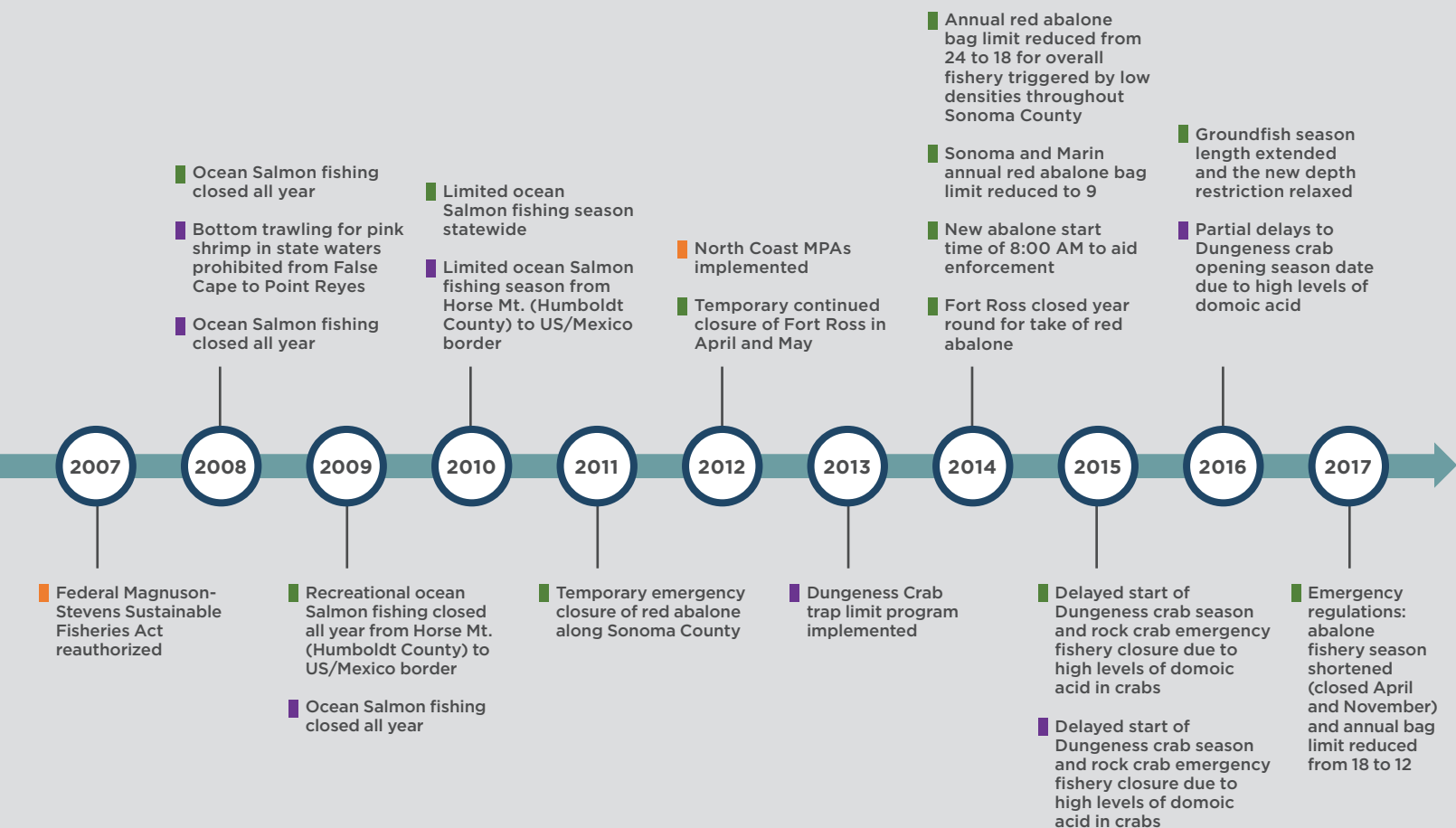




## THE MPA COLLABORATIVE NETWORK: A LOCAL VOICE IN MPA MANAGEMENT

The MPA Collaborative Network provides a framework for local stakeholders to engage in the MPA adaptive management process, including outreach and education, to increase compliance of local MPA regulations. The MPA Collaborative Network consists of 14 regional MPA Collaboratives statewide that are open to anyone and provide a venue for diverse stakeholders to engage in the stewardship of MPAs at a county level.<sup>6</sup>

There are three active MPA Collaboratives in the North Coast region: Del Norte, Humboldt, and Mendocino. Each Collaborative works with state partners to advance local priorities, activities, and projects, such as MPA and tribal videos, presentations to local schools and clubs, and soliciting the installation of MPA signs and kiosks.





## Enforcement and Compliance

MPA success relies on both proper enforcement of, and public compliance with, MPA regulations. The DFW Law Enforcement Division (LED) is the primary agency responsible for enforcing MPA regulations, primarily using small patrol skiffs, aircraft, and foot patrols along the North Coast region. DFW occasionally receives assistance from the National Oceanic and Atmospheric Administration (NOAA), U.S. Coast Guard, local sheriffs, and California Highway Patrol. There are 10 enforcement officers who enforce MPA regulations throughout the North Coast region; four officers are dedicated to marine enforcement and six patrol the MPAs in their district.

Based on the best available DFW citation record information, from January 2013 to July 2017, 2,052 separate marine violations across 1,275 individual citations were issued in the North Coast. Of these, only 26 (2%) were direct violations of MPA rules and regulations, with violations occurring in four of the 20 MPAs and one of the seven special closures in the region. There were 15 violations issued in the Pyramid Point SMCA, two in the

Point Cabrillo SMR, five in the Ten Mile SMR, one in the South Cape Mendocino SMR, and three in the Castle Rock Special Closure. These violations generally occurred in areas that are relatively easy to access; the Pyramid Point SMCA, Point Cabrillo SMR, and Ten Mile SMR are all within one mile of a highway, and the Castle Rock Special Closure is about a five-minute boat ride from Crescent City harbor. Of these MPA violations, nearly half of them came from illegal beach fishing.

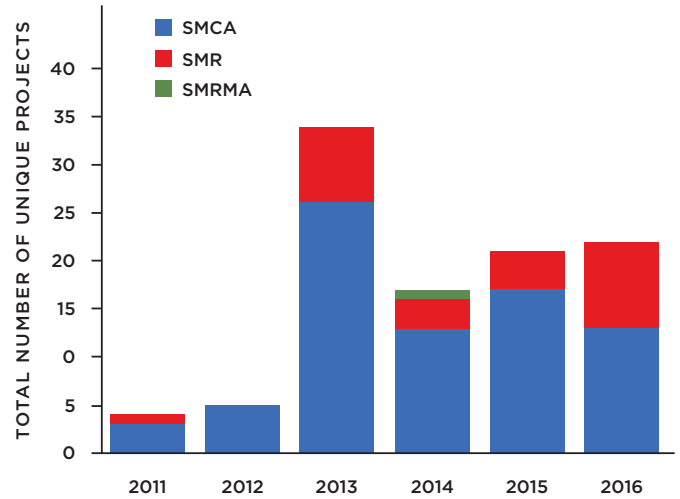
Improved technology, increased public awareness of MPAs, and community support will facilitate compliance through optimizing surveillance, detection, and interdiction. DFW LED is advancing finer resolution analyses to determine specific violation types and strategically plan continued enforcement efforts.

## Policy and Permitting

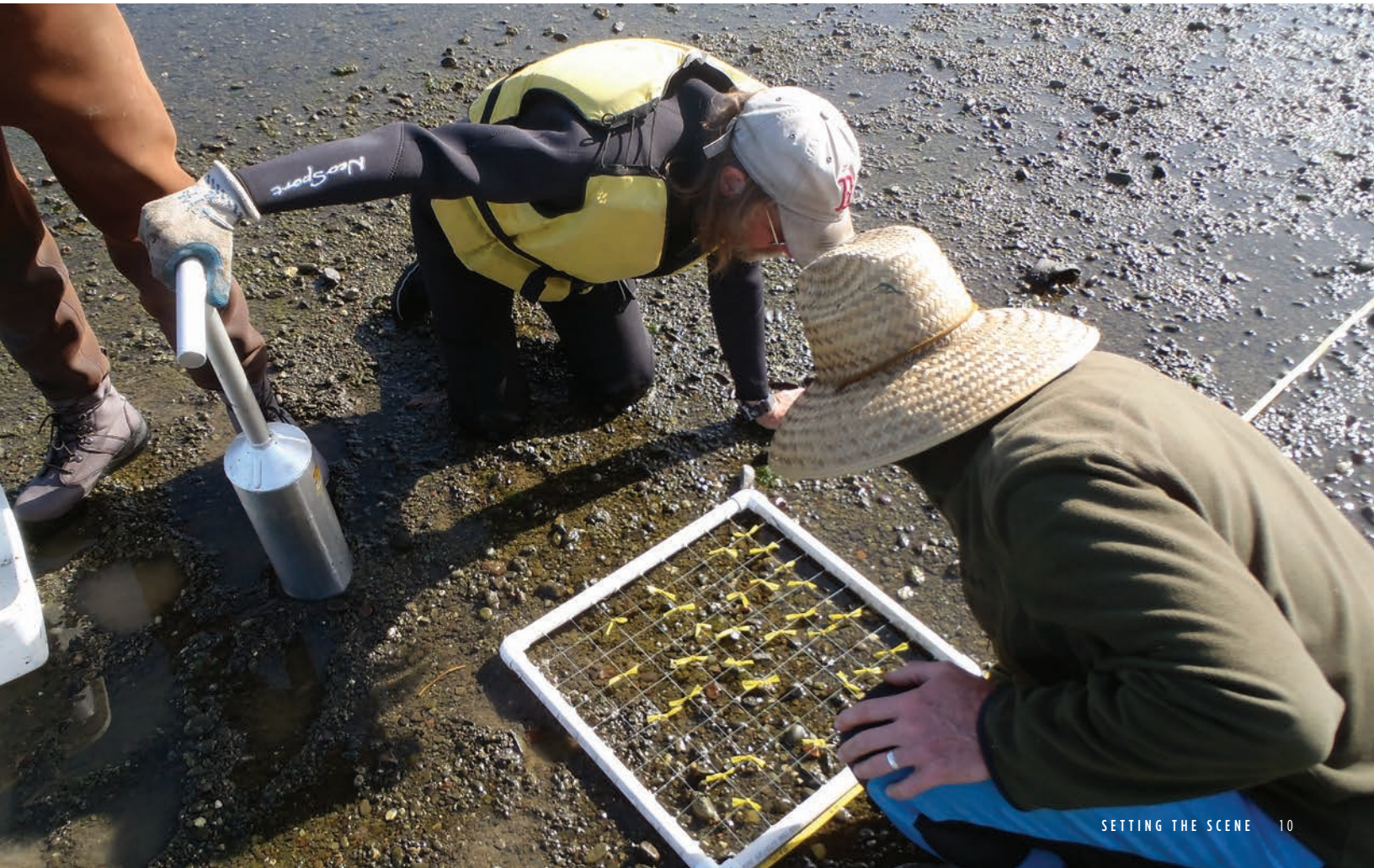
A scientific collecting permit (SCP) issued by DFW is required to take wildlife (including marine fishes, invertebrates, algae, and seagrasses) for scientific, educational, or propagation purposes. All SCP requests go through a rigorous review process by DFW, especially those project requests within MPAs. Projects within MPAs are evaluated cumulatively to ensure limited impacts to populations when sampling involves take; all possible efforts are made to ensure research projects have no lasting impacts.

### SCIENTIFIC COLLECTING PERMIT ACTIVITIES

From 2011 to 2016, DFW approved 93 SCPs for 103 unique research projects to work in North Coast MPAs. The highest number of unique projects occurred within SMCA's (77), followed by SMR's (25), and one within a state marine recreational management area (SMRMA). The highest number of SCPs issued with unique projects was in 2013 with 34, followed by 2016 with 22. The increased number of SCPs issued since 2012 reflects the North Coast baseline monitoring effort, and an overall increased interest in studying MPA effects.



Total number of unique projects permitted for work in the North Coast MPAs, 2011-2016. Source: DFW





## Research and Monitoring

### WHY MONITOR MPAS?

The MLPA requires that the statewide network of MPAs be monitored to evaluate progress toward meeting its goals (see page 3), and that the results of monitoring inform adaptive management decisions. The MLPA defines adaptive management as learning from program actions such as monitoring and evaluation of ecosystems to ensure management effectiveness.

### TRACKING CONDITIONS IN CALIFORNIA'S COAST AND OCEAN

The Statewide MPA Monitoring Program takes an ecosystem-based approach that evaluates the condition of California's coastal and marine ecosystems, and how they change through time. Monitoring is conducted by academic scientists, community or citizen scientists, fishermen, government agencies (federal, state, local, and tribal), and non-profit organizations.

Key aspects of an ecosystem are identified that give a complete picture of the health of an ecosystem when measured together. For example, by monitoring species at the top of the food web, such as seabirds, scientists can draw conclusions about the status of plants or forage fish they depend on, and thus of the ecosystem as a whole. Human activities are indicators, too. For example, by surveying where people are fishing and what is being fished, and tracking both factors over time, scientists and resource managers can evaluate the influence and socioeconomic effects of MPAs on particular fisheries.

### EVALUATING MPA DESIGN AND MANAGEMENT DECISIONS

Many decisions went into creating California's network of MPAs: How big should they be? How far apart? What activities should be allowed within their boundaries? MPA monitoring in California explicitly considers how these decisions affect marine life and human activities. Understanding how ecosystems respond to MPAs can help inform the State's adaptive management process to learn and evaluate whether individual MPAs, and the network as a whole, are making progress towards meeting the goals of the MLPA.

### CALIFORNIA'S APPROACH: A NEW FRAMEWORK, IMPLEMENTED IN TWO PHASES

California adopted a two-phase approach to MPA monitoring to track the ecological and socioeconomic conditions in and around the network of MPAs.

#### **Phase 1: Regional Baseline Monitoring**

At or near the time of MPA implementation in each coastal region, California initiated baseline monitoring to establish a regional benchmark of ecological and socioeconomic conditions, and document any initial changes resulting from MPA implementation. Funded by the State through a \$16 million investment (\$4 million per region), baseline monitoring serves as an important set of data against which future conditions can be measured.

#### **Phase 2: Statewide Long-Term Monitoring**

As regional baseline monitoring is completed, the State is designing and implementing long-term statewide monitoring. The State has committed an annual General Fund allotment of \$2.5 million for statewide monitoring which began in 2016. An Action Plan (see page 26), which will guide long-term monitoring and future spending of Phase 2 activities, will be released in 2018. With an efficient long-term monitoring approach, California will provide access to data that support near- and long-term decisions regarding adaptive management of coastal and marine ecosystems.

### LEARN MORE: *Setting the Scene*

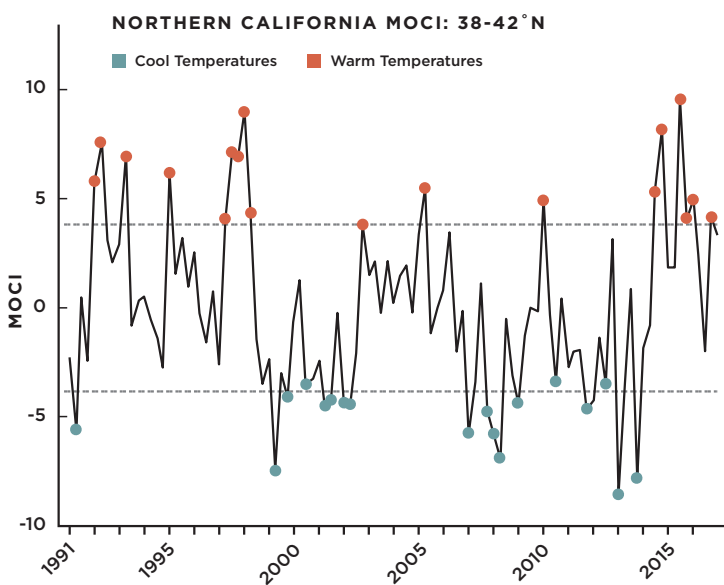
- 1. MPA Management Program, brochures and maps:**  
[goo.gl/52N9Nx](http://goo.gl/52N9Nx)
- 2. 2016 Master Plan (and references therein):**  
[goo.gl/BYg7Ap](http://goo.gl/BYg7Ap)
- 3. MPA research and monitoring:** [goo.gl/wHkFD9](http://goo.gl/wHkFD9)
- 4. MPA Statewide Leadership Team and Partnership Plan:**  
[goo.gl/pG03yv](http://goo.gl/pG03yv)
- 5. State Parks Online Resources for Teachers and Students:**  
[ports.parks.ca.gov](http://ports.parks.ca.gov)
- 6. MPA Collaborative Network:** [mpacollaborative.org](http://mpacollaborative.org)

## PHYSICAL OCEAN CONDITIONS

Oceanographic conditions can vary widely due to multi-year cycles such as El Niño and the Pacific Decadal Oscillation. Variations also occur on shorter timescales both seasonally and annually due to natural fluctuations in wind and other forcing mechanisms which affect currents, temperature, upwelling, and freshwater input. These factors can have profound impacts on the marine algae, plants, and animals that call this region home, as well as the humans who are part of, visit, and depend on these important ecosystems. Considering these fluctuating environmental conditions during the baseline period is essential to understand ecological changes inside and outside regional MPAs over time.

### DETECTING REGIONAL PATTERNS

Researchers compiled and synthesized a suite of long-term oceanographic and atmospheric measurements (1991-2016) to provide historical perspective on conditions occurring during the baseline period.<sup>1</sup> From these data, researchers derived a seasonal indicator called Multivariate Ocean Climate Indicator (MOCI), which provides regional-scale information on whether the marine environment is tending towards warmer, less productive conditions or cooler, more productive conditions. The data capture coherent patterns across the region and show the intensity of the unusual conditions that occurred during the baseline study period.



Multivariate Ocean Climate Indicator (MOCI) for the North Coast of California. Red points indicate warmer than usual temperatures and weak upwelling, blue points indicate unusually cool temperatures and strong upwelling. Source: figure adapted from the oceanographic baseline report.<sup>1</sup>

### THE NORTH PACIFIC MARINE HEATWAVE

Oceanographic conditions along the North Coast from mid-2014 through at least early 2016 were marked by unusually warm ocean conditions. Changing upwelling dynamics, unusual heat fluxes, and offshore warm water masses led to the North Pacific Marine Heatwave, which has no analog in the historical record. The atmospheric dynamics that gave rise to the marine heatwave also contributed to drought conditions in California.

These anomalous conditions contrast starkly from previous years, and resulted in persistently warmer than usual temperatures in the coastal ocean, and an unprecedented harmful algal bloom. This bloom produced high domoic acid concentrations that directly affected Dungeness crab<sup>2</sup> and bivalve fisheries, and pervaded even the highest trophic levels of the CCLME (e.g. domoic acid poisoning deaths of California sea lions). These unusual conditions have important consequences for larval transport, nutrient supply, productivity, plankton communities, and ecosystem structure in the nearshore environment.

### ENVIRONMENTAL CONTEXT

Despite the unprecedented North Pacific Marine Heatwave, analysis of spatial patterns in the data suggest a relatively consistent alongshore structure and seasonal pattern of regional oceanographic conditions in terms of where fronts (strong temperature gradients) and areas of relative high productivity (imperfectly indexed chlorophyll concentrations) are located. Analyses of regional and local conditions suggest that this spatial structure was not substantially disrupted by anomalous events, even though the average conditions changed dramatically.

Accounting for oceanographic conditions through ongoing large-scale and local measurements provides a strong foundation to enhance our understanding of ecological patterns emerging from baseline monitoring and beyond. The Central and Northern California Coastal Ocean Observing System (CeNCOOS) works closely with partners, researchers, and managers to track these oceanographic conditions.<sup>3</sup>

### LEARN MORE: *Physical Ocean Conditions*

- 1. Oceanographic Baseline Report:**  
[goo.gl/qCwZkM](http://goo.gl/qCwZkM)
- 2. DFW Dungeness Crab Fishery Spotlight:**  
[oceanspaces.org/nc-cdfw-crab](http://oceanspaces.org/nc-cdfw-crab)
- 3. CeNCOOS:** [cencoos.org](http://cencoos.org)



## ESTABLISHING A BENCHMARK

### North Coast Baseline Monitoring

Marine ecosystems change over time, and these changes are driven by multiple factors. Baseline monitoring at or near the time of MPA implementation creates an important benchmark of ecological and socioeconomic conditions in the region essential to track any potential MPA effects over time. Data and results from baseline monitoring will not only inform long-term MPA monitoring and adaptive management decisions, but also other management priorities such as fisheries, water quality, and climate change adaptation.

In the North Coast, 11 baseline monitoring projects—selected through a competitive process that included a peer review of all proposals—covered a range of ecosystems and human activities in the region. Academic,

government, and citizen scientists, as well as tribes, fishermen, and volunteers, worked collaboratively to gather baseline data in the North Coast. Following MPA implementation, baseline projects were selected in 2013, and each project collected data for 1 to 3 years between 2013 and 2016. Final baseline technical reports were completed by spring of 2017. The suite of data collected throughout the baseline study period provide the first thorough characterization of ecological and socioeconomic conditions of the region.



## North Coast MPA Baseline Monitoring Projects

### ESTUARINE ECOSYSTEMS

A team of academic and tribal government scientists, non-profit partners, and ecological consultants surveyed plants, invertebrates, and fishes in tidal mudflats and eelgrass beds in four North Coast estuaries.

[goo.gl/qCwZkM](https://goo.gl/qCwZkM)

### SANDY BEACH AND SURF-ZONE ECOSYSTEMS

A team of academic, tribal government, and citizen scientists, and commercial and recreational fishermen surveyed sandy beaches and adjacent surf-zone ecosystems inside and outside of MPAs to identify the connections between beach and surf-zone organisms and nearby ecosystems.

[goo.gl/WV9N88](https://goo.gl/WV9N88)

### ROCKY INTERTIDAL ECOSYSTEMS

A team of marine ecologists and tribal government scientists surveyed invertebrates, algae, and fishes inside and outside MPAs in rocky intertidal habitats along the coast.

[goo.gl/9yAuu5](https://goo.gl/9yAuu5)

### ROCKY REEFS AND KELP FOREST ECOSYSTEMS: CITIZEN SCIENCE

A network of highly-trained and tested volunteer divers quantified physical habitat, fish, algae, and invertebrates in kelp forest and shallow rocky reef ecosystems in MPAs and associated reference sites.

[goo.gl/3koiaB](https://goo.gl/3koiaB)

### ROCKY REEFS AND KELP FOREST ECOSYSTEMS

Using boats to survey offshore, a team of research divers and commercial urchin fishermen quantified fish, algae, invertebrates, and physical habitat on shallow rocky reefs and kelp forests inside and outside MPAs.

[goo.gl/PfSvm2](https://goo.gl/PfSvm2)

### NORTH COAST OCEANOGRAPHIC CONDITIONS

Researchers compiled and analyzed oceanographic and atmospheric data to depict ocean conditions along the North Coast relevant to understanding the regional biological variability.

[goo.gl/dTDh2q](https://goo.gl/dTDh2q)

### ROCKY REEF NEARSHORE FISH COMMUNITIES

In this collaborative fisheries project, a team of scientists, CPFV captains, and volunteer anglers quantified the diversity, abundance, movement, and size structure of rocky reef-associated fish communities along the North Coast.

[goo.gl/Kn1dtn](https://goo.gl/Kn1dtn)

### NEARSHORE SEABIRD DYNAMICS

A team of academic and citizen scientists, federal wildlife officials, and a private research center evaluated seabird use of nearshore habitats to breed, roost, and forage inside and outside MPAs.

[goo.gl/AQVy95](https://goo.gl/AQVy95)

### MID-DEPTH AND DEEP SUBTIDAL ECOSYSTEMS

Researchers led a project that used a remotely operated vehicle (ROV), equipped with video and still cameras, to quantify fish and invertebrates over mid-depth rock, soft bottom subtidal, and deep ecosystems within MPAs and associated reference sites.

[goo.gl/jc1Koa](https://goo.gl/jc1Koa)

### TRADITIONAL ECOLOGICAL KNOWLEDGE

Tolowa Dee-ni' Nation, in partnership with the InterTribal Sinkyone Wilderness Council, Cher-Ae Heights Indian Community of the Trinidad Rancheria, and the Wiyot Tribe, developed a project incorporating TEK, encompassed by the project researchers' preferred term of T/ITK, to enhance the characterization of ecologically and biologically important species within sandy beach, rocky intertidal, kelp, and mid-depth rock ecosystems.

[goo.gl/6wFdo5](https://goo.gl/6wFdo5)

### SOCIOECONOMICS OF FISHERIES

Social science researchers conducted a socioeconomic survey and developed estimates of the quantity, spatial distribution, and economic value of human activities in the North Coast, including commercial fishing and commercial passenger fishing vessel activity.

[goo.gl/84vdo3](https://goo.gl/84vdo3)

# HUMAN ACTIVITIES IN THE NORTH COAST

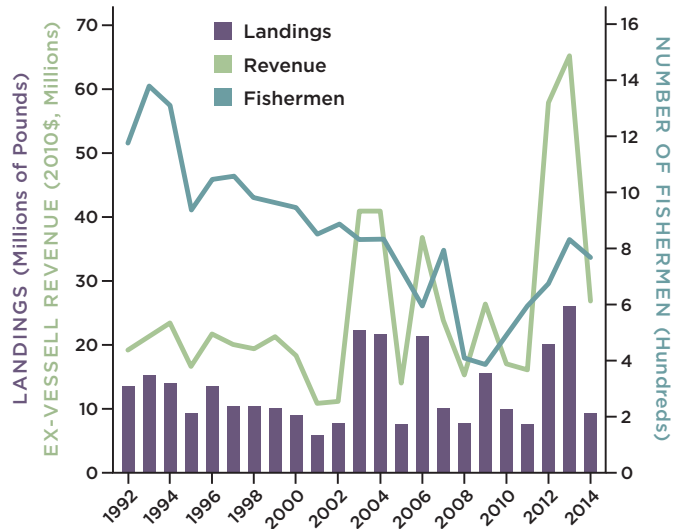
## North Coast Fisheries

Commercial and recreational fisheries have long been part of the local economy in the North Coast region. To help establish a benchmark of human uses and socioeconomic conditions for the region, baseline research assessed the status and trends of commercial and recreational fishing activity. These data represent a benchmark of information on initial changes, but longer-term studies will be needed to understand any possible MPA effects. However, initial changes and perceptions following MPA implementation for both recreational and commercial fisheries are explored in more depth later in the document (page 24).

### COMMERCIAL FISHING

Humboldt State University (HSU) and Ecotrust researchers used landings data from DFW to characterize the status of commercial fishing from 1992 to 2014 (reporting period), and explore historical economic trends in the North Coast commercial fisheries of interest (FOIs): Dungeness crab, nearshore finfish, salmon, and urchins.<sup>1</sup>

Researchers found that the number of North Coast commercial fishermen participating in the FOIs has on average been declining, with a reported 770 North Coast commercial fishermen active in the FOIs in 2014. While this is approximately 65% fewer fishermen than in 1992, activity has increased recently with participation up approximately 50% from a regional low in 2009.



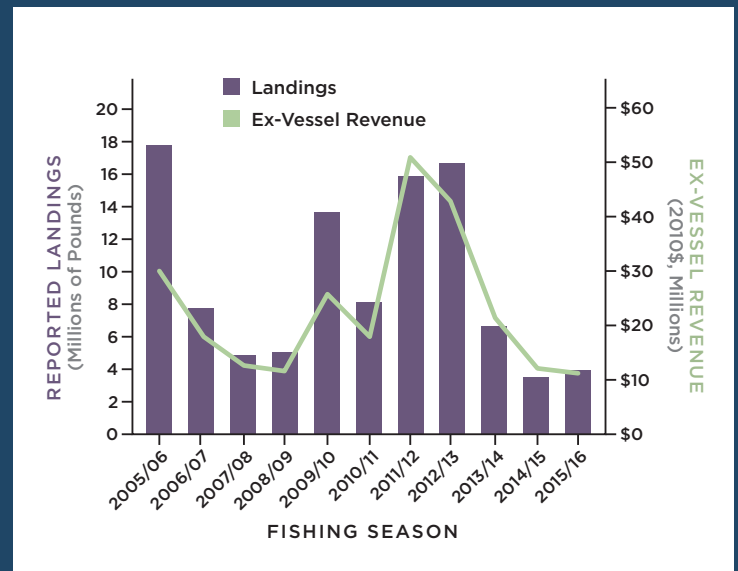
North Coast region commercial landings, ex-vessel revenue (adjusted for inflation to reflect 2010\$), and number of fishermen, fisheries of interest, 1992-2014. Source: socioeconomic baseline report<sup>1</sup> using DFW data.

While overall pounds of fish landed and ex-vessel revenue (price per pound paid to fishermen upon landing of catch) fluctuated throughout the reporting period, both have displayed a modest upward trend in recent years. Dungeness crab was the dominant FOI for both pounds landed and ex-vessel revenue, averaging 71% and 79% of the total landings and total ex-vessel revenue, respectively.

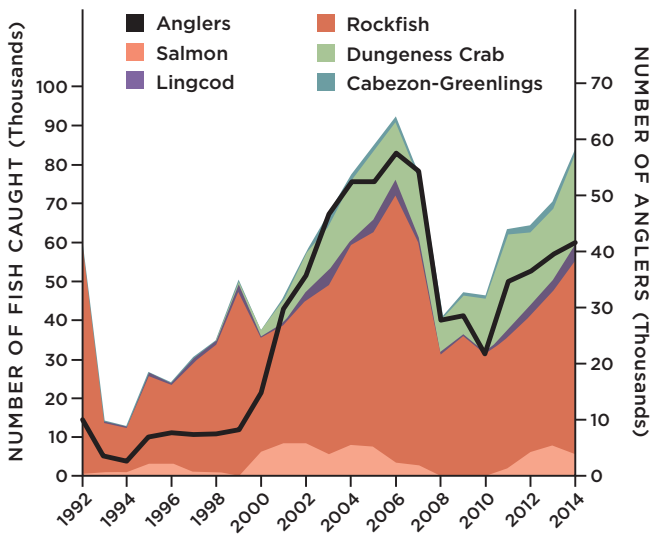
## CALIFORNIA'S DUNGENESS CRAB FISHERY

The Dungeness crab commercial fishery is iconic in the North Coast, and one of the oldest, most lucrative fisheries in the state. The State Legislature has regulated the commercial fishery since 1895, and California's management efforts are coordinated with Oregon and Washington. Due to shifts in oceanographic conditions, Dungeness crab populations typically exhibit natural fluctuations in abundance, aggregation locations, and time of molting. The cyclical nature of crab populations, as well as changes in fishing effort, can drive variations in landings and ex-vessel revenue from season to season.<sup>2</sup>

The North Coast fishery experienced several notable events between 2005 and 2016 that demonstrate this cyclical pattern. The 2005/06, 2011/12, and 2012/13 seasons exhibited higher than usual reported catch and ex-vessel revenue, while both sharply decreased from 2013 to 2016. The 2015/16 season was severely delayed, after a massive harmful algal bloom associated with the North Pacific Marine Heatwave caused dangerous levels of domoic acid build-up in crabmeat and viscera, making the crab unsafe for human consumption.



Reported California Dungeness crab commercial landings and ex-vessel revenue (adjusted for inflation to reflect 2010\$) from 2005/06-2015/16 fishing seasons for ports located in the North Coast MPA region. Data source (extracted June 2017): California Fisheries Information System, DFW.



Average number of anglers and total number of fish caught for each fishery aboard CPFVs, 1992-2014. Source: socioeconomic baseline report<sup>1</sup> using DFW data.

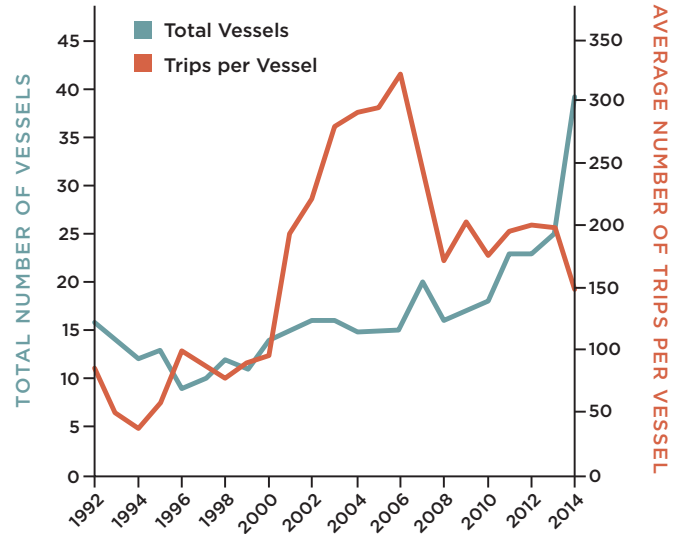
### COMMERCIAL FISHING ECONOMY

In 2014 total FOI ex-vessel revenue was \$26,890,974, while the total estimated income for all businesses in the region was approximately \$5.6 billion.<sup>1</sup> While direct income from commercial fishing makes up <1% of the region's total, commercial fishing has a major role in the regional port economies. Commercial fishing generates "multiplier effect" jobs and income for other resources such as bait, ice, fuel, repair and essential support for maintenance of marina and port infrastructure.

### RECREATIONAL FISHING

Researchers characterized CPFVs, or party boats, by examining DFW logbook data from 1992 to 2014 (reporting period).<sup>1</sup> North Coast CPFV operators generally targeted rockfish, lingcod, and salmon, with rockfish, Dungeness crab, and salmon dominating their catch. On average, 28,235 anglers took 2,934 trips per year aboard CPFVs.

The total number of CPFVs working in the North Coast increased steadily from a low of nine vessels in 1996 to a high of 39 vessels in 2014. The average number of trips per CPFV generally increased until 2006 where it peaked at an average of 324 trips per CPFV. Starting in 2007, the average annual number of trips per CPFV dropped steeply (except in 2009) and continued declining through the end of the reporting period.



Total number of CPFVs and average number of trips per vessel in the North Coast, 1992-2014. Source: socioeconomic baseline report<sup>1</sup> using DFW data.

The decline in the number of trips per vessel coincides with an increase in the total number of CPFVs beginning in 2008. Additionally, the decline in average CPFV trip number coincides with the global financial economic crisis beginning in 2007, as well as the emergency salmon fishing closures in 2008 and 2009. The salmon closure decreased the number of anglers, trips, and fish caught during those years. After the salmon season reopened the number of anglers, trips, and fish caught increased, but have not reached pre-closure levels.

### RECREATIONAL ABALONE HARVESTING

DFW currently uses the Abalone Recovery Management Plan (ARMP)<sup>3</sup> to manage the State's seven abalone species. North of the Golden Gate Bridge, red abalone comprise the only remaining active abalone fishery in California. Following a catastrophic mix of ocean conditions beginning in 2011, northern California red abalone populations have been declining.<sup>4</sup> DFW made several management recommendations to the FGC, based on the ARMP guidelines to mitigate the impacts to the fishery. Some of the implemented management actions included: 1) an emergency closure, 2) reducing allowed catch, and 3) establishing a daily start time. The regulatory timeline provides more details on FGC actions (see pages 7-8).

#### LEARN MORE: *Human Uses*

1. **Human Uses Baseline Report:**  
[goo.gl/NuMii5](http://goo.gl/NuMii5)
2. **DFW Dungeness Crab Fishery Spotlight:**  
[oceanspaces.org/nc-cdfw-crab](http://oceanspaces.org/nc-cdfw-crab)
3. **Abalone Recovery Management Plan:**  
[goo.gl/UHgvqk](http://goo.gl/UHgvqk)
4. **DFW Abalone Fishery Spotlight:**  
[oceanspaces.org/nc-cdfw-abalone](http://oceanspaces.org/nc-cdfw-abalone)
5. **DFW Commercial Finfish Spotlight:**  
[oceanspaces.org/nc-cdfw-finish](http://oceanspaces.org/nc-cdfw-finish)
6. **DFW Mapping CRFS Catch Rates:**  
[oceanspaces.org/nc-cdfw-crfs](http://oceanspaces.org/nc-cdfw-crfs)





## NEARSHORE ECOSYSTEMS

### Sandy Beaches

Sandy beaches are usually easily accessible, natural places where people visit and recreate. However, they are often overlooked as important ecosystems that provide vital foraging habitat for invertebrates, shore birds, and surf-zone fishes. During ecological surveys of sandy beaches, researchers observed over 70 invertebrate and 68 bird species.<sup>1</sup> On the northern California coast, small pocket beaches (<1 km of shoreline extent) are common, but they differ in the abundance and diversity of invertebrates and birds that use them, compared to longer sandy beach ecosystems (>1 km of shoreline extent) that occupy more of the coastline in the region. Ecologically important sandy beach habitat makes up about one-third of the coastline in the North Coast, of which approximately 11% is protected within all North Coast MPAs and approximately 4% is protected within North Coast SMRs.

#### TROPHIC RELATIONSHIPS

Sandy beaches are connected to other coastal ecosystems, such as kelp forests, rocky reefs, and the nearshore ocean. When drift algae, kelp, and seagrasses wash ashore from these nearby ecosystems, forming beach wrack, a

diverse community of intertidal invertebrates responds to this imported subsidy. On beaches where fresh wrack accumulates, invertebrates such as talitrid amphipods or “beach hoppers” are more abundant. The wrack fuels a rich beach food web, attracting invertebrates that provide a vital food source for wintering and migratory shorebirds and terrestrial birds.

Similarly, intertidal suspension feeders, such as sand crabs, which sieve plankton from the wave wash with their feathery antennae, provide an important prey resource for both shorebirds and surfperch. On beaches where there were more sand crabs, shore-based anglers caught more redbait surfperch, a major predator of sand crabs.<sup>1</sup>

On long sandy beaches where shorebirds were abundant, sand crabs made up 78% of all the invertebrate biomass, while on pocket beaches sand crabs were only 2% of the biomass. In contrast, beach hoppers were 58% of the invertebrate biomass on pocket beaches where kelp wrack was abundant and shorebirds were scarce. However, they were less than 1% of the invertebrate biomass on longer sandy beaches.<sup>1</sup>

## Estuaries

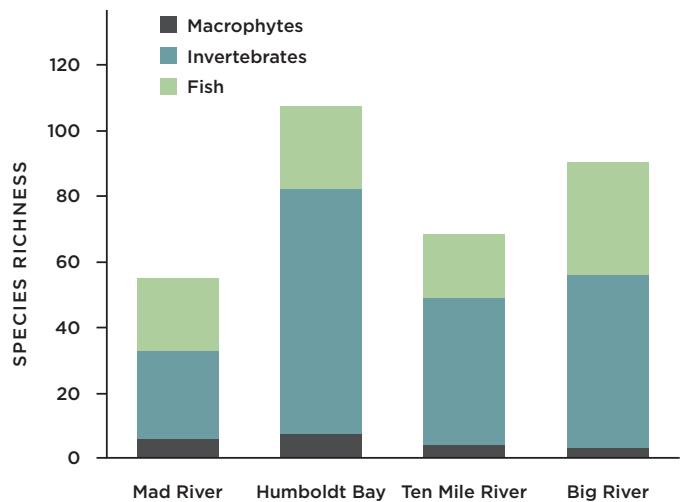
Estuaries are among the most productive and diverse ecosystems in the world. Along California's North Coast, estuaries range from brackish lagoons that breach every several years to embayments, like Humboldt Bay, that are dominated by oceanic conditions. These estuaries support important habitats such as eelgrass and salt marsh, provide key ecosystem functions such as nursery grounds for juvenile invertebrates and marine and anadromous fishes, and roosting and foraging sites for shorebirds, waterfowl, seabirds, and marine mammals.

### EVER-CHANGING ECOSYSTEMS

Researchers from HSU were the first in the state to study estuarine ecosystems as part of MPA baseline research. For the North Coast estuarine MPAs, almost all activities occurring in each estuary prior to the creation of the MPA were allowed to continue afterward, so there is little expectation of an MPA effect at this time. However, researchers did find North Coast estuaries to be complex and dynamic ecosystems, driven largely by oceanographic, watershed, and geomorphological conditions (i.e. salinity, degree of freshwater input, physical characteristics). The biodiversity displayed within the three studied North Coast estuarine MPAs likely represents only a small fraction of the overall estuarine biodiversity.<sup>2</sup>

Species richness was highest in Humboldt Bay, followed by Big River, Ten Mile River, and Mad River estuaries, respectively. However, the number of fish species was highest in Big River estuary, likely because the mouth of the estuary remains open to the ocean during summer

months unlike other river-dominated estuaries. Species of management interest, such as Dungeness crab, rockfish, salmonids, and eelgrass, were found in all estuaries studied; however, abundance and size patterns of each species fluctuated widely across years and sites. For example, eelgrass was abundant during 2014 in Humboldt Bay and Big River estuary but declined at both sites from 2015 to 2016. While the driving force behind this abundance change is still unknown, further monitoring could help explain the trend.



Species richness across four North Coast estuaries. Source: estuarine baseline report.<sup>2</sup>



### POTENTIAL INTERTIDAL IMPACTS OF THE NORTH PACIFIC MARINE HEATWAVE

Rockfish recruits, seen in the hundreds to thousands at several rocky intertidal sites in prior years, were noticeably absent during the study period. Warmer seawater temperatures and reduced coastal upwelling may have affected larval rockfish survival, movement patterns, or habitat usage.<sup>3</sup>

Starting in 2013, a disease known as “sea star wasting syndrome,” typically associated with warm water temperature events, caused a mass die-off of sea stars across the entire eastern Pacific. While the researchers in this study documented sea stars as present and healthy in some abundance during the summer of 2014, populations at these same sites had crashed by winter. Some recovery was evident by the following summer (2015), with a significant recruitment of small, young sea stars seen throughout the rocky outcroppings surveyed.



## Rocky Intertidal

Rocky intertidal ecosystems occur at the interface between the land and ocean, and represent one of the most diverse and well-studied marine habitats worldwide. On the North Coast, rocky intertidal habitats harbor species that are economically and culturally important to local communities. Although intertidal monitoring programs (i.e. Multi-agency Rocky Intertidal Network [MARINe]) existed in the region before MPA implementation, the MPA baseline monitoring project expanded monitoring site coverage and fostered new partnerships and projects unique to the North Coast.<sup>3</sup>

### BASELINE DIFFERENCES

Baseline monitoring results indicate that patterns of species diversity and habitat characteristics are divided into two bioregions, with the break occurring just south of Cape Mendocino near the southern end of the Lost Coast. Sites north of this break tended to have more complex rock habitat than southern sites.

The initial baseline surveys also show no significant difference in community composition of algae, invertebrates, and tidepool fishes between MPAs and reference sites. Researchers suspect that a biological response to protection will not be detectable for some time, but the similarity between MPAs and their nearby reference sites establishes a good baseline to detect any changes due to protection.

## Seabirds

California seabirds are long-lived, high level predators that are a crucial part of marine ecosystems. During the breeding season, many seabirds nest in colonies, usually

on rocks or small islands and forage in the waters adjacent to the colony, returning to their nests to incubate eggs or provide food to their young throughout the day. As such, they have limited flight distances from the colonies during nesting. MPAs and special closures can provide direct and indirect benefits to seabird colonies within MPA boundaries.

### NORTH COAST POPULATIONS

Counts of three easily observed seabird species, Common Murre, Brandt's Cormorant, and Double-crested Cormorant, revealed these individuals were spread across 32 distinct colonies, including six that are now in special closures and nine that are located in or immediately adjacent to SMRs or SMCAs. Long-term trends in Common Murre population size showed a pattern of increase throughout the North Coast.<sup>4</sup>

There were few human-caused disturbances observed during the baseline period, with the North Coast displaying the lowest disturbance rates among the other regions in the state. This is especially important considering some seabird species are known to be sensitive to human disturbance, and may abandon nesting sites if a threat is perceived.

### LEARN MORE: *Nearshore Ecosystems*

- 1. North Coast Sandy Beaches Baseline Report:**  
[goo.gl/UHgvqk](https://goo.gl/UHgvqk)
- 2. North Coast Estuarine Habitats Baseline Report:**  
[goo.gl/MT3pG9](https://goo.gl/MT3pG9)
- 3. North Coast Rocky Intertidal Baseline Report:**  
[goo.gl/Zu6gLB](https://goo.gl/Zu6gLB)
- 4. North Coast Seabirds Baseline Report:**  
[goo.gl/pwKn8s](https://goo.gl/pwKn8s)

## SUBTIDAL ECOSYSTEMS

### Kelp Forests and Rocky Reefs

The North Coast's nearshore rocky reefs are comprised of complex substrate from flat reefs and boulders, to rocky pinnacles and steep walls. Algae of all kinds grow on these rocky reefs, including those species that create kelp forests, which can extend all the way to the waters surface, from as deep as 17 meters (56 feet). These kelp forests and expansive reefs provide an intricate habitat that is utilized by many species of fish, invertebrates, sea birds, and marine mammals. This habitat also supports a wide variety of human activities, from fishing and sea urchin harvesting, to diving and watching marine life.

While these rocky reefs and kelp forest ecosystems are widely used and full of marine life, surveying this diverse subtidal habitat can be challenging. Two projects surveyed the North Coast rocky reefs using SCUBA: (1) One led by

HSU divers<sup>1</sup> and (2) the other by highly trained citizen science divers through Reef Check California (RCCA).<sup>2</sup> To characterize kelp forest communities along the North Coast, surveys assessed the abundance, size frequency and diversity of fish, invertebrates, and algae using comparable methods.

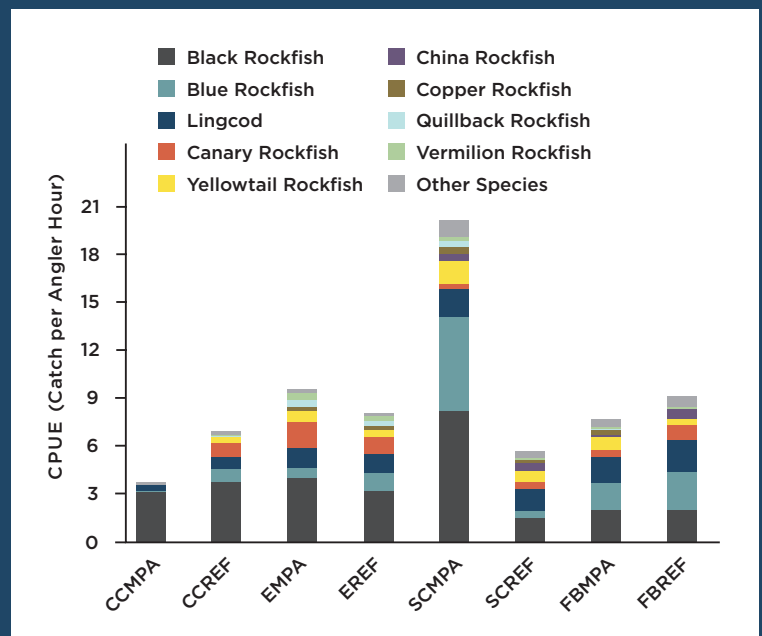
During the study period, kelps such as the canopy forming bull kelp and other understory species, were nearly absent from most reefs, as were important sea stars, such as the sunflower star and the giant spined sea star; red and purple sea urchins dominated the reefs at most sites. Black and blue rockfish were the most abundant fish species with black rockfish abundance decreasing north to south, and blue rockfish exhibiting the opposite pattern (figure on page 24.)

### COLLABORATIVE FISHING SURVEYS

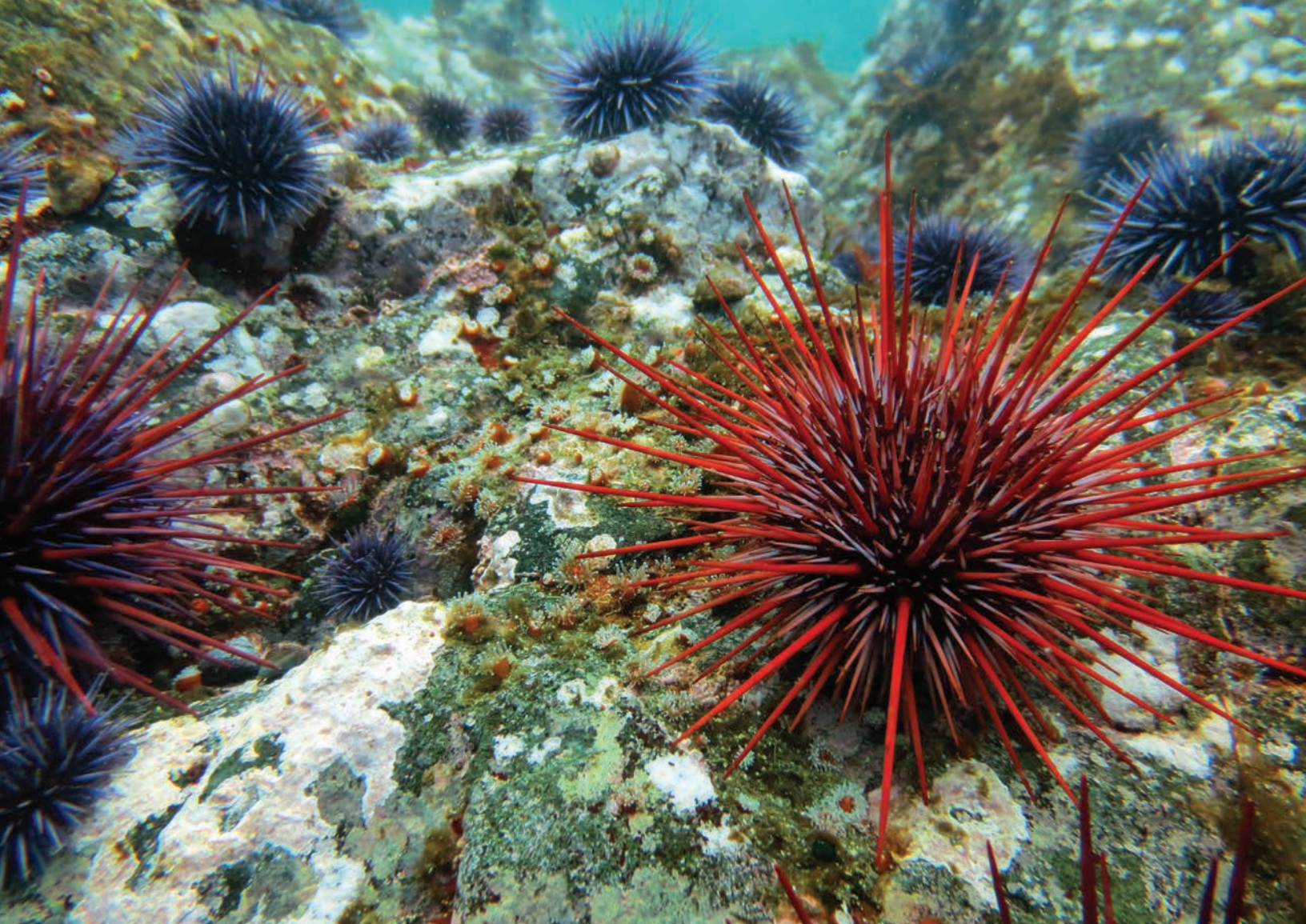
By combining the expertise of scientists with the experience and skills of the local fishing community, collaborative fishing surveys provide a unique opportunity to generate baseline data. Collaborative hook-and-line surveys were conducted in four MPAs: Pyramid Point SMCA, South Cape Mendocino SMR, Sea Lion Gulch SMR, and Ten Mile SMR. For each MPA surveyed, there was a nearby reference site also surveyed.<sup>3</sup>

Over 4,200 fish of 23 different species were caught, of which 3,491 fish were tagged. Catch was dominated by three species: black rockfish, blue rockfish, and lingcod, (39%, 19%, and 15% of the catch, respectively). The combined catch of all rockfish species accounted for 84% of the total catch. Although there were few tag returns (<1%) there is an emerging pattern of northward movement (>300 km) of black rockfish.

The survey identified differences in relative abundance and diversity within and between some pairs of MPA and reference sites. Researchers believe the current patterns in abundance can be explained by the historic levels of fishing pressure, not by the protected status, with locations closest to fishing ports having higher historic fishing effort, and therefore lower relative abundance.



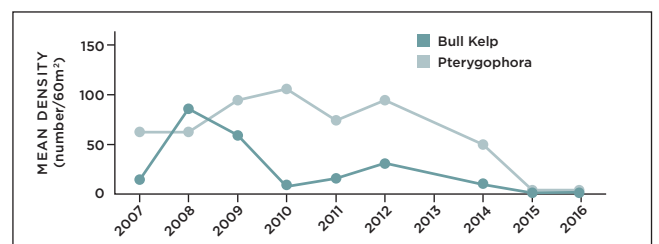
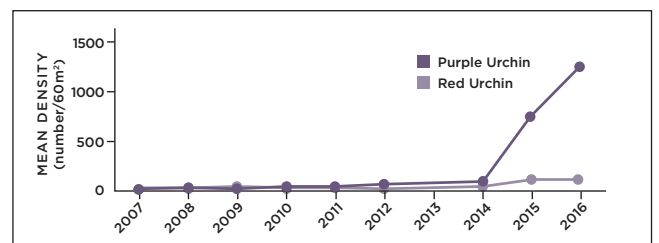
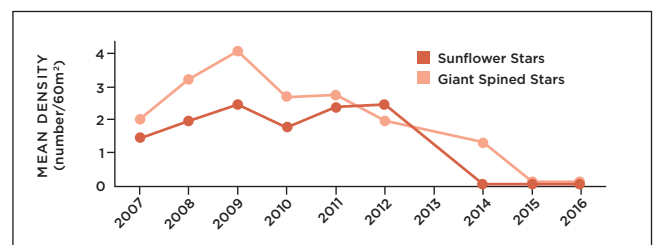
Comparison of relative abundance and species composition at each MPA and reference (REF) site. Catch per angler hour (CPUE) averaged over the 2014 and 2015 sampling seasons for the top nine most abundant species and all other species combined. CC: Crescent City; E: Eureka; SC: Shelter Cove; FB: Fort Bragg; RF: rockfish. Source: fishing survey baseline report.<sup>3</sup>



### IMPORTANCE OF LONG-TERM DATA

Long-term kelp forest monitoring data from RCCA reveals the massive changes that kelp forest communities experienced just prior to and during the study period. Before 2014, sea stars could be found throughout reefs in the region, urchins were present in low numbers, and kelps dominated the area, providing habitat for fish and invertebrates. During the study period, sea stars disappeared from these reefs, urchin populations increased 100-fold and formed urchin barrens at many sites, with little to no kelp or other algal species present. While algal and invertebrate abundances displayed marked changes during baseline monitoring, fish population densities resembled densities seen since 2007.

Panels show the changes in mean species' densities at three long-term RCCA North Coast monitoring sites (reference sites, Mendocino Headlands and Portuguese Beach, and MPA site, Van Damme) for important species of sea stars (top), sea urchins (middle) and kelps (bottom.) Source: RCCA baseline report.<sup>2</sup>





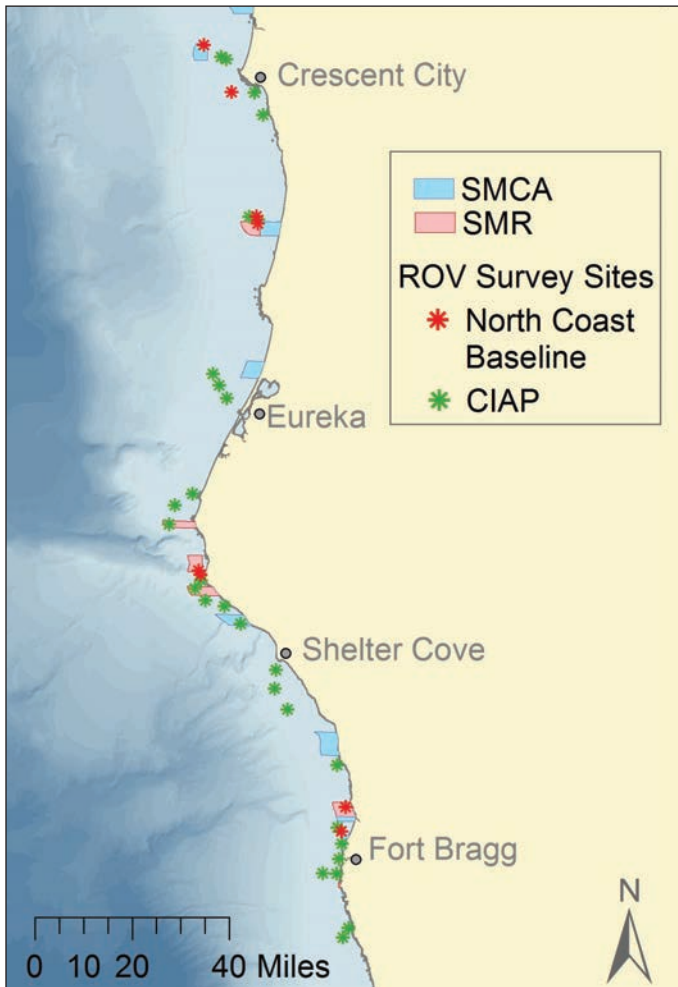
## Mid-Depth and Deep Ecosystems

Mid-depth and deep habitats occurring at depths greater than 30m are home to hundreds of species of fishes and invertebrates. These habitats are generally outside of SCUBA diving research depths, making it difficult to explore and study these areas. In order to characterize the baseline condition of these seldom studied ecosystems, an ROV was deployed in 2014 and 2015 to conduct visual surveys of mid-depth rocky reefs (30-100m), soft bottom subtidal ecosystems (30-100m), and deep canyon ecosystems (deeper than 100m).

### TWO PROJECTS, ONE GOAL

Marine Applied Research and Exploration's (MARE) ROV proposal was one of the 11 projects awarded funding to conduct baseline research on the North Coast.<sup>4</sup> A \$1.9 million grant awarded to DFW in 2014 from the Coastal Impact Assistance Program (CIAP) enabled DFW to conduct an extensive three-year ROV survey inside and outside MPAs across California in addition to the MARE baseline work.<sup>5</sup>

For a cost-efficient approach to monitoring, DFW collaborated with MARE to deploy MARE's ROV on a joint



25-day expedition along the North Coast. By combining MARE's baseline MPA monitoring surveys with the CIAP grant surveys, an additional 28 sites and three MPAs were added to the North Coast baseline's two-year survey of eight sites at four MPAs. This collaboration enabled DFW and MARE to maximize ship time and visit additional locations on the North Coast; most of which had never been visually surveyed before.

### FISH ASSEMBLAGES

Fish groupings across rocky reefs were dominated by rockfish (85% of the fish observed), with young-of-year (YOY) rockfish accounting for 60% of all observations; a stark contrast to observations in tidepools. Of the adult rockfish identified, blue, canary, and olive/yellowtail rockfish were the three species/groupings most commonly observed. The surveys also documented greater numbers and larger individuals of lingcod and yelloweye rockfish when compared to other parts of the State. On sandy bottoms, flatfish and unidentified smelt were the most commonly observed fish species.

Overall, fish species composition and density was similar between MPAs and affiliated reference sites, with one notable exception. Point St. George Reef Offshore SMCA had rockfish densities over three times greater than its reference site, and over twice as many yelloweye rockfish observed than at any other study area.

### INVERTEBRATE ASSEMBLAGES

Seven invertebrate species/groupings made up 89% of all observations, and included: white-plumed anemones, slipper and California sea cucumbers, short red gorgonians, California hydrocoral, sea stars, sea whips, and sea pens.

Similar to observations in shallower North Coast ecosystems, sea stars displayed considerable population declines associated with sea star wasting syndrome, even at great depths. During the 2014 surveys, active signs of the wasting syndrome were observed in several different species of sea stars; by the 2015 surveys, many of these species were observed in very low numbers, or not at all.

### LEARN MORE: *Subtidal Ecosystems*

- 1. HSU Kelp Forest Baseline Report:**  
[goo.gl/sm3nYP](http://goo.gl/sm3nYP)
- 2. RCCA Kelp Forest Baseline Report:**  
[goo.gl/tRMCrg](http://goo.gl/tRMCrg)
- 3. Collaborative Fishing Survey Baseline Report:**  
[goo.gl/uzm9JN](http://goo.gl/uzm9JN)
- 4. MARE ROV Baseline Report:**  
[goo.gl/qe9W11](http://goo.gl/qe9W11)
- 5. Summary of DFW ROV Monitoring:**  
[oceanspaces.org/nc-cdfw-rov](http://oceanspaces.org/nc-cdfw-rov)



## TRADITIONAL ECOLOGICAL KNOWLEDGE

### North Coast Tribal Communities

TEK, encompassed by the project researchers' preferred term of T/ITK, is the product of keen observation, patience, experimentation, and long-term relationships with the resources. While no single definition of TEK 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."<sup>1</sup>

The North Coast is home to many tribes and tribal communities who continue to practice their customary ways of living and carry out this unique epistemological approach. Three federally recognized Native American Tribes in California (Tolowa Dee-ni' Nation, Cher-Ae Heights Indian Community of the Trinidad Rancheria, and the Wiyot Tribe) as well as a consortium of ten federally recognized Native American Tribes in California, known as the InterTribal Sinkyone Wilderness Council, led a unique baseline project to incorporate T/ITK as part of understanding the historical and current ocean conditions in the region.<sup>2</sup> The project represents the first time T/ITK has been collected as part of baseline monitoring throughout the State.

### INVALUABLE INFORMATION

The project sought to highlight the types of information that T/ITK is able to provide, and document tribal community perspectives. Project leads coordinated 13 tribal communities in the compilation of T/ITK as it pertained to five keystone species (clams, mussels, smelt, abalone, and seaweed) and their associated ecosystems. The project's scope included the review of 120 pieces of archival materials held by individual tribal entities as well as literature held within other institutional archives (e.g. universities and libraries).

In addition, extensive interviews with 69 tribal members were conducted. Each interview encompassed a wide range of questions including temporal changes in presence of keystone species, perceptions of threatened areas along the North Coast, traditional stewardship practices, and feelings toward the MPA design and siting process and tribal take regulations.

#### LEARN MORE:

##### *Traditional Ecological Knowledge*

**1. Traditional Ecological Knowledge, Berkes 1999:**

[goo.gl/yRWpTi](https://www.google.com/search?q=googl/yRWpTi)

**2. Traditional Ecological Knowledge Baseline Report:**

[goo.gl/jFff1B](https://www.google.com/search?q=googl/jFff1B)

## EXPLORING CHANGES

The North Coast MPAs, as part of the statewide network, are designed to achieve the goals of the MLPA (see page 3). However, change happens slowly in temperate ocean ecosystems. For example, long-living and slow-maturing rockfish inhabit deep and shallow reefs, while algae and invertebrate populations on rocky shores fluctuate in response to wind, wave, and human disturbance. While significant changes in marine life populations were not expected to occur within five years of MPA implementation, some initial changes may provide early hints of how ecosystems may respond to protection in the future.

### SOCIOECONOMIC CHANGES

Some immediate socioeconomic changes due to MPA implementation can be expected as MPAs limit or prohibit the take of marine resources from within MPA boundaries, thereby changing patterns of fishing or harvesting. Detecting MPA effects on regional socioeconomics is more challenging because socioeconomic change occurs amid a wide array of cultural, political, economic, and environmental factors. Data presented here represent initial impressions and changes, but more time is required to establish firm links between MPAs and broad scale socioeconomic changes.

#### Commercial Fishing

Following extensive outreach and engagement with North Coast fishermen, researchers from HSU conducted in-person interviews with 163 commercial fishermen to gather post-MPA socioeconomic baseline information.<sup>1</sup> Of those commercial fishermen interviewed, 73% stated that MPAs had directly affected their fishing, with the most frequently cited effect of MPA implementation being that they cannot fish in (or go to) traditional fishing grounds. Despite this, nearly 66% of respondents reported no change to recent fishing income following MPA implementation (other responses almost equally reported increases or decreases).

#### Recreational Fishing

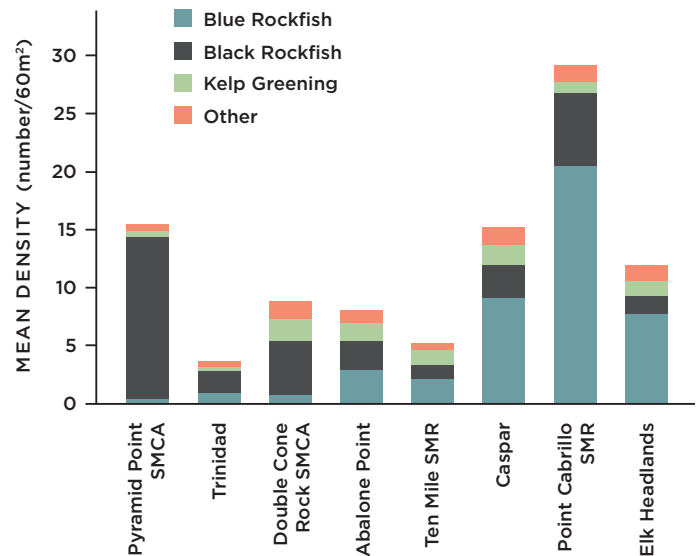
HSU researchers also conducted in-person interviews with 15 CPFV operators to gather post-MPA recreational socioeconomic baseline information.<sup>1</sup> CPFV operators indicated that MPAs had directly affected their operations for the rockfish/lingcod fishery the most. When targeting these species, 79% of CPFV operators reported they could no longer fish in traditional grounds, and nearly 43% indicated having to travel longer distances to fish. Other fisheries targeted by CPFV operators were not nearly as impacted, with less than 28% of CPFV operators indicating MPAs affecting other targeted fisheries. Akin to commercial fishing, CPFV operators generally did not report changes to their annual operating income before and after MPA implementation.

## ECOLOGICAL CHANGES

By reducing fishing pressures, MPAs can lead to increases in the abundance and size of some fish and invertebrate species. Not all species should be expected to respond equally to MPA implementation, nor at the same rates, and these changes may take several years to develop. Detecting changes in species abundance or size in the first five years following MPA implementation is therefore unlikely, but long-established MPAs in the region may be examples of what we might expect in the future as MPAs mature.

#### An Old MPA in the North Coast

Both HSU and RCCA projects surveyed Point Cabrillo SMR, an established MPA in the North Coast since 1975, which may provide a possible glimpse into the ecological changes associated with MPAs in the region. Since 1975, the commercial take of finfish and marine aquatic plants has been prohibited in the area. RCCA found fish within Point Cabrillo SMR to be larger than the same species in the surrounding areas, and fish biomass was higher at this site compared to other study sites.<sup>2</sup> The SCUBA divers from HSU observed nearly doubled abundances of fishes in Point Cabrillo SMR relative to nearby sites, particularly for commercially and recreationally fished rockfish species, along with significantly higher abundances of red sea urchins.<sup>3</sup>



Mean densities of the most abundant fish species counted at all sites. “Other” category includes Striped Surfperch, Lingcod, Cabezon, Painted Greenling, and Gopher, Vermilion, Black and Yellow, China, and Copper Rockfishes. Young of the year rockfish are excluded from data presented here. Adapted from HSU technical report.<sup>3</sup>

### LEARN MORE: *Exploring Changes*

1. **Human Uses Baseline Report:**  
[goo.gl/NuMii5](http://goo.gl/NuMii5)

2. **RCCA Kelp Forest Baseline Report:**  
[goo.gl/tRMCrg](http://goo.gl/tRMCrg)

3. **HSU Kelp Forest Baseline Report:**  
[goo.gl/sm3nYP](http://goo.gl/sm3nYP)



# INFORMING OCEAN MANAGEMENT DECISIONS

Coastal communities depend on the rich waters of the North Coast, as they sustain productive commercial and recreational fisheries, recreational activities, and tourism. The wealth of knowledge about this region from MPA monitoring is valuable for a wide range of resource management decisions, and results are broadly serving California.

## Changing Ocean Conditions

Climate change is impacting marine ecosystems on the North Coast as well as elsewhere in the State, by causing rising sea levels, warming water temperatures, and changes in ocean chemistry. These changes can affect the health and performance of North Coast ecosystems.

As exemplified by the impacts of the North Pacific Marine Heatwave (see page 12), warmer waters make it difficult for species that thrive in cool water temperatures to survive, such as canopy forming bull kelp. Warming waters may allow for northward range expansions of marine species. In the North Coast, at least one northward range expansion was documented for the Hopkins rose

nudibranch. Typically found in Southern California, and occasionally in Central California, this sea slug was commonly observed along rocky substrate during North Coast baseline monitoring. Rising sea levels are also expected to reduce the availability of coastal habitat for larval settlement, increasing the difficulty for algae, invertebrates, and marine plants to survive. Coastal California is already experiencing the early impacts of a rising sea level, including more extensive coastal flooding during storms, high tides, and increased coastal erosion.

MPAs are one tool resource managers can use that may help mitigate additional marine ecosystem stressors, and possibly serve as refugia for species threatened by these changes.

## Coupling Ocean Acidification and MPA Monitoring Programs

Ocean acidification (OA) refers to chemical changes that are occurring as increasing levels of carbon dioxide are dissolved into ocean and coastal waters. These changes result in increasingly acidic waters, which make it difficult

for calcifying organisms to form their shells, and affect the growth, survival, and behavior of marine species.

California already has some key efforts in place to address OA. In 2016, the West Coast Ocean Acidification and Hypoxia Science Panel released its major findings and recommendations to address OA.<sup>1</sup> California's Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) is leading an effort to develop updated indicators of climate change in California, including OA indicators.<sup>2</sup> OPC is leading efforts to develop an inventory of state and federal OA monitoring that will draw on the OEHHA indicators of climate change, and supporting work to incorporate OA monitoring into existing research and monitoring projects.

## Linking Natural Resource and Water Quality Management

Water quality information provides important context for understanding the drivers of ecosystem condition and for interpreting trends. In the 1970s, the State Water Resources Control Board (SWRCB) established water quality protection areas, called Areas of Special Biological Significance (ASBS), throughout California. Four of these ASBSs were established in the North Coast, and three overlap with North Coast MPAs, including Reading Rock SMCA, Sea Lion Gulch SMR, and Big Flat SMCA. Statewide, ASBS are monitored and maintained for water quality by the SWRCB. Partners, working with the Leadership Team,

are identifying opportunities to align monitoring programs for MPAs, water quality, and water quality protected areas like ASBS to leverage resources, capacity, and expertise.<sup>3</sup>

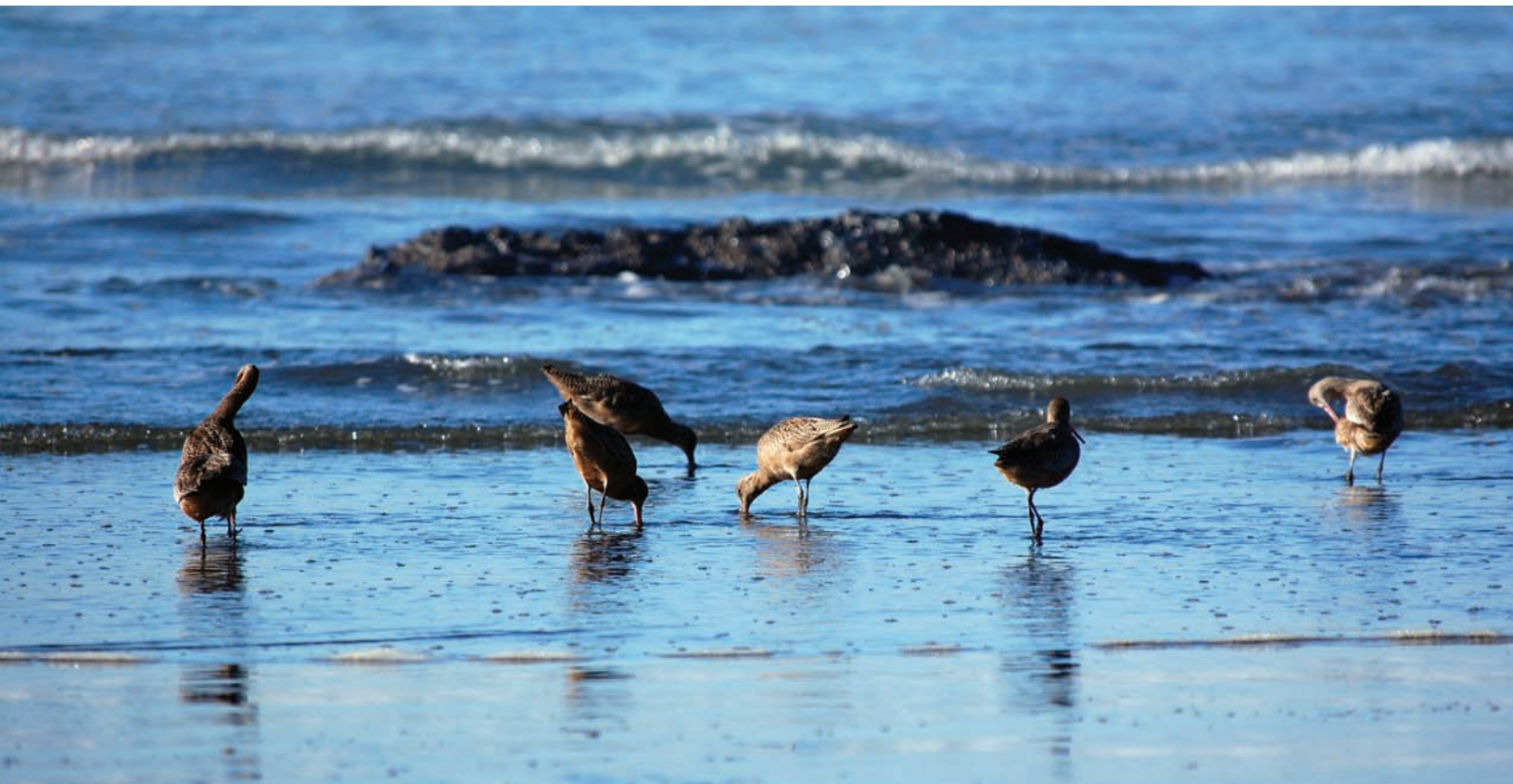
## Looking Forward

The State is currently developing quantitative and expert-informed approaches to long-term monitoring and will synthesize these approaches into the Action Plan.

The Action Plan will identify a priority list of indicators and sites for long-term monitoring to evaluate the performance of the MPA network at meeting the goals of the MLPA. The Action Plan will aggregate and synthesize work to date as well as contain more recent work that has developed quantitative approaches to siting and indicator selection. The Action Plan is expected to be released in 2018.

### LEARN MORE: *Informing Decisions*

- 1. OAH Panel major findings and recommendations report:**  
[westcoastoah.org/executivesummary](http://westcoastoah.org/executivesummary)
- 2. OEHHA Indicators of Climate Change in California report:**  
[goo.gl/h2M2Zn](http://goo.gl/h2M2Zn)
- 3. MPA Statewide Leadership Team:**  
[goo.gl/pG03yv](http://goo.gl/pG03yv)



## EXPANDING AVAILABLE DATA

### California Coastal Monitoring

Designed to identify the geographic and temporal coverage of monitoring activities in the North Coast, the North Coast Monitoring Survey provides a detailed picture of the current monitoring capacity in the region. The results help to identify the geographic and temporal coverage of monitoring activities inside and outside of the region's MPAs. The survey results are publicly available through an interactive dashboard, an online platform to learn and connect with the monitoring community.<sup>1</sup> Survey results will help DFW, OST, OPC, and other partners design and implement a partnership-based plan for cost-effective, long-term MPA monitoring, which will be guided by the Action Plan.

#### FISHERIES DATA EXPLORER

Ecotrust has developed an online data viewer to display reported commercial fisheries and CPFV data gathered statewide during baseline monitoring (1992-2014). This tool allows the public and researchers to view important data, such as number of fishermen, pounds of fish landed, and ex-vessel revenue from specific fisheries and ports, in a dynamic and on-demand way.<sup>2</sup>

#### CALIFORNIA NATURAL RESOURCES AGENCY OCEAN DATA CATALOG

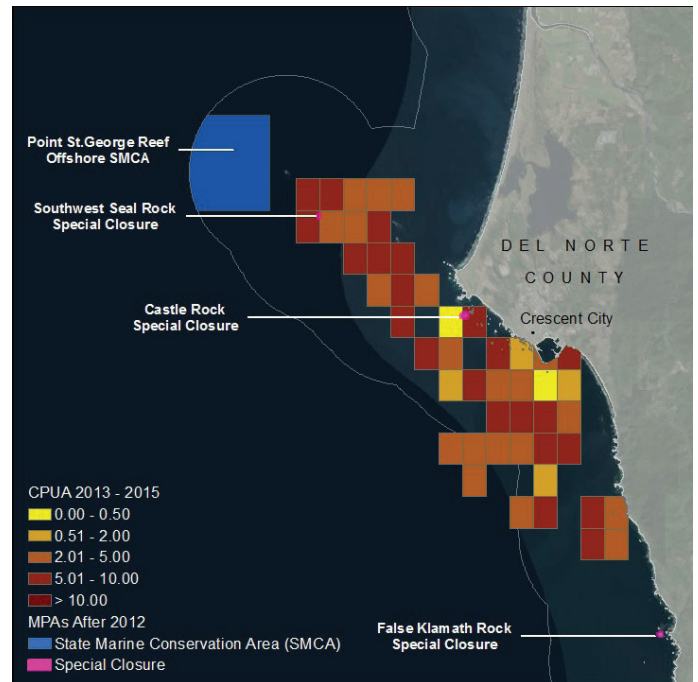
The California Natural Resources Agency (CNRA), which houses OPC, in partnership with DFW, will develop and provide access to an open source, data distribution system by 2018. The powerful system will aggregate data sources across disciplines and geographic areas to provide a comprehensive picture of marine ecosystems across California. The system will include, for example, baseline data sources, future long-term data sources, and intertidal and subtidal data sets that extend over a decade, among others. Almost all data, except those related to endangered species and those that can personally identify individuals, will be available to public users and decision makers via the web portal.

#### MAPPING CATCH RATES FROM THE CALIFORNIA RECREATIONAL FISHERIES SURVEY

DFW's California Recreational Fisheries Survey (CRFS) operates year-round statewide, to collect fishery-dependent data on California's marine recreational finfish fisheries. The survey data provide an estimate of recreational catch and effort over time across state marine waters, and is summarized by yearly catch per unit angler (CPUA) of reef dwelling fishes within standard one minute of latitude and longitude reporting blocks. Spatial representation of CPUA by private or recreational boat modes targeting common rocky reef dwelling species from 2006 to 2015 are published on MarineBIOS<sup>3</sup>, a DFW

hosted interactive web map with a variety of marine spatial planning map layers.

Catch of cabezon, greenling, lingcod and rockfish species were summed and attributed to standardized one minute latitude by one minute longitude cells (blocks) recorded during the CRFS dockside interview of anglers. The overall North Coast region-wide median CPUA for all blocks across all years is 4.67, which is comparatively high relative to catch rates in other coastal regions. For comparison, the South Coast median catch rate over the same period is 0.90, the Central Coast is 3.6 and the North Central Coast is 6.0. This northern regional catch rate suggests that catch efficiency and fishing success is rather good where fishing occurred. However, the aggregate rate does not detail how particular areas within the region are changing over time with respect to MPAs, other local scale influences, or how fishing success may shift spatially within the broader area. Further review of the mapped CPUA data on MarineBIOS may offer some additional details about fishing patterns.



Recreational catch per unit angler (CPUA) rates for popular reef dwelling fishes in the Crescent City area after MPA implementation (2013-2015). Source: DFW CRFS

#### LEARN MORE: *Expanding Data*

- 1. CA Coastal Monitoring Dashboard:**  
[tools.oceanspaces.org/dash#/welcome](https://tools.oceanspaces.org/dash#/welcome)
- 2. Ecotrust Fisheries Data Explorer:**  
[oceanspaces.org/fisheries-data-explorer](https://oceanspaces.org/fisheries-data-explorer)
- 3. MarineBIOS:**  
[map.dfg.ca.gov/marine](https://map.dfg.ca.gov/marine)

## Collaborators



## Species Names

COMMON NAME	SCIENTIFIC NAME
Abalone	<i>Haliotis</i> spp.
Albacore tuna	<i>Thunnus alalunga</i>
Beach hoppers	<i>Megalorchestia</i> spp.
Black rockfish	<i>Sebastes melanops</i>
Black and yellow rockfish	<i>Sebastes chrysomelas</i>
Blue rockfish	<i>Sebastes mystinus</i>
Brandt's Cormorant	<i>Phalacrocorax penicillatus</i>
Bull kelp	<i>Nereocystis luetkeana</i>
Cabezon	<i>Scorpaenichthys marmoratus</i>
California hydrocoral	<i>Sylaster californicus</i>
California sea cucumber	<i>Parastichopus californicus</i>
Canary rockfish	<i>Sebastes pinniger</i>
China rockfish	<i>Sebastes nebulosus</i>
Common Murre	<i>Uria aalge</i>
Copper rockfish	<i>Sebastes caurinus</i>
Double-crested Cormorant	<i>Phalacrocorax auritus</i>
Dungeness crab	<i>Metacarcinus (Cancer) magister</i>
Eelgrass	<i>Zostera marina</i>
Giant spined sea star	<i>Pisaster giganteus</i>
Gopher rockfish	<i>Sebastes carnatus</i>
Greenling	<i>Hexagrammidae</i>
Hopkins rose nudibranch	<i>Okenia rosacea</i>
Kelp crab	<i>Pugettia producta</i>
Kelp greenling	<i>Hexagrammos decagrammus</i>
Lingcod	<i>Ophiodon elongatus</i>

COMMON NAME	SCIENTIFIC NAME
Market squid	<i>Doryteuthis (Loligo) opalescens</i>
Mussels	<i>Mytilus</i> spp.
Olive/yellowtail rockfish	<i>Sebastes serranoides/flavidus</i>
Painted greenling	<i>Oxylebius pictus</i>
Stalked kelp	<i>Pterygophora californica</i>
Purple sea urchin	<i>Strongylocentrotus purpuratus</i>
Quillback rockfish	<i>Sebastes maliger</i>
Red abalone	<i>Haliotis rufescens</i>
Red sea urchin	<i>Mesocentrotus franciscanus</i>
Redtail surfperch	<i>Amphistichus rhodoterus</i>
Rockfish	<i>Sebastes</i> spp.
Salmon	<i>Oncorhynchus</i> spp.
Sand crab	<i>Emerita analoga</i>
Sea pen	<i>Pennatulacea</i>
Sea whips	<i>Halopteris californica</i>
Short red gorgonian	<i>Swiftia spauldingi</i>
Slipper sea cucumber	<i>Psolus chitonoides</i>
Smelt	<i>Osmeridae</i>
Spot prawn	<i>Pandalus platyceros</i>
Striped surfperch	<i>Embiotoca lateralis</i>
Sunflower star	<i>Pycnopodia helianthoides</i>
Surfperch	<i>Embiotocidae</i>
Vermilion rockfish	<i>Sebastes miniatus</i>
White-plumed anemone	<i>Metridium farcimen</i>
Yelloweye rockfish	<i>Sebastes ruberrimus</i>

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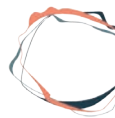
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