MPA MONITORING PLAN

December 2017

North Coast
MPA Monitoring Plan

Developed to meet the requirements of California's Marine Life Protection Act

December 2017

ACKNOWLEDGEMENTS

The North Coast Monitoring Plan was prepared by the California Department of Fish and Wildlife using templates from previous regional monitoring plans developed by the California Ocean Science Trust.

Many stakeholders from the North Coast region, together with scientists from California and elsewhere in the United States, contributed their time, knowledge, and experience. Staff from a variety of California orgranizations and institutions also provided information, expertise, and comment throughout the development of this plan, including the Fish and Game Commission, Ocean Protection Council, and the Ocean Science Trust.

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The California Department of Fish and Wildlife is the agency charged with managing the statewide MPA network. To find out more about California's MPA Management Program visit: www.wildlife.ca.gov/Conservation/Marine/MPAs

EXECUTIVE SUMMARY

The California Legislature passed the Marine Life Protection Act (MLPA, Chapter 10.5 of the California Fish and Game Code, §2850-2963) in 1999, requiring the State to redesign its pre-existing system of marine protected areas (MPAs) to function as a statewide network in order to increase its coherence and effectiveness at protecting marine life, habitats, and ecosystems. This was accomplished through four incremental science-based and stakeholder-driven regional MLPA planning processes spanning from 2004 to 2012. On December 19, 2012, 20 new or redesigned MPAs and 7 special closures were implemented in California's North Coast region. The North Coast region extends from the California/Oregon border south to Alder Creek, just north of Point Arena (Mendocino County), and encompasses approximately 892 square nautical miles of California's jurisdictional waters (0-3 nautical miles from shore) including offshore rocks. The protected areas in this region cover approximately 119 square nautical miles, or about 13 percent of Northern California waters.

The MLPA also required the California Department of Fish and Wildlife to develop a Master Plan[ES1] for MPAs that would guide the implementation of the MPA Management Program. The Master Plan needs to ensure that monitoring of MPAs is useful for adaptive management, and evaluates the MPA network effectiveness at meeting the goals of the MLPA. This Master Plan presents a statewide MPA monitoring framework that helps guide baseline MPA monitoring across the State including the North Coast region. The framework takes an ecosystem-based approach to encompass the breadth of ecosystems, including human uses in the region, and to help scientifically evaluate MPA design and management decisions. To date, the monitoring framework has guided baseline monitoring and the development of regional monitoring plans. Moving forward, it will inform the process of building out a more detailed Statewide MPA Monitoring Action Plan.

A set of 11 ecosystem features were initially chosen to collectively represent and encompass the North Coast region to help inform baseline and future MPA monitoring. These ecosystem features provide the focus for two core MPA monitoring elements: *assessment of ecosystem condition and trends*, and *evaluation of MPA design and management decisions*. Assessments of ecosystem condition and trends will enable tracking of the state of marine ecosystems, including human activities in the region, inside and outside the MPAs. Evaluations of specific MPA design and management decisions, such as MPA size and spacing, will examine the effects of these decisions on ecosystems, including socioeconomic and cultural uses, to measure the effectiveness of management actions. To interpret MPA monitoring results correctly, it will be important to consider other types of information, referred to as contextual information. This includes, for example, oceanographic, water quality, and economic information.

Each core element is designed to be adaptable to best fit with available resources and capacity at the time it is implemented and to facilitate development of partnerships to conduct and support monitoring. For example, two options have been included for monitoring ecosystem condition through time: *ecosystem feature checkups* and *ecosystem feature assessments*. The checkups are designed to be implemented through partnerships with citizen-science groups and community organizations, while the assessments are designed to take advantage of technically robust monitoring partnerships such as among state and federal agencies and with research institutions.

The North Coast MPA Monitoring Plan was developed to help inform future monitoring of MPAs established in California's North Coast region. Eleven 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 and provided the first thorough characterization of ecological, cultural, and socioeconomic conditions of the region. The North Coast Monitoring Plan reflects stakeholder input received during the MLPA Initiative Planning Process (planning process) and recommendations for monitoring key indicator species and ecosystem features put forth in the final baseline monitoring technical reports. This plan is a living document that will be updated through time as new information becomes available.

[ES1] DFW (2016). California's MLPA Master Plan for MPAs.

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1. Introduction

On December 19, 2012, 20 new or redesigned marine protected areas (MPAs) and 7 special closures were implemented in the North Coast region. This region is one of four coastal regions throughout California with new and redesigned MPAs. This was a step towards implementation of the 1999 California Marine Life Protection Act (MLPA, Chapter 10.5 of the California Fish and Game Code, §2850-2963). This Act directs the State of California to complete a statewide network of MPAs.

MPAs are a subset of marine managed areas (MMAs)[1]. However, throughout this document the more common term "MPA" is used as an umbrella to refer to all types of protected areas, and includes two MPA classifications (state marine reserve [SMR] and state marine conservation area [SMCA]), and one MMA classification (state marine recreational management area [SMRMA]). The special closure designation, which is not an MPA, is a relatively small, discrete, land-based area that contributes to the goals of the MLPA through protections complementary to MPAs.

The North Coast region extends from the California/Oregon border south to Alder Creek, just north of Point Arena, and encompasses California's jurisdictional waters up to 3 nautical miles from shore, including offshore rocks. The MPAs in this region cover approximately 119 square nautical miles, or about 13 percent of Northern California waters.

ROLE OF THE MONITORING PLAN

The purpose of the North Coast MPA Monitoring Plan (Monitoring Plan) is to inform future monitoring of MPAs in the North Coast region. The primary intended audiences are the California Fish and Game Commission (FGC), California Ocean Protection Council (OPC), and other state entities that have significant authority, mandates, or interests that relate to the MPA network, as well as existing and potential partners conducting monitoring and funding research.

The Monitoring Plan presents a framework for MPA monitoring (Figure 1-2)[2] and shows how that framework will be applied to the region, with adaptations and refinements as necessary to reflect the unique aspects of the region. It is not an implementation plan, meaning that it does not contain specifics such as exactly what will be monitored in which locations and when. However, it does provide guidance for making those decisions.

Guided by the Statewide MPA Monitoring Program, monitoring in the North Coast region and across the State is being implemented in two phases:

- Phase 1 – regional, baseline monitoring, which will conclude in early 2018; and
- Phase 2 – statewide, long-term monitoring, which will build on the foundation established through Phase 1.

Both phases are further described in subsequent sections.

The Monitoring Plan also provides a flexible and scalable approach for implementing monitoring, to make best use of available resources and potential partners. California is home to long-standing ecological monitoring programs that include university, local, state, tribal, and federal government programs, as well as citizen science programs. These ongoing monitoring programs, as well as extensive historical data sets (including those associated with fisheries, water quality, and other management mandates) offer the opportunity to develop cost-effective and efficient monitoring. This Monitoring Plan has been designed to facilitate a partnership-based and collaborative approach for implementing MPA monitoring.[3]

[1] DFW (2016). MLPA Master Plan for MPAs, Section 2.1.
[2] DFW (2016). MLPA Master Plan for MPAs, Appendix C, Section 5.2.
[3] Ocean Protection Council (2014). The California Collaborative Approach: Marine Protected Areas Partnership Plan.

This Monitoring Plan is a living document. Just as the MPAs will be managed adaptively, so should monitoring be evaluated and refined to ensure it continues to meet management needs. Monitoring should evolve as appropriate to reflect increasing knowledge and respond to changes in the environment or management priorities.

SCOPE OF THE PLAN

This plan considers all MPAs and special closures in the region, providing for monitoring inside and outside MPAs. The regional MPAs adopted by the FGC are comprised of MPAs of three different types (SMRs, SMCAs, and SMRMAs), plus additional special closures.[4] SMRs prohibit fishing and other extractive uses, while allowing research, education, and non-consumptive uses consistent with the protection of marine resources**.** SMCAs and SMRMAs allow a range of uses, including specified fishing and other extractive activities. Finally, special closures, which are not MPAs, are areas designed by the FGC that prohibit access or restrict boating activities in waters adjacent to seabird rookeries or marine mammal haul-out sites. Special closures are used by the FGC for relatively small, discrete areas to also contribute to the goals of the MLPA through protections complementary to MPAs. General definitions for these classifications of the protected areas adopted pursuant to the MLPA are described in detail in Table 3 of the 2016 Master Plan.

HOW THE PLAN WAS DEVELOPED

The North Coast Monitoring Plan was developed by the California Department of Fish and Wildlife (DFW), in collaboration with the OPC, to reflect management and community priorities, and ensure consistency with other regional monitoring plans previously developed by the OST and adopted by the FGC. From 2012 to 2013, OST and the DFW held informal gatherings and public workshops in the North Coast region to work with the local communities and understand stakeholder perspectives on and priorities for MPA monitoring. By March 2013, draft monitoring metrics for baseline characterization and assessment of initial ecological, socioeconomic, and cultural changes were identified in collaboration with the North Coast community.[5]

Baseline monitoring commenced in 2013 with 11 individual projects targeting the key habitats, socioeconomics, and cultural uses in the North Coast region. Project results helped inform North Coast monitoring priorities and this regional Monitoring Plan. In mid-2017, a first draft of the regional plan was developed and reviewed by the MPA Monitoring Program Team, which includes the DFW, OPC, and OST. This team performed a technical review of the monitoring metrics and the recommendations put forth in the baseline monitoring peer-reviewed technical reports. The team also reviewed the plan's alignment with the DFW's management priorities and policy mandates. A final draft of the Monitoring Plan will be presented to the FGC in 2018.

[4] Definitions of each MPA classification are available on the DFW website.

[5] OST, DFW, OPC, and CASG (2013). *Request for Proposals: North Coast MPA Baseline Program, Appendix 1.*

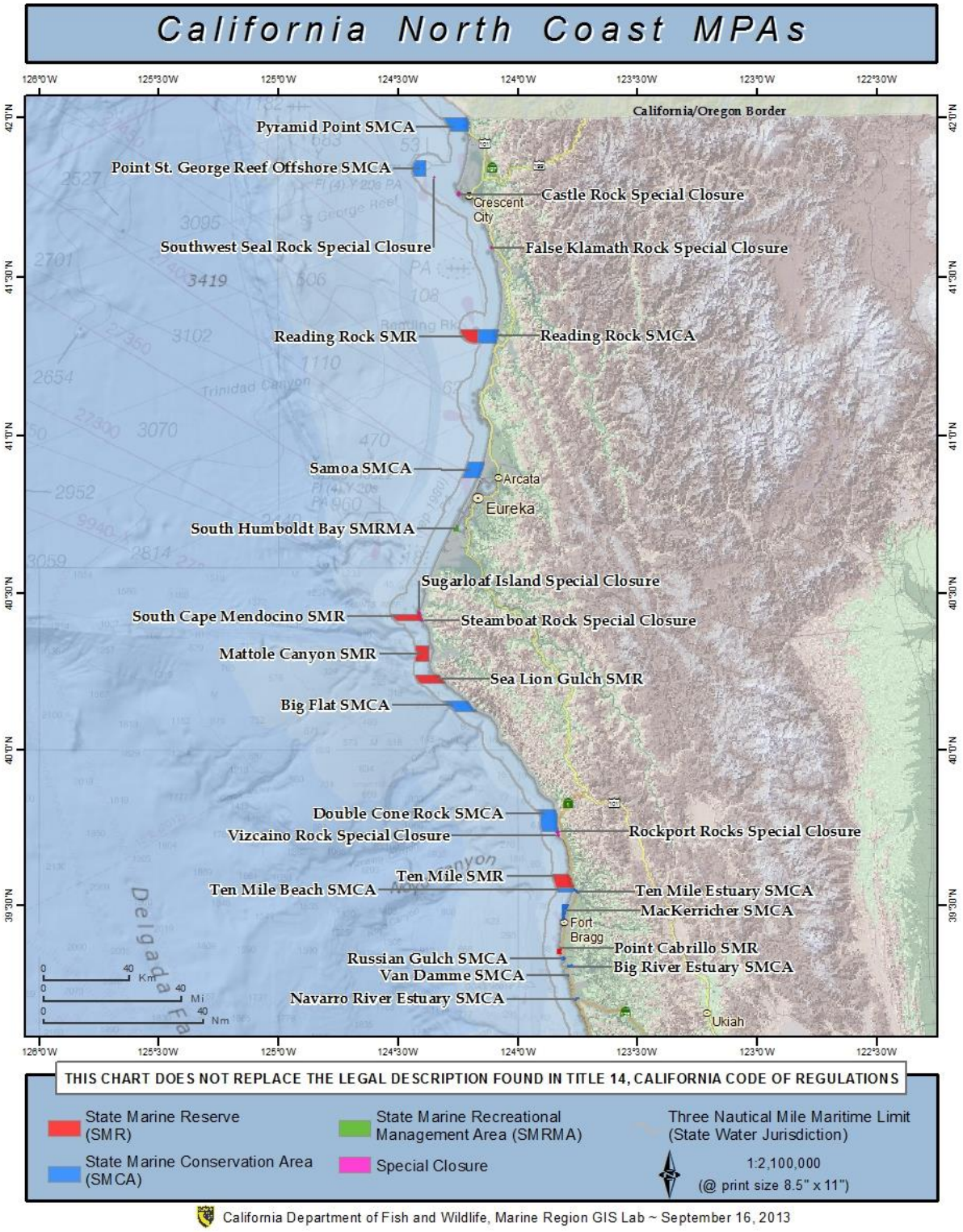


Figure 1-1. *Map of North Coast MPAs implemented on December 19, 2012.*

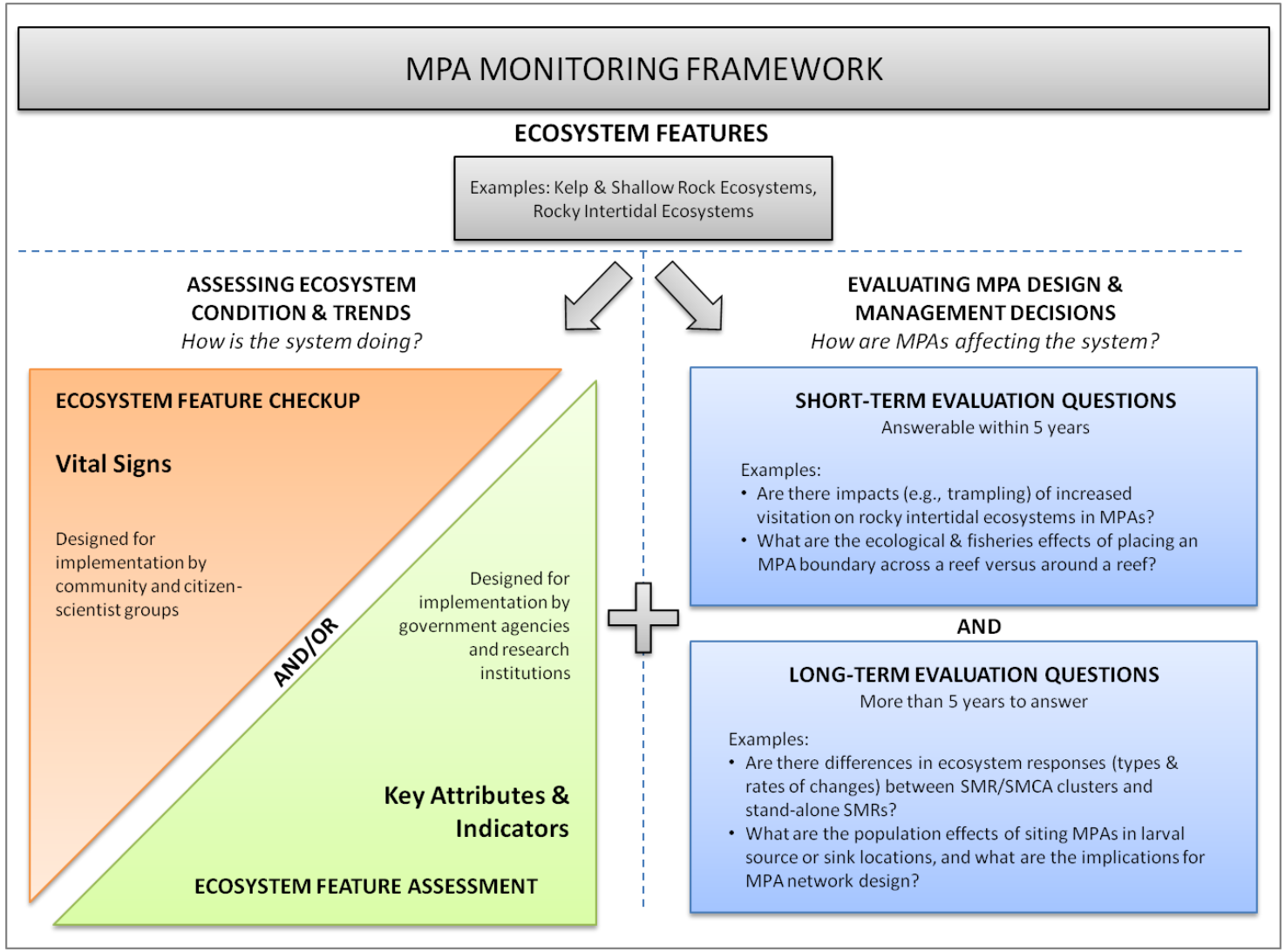


Figure 1-2. *Statewide MPA monitoring framework, displaying the two primary monitoring elements: 1) assessing ecosystem condition and trends, and 2) evaluating MPA design and management decisions.*

2. Setting the Scope of MPA Monitoring

The scope of monitoring is guided by overarching policy documents (including the MLPA and the 2016 Master Plan for MPAs) and by policy guidance and decisions established during the regional planning process. This guidance is applied to inform the MPA Management Program's adaptive management process. Under this adaptive management context, policy guidance was first used to develop key characteristics of the MPA monitoring framework, and then used to refine the framework so that it better applies to the North Coast region.

EMPLOYING AN ADAPTIVE MANAGEMENT FRAMEWORK FOR MONITORING

MPA monitoring is one step in a larger cycle of the adaptive management process outlined in the 2016 Master Plan for MPAs (Figure 2-1). In an adaptive management context, MPA monitoring results, as well as statutory directives, MPA objectives, and design considerations serve as the cornerstones to improve management. Long-term monitoring, combined with other scientific information, governance and management review, workshops, and public forums, inform interim MPA evaluations and the formal 10-year management review cycle. This cycle provides important context for MPA monitoring; it guides monitoring to focus on information, which supports making informed future management decisions.

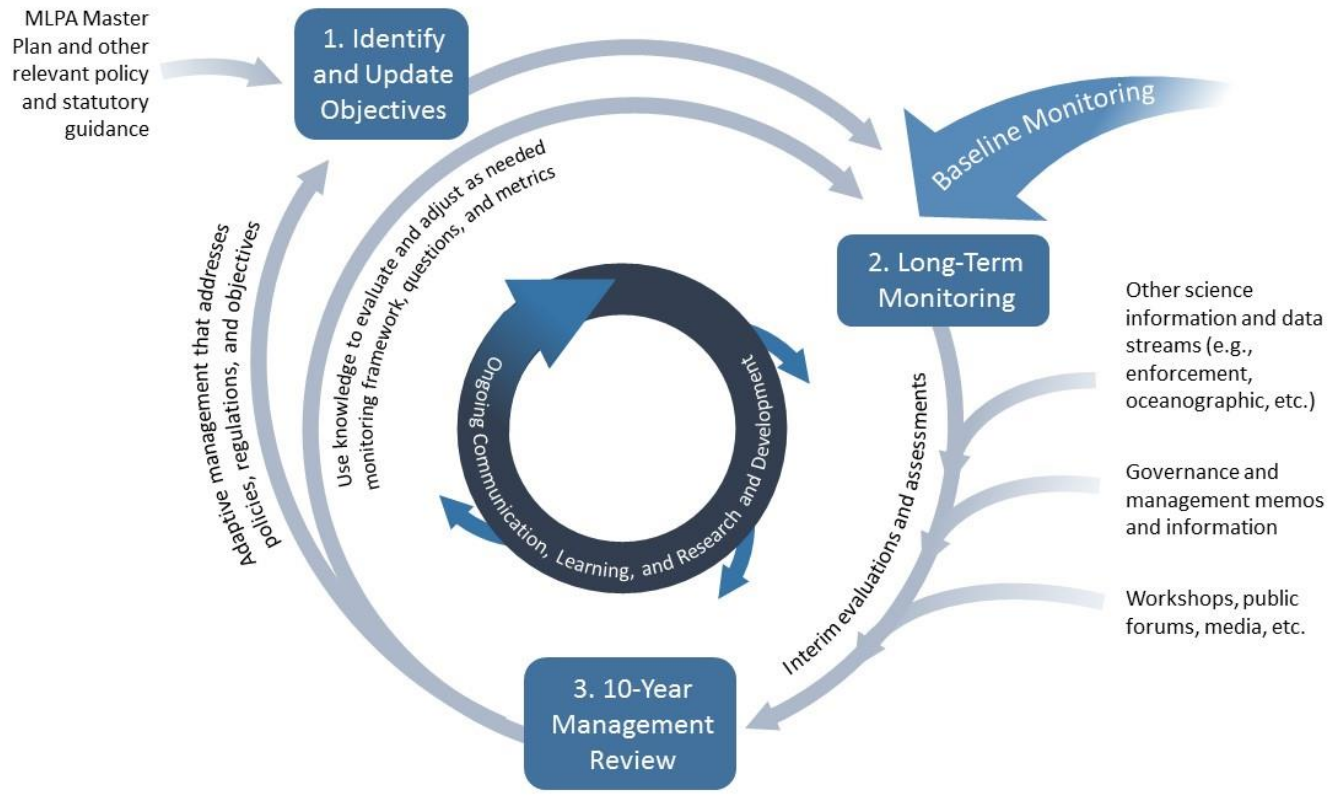


***Figure 2-1**. The Adaptive Management process for the MPA Management Program.*

POLICY GUIDANCE FOR MPA MONITORING

The following policy guidance helps inform the adaptive management process for the MPA Management Program as a whole, and sets the scope of MPA monitoring:

- ***The Marine Life Protection Act*** – The MLPA is the overarching legislation that requires the design and management of California's MPAs as a statewide network. The MLPA also requires monitoring, research, and evaluation to facilitate adaptive management of MPAs and ensure the network meets the goals of the MLPA (see box below). As such, the Act provides the paramount guidance for monitoring.
- ***The Master Plan for MPAs*** – The MLPA requires the DFW to develop, and the FGC to adopt, a master plan that guides the implementation of a Marine Life Protection Program (also known as MPA Management Program) to improve the design and management of California's MPAs to the extent possible, as a statewide network.
    - The 2008 Master Plan for MPAs guided the design and siting process for MPA proposals and provided important recommendations about the role and function of MPA monitoring.
    - The 2016 Master Plan for MPAs focuses on the shift from MPA design and siting to managing California's redesigned MPA network to meet the goals of the MLPA. The 2016 Master Plan establishes the Statewide MPA Monitoring Program, which draws from regional components to gather sufficient information and inform the adaptive management process. The 2016 Master Plan is also complemented by the Partnership Plan.
- ***The North Coast MLPA Initiative Planning Process*** – During the planning process, region-specific MPA design considerations were developed, such as regional goals and objectives,[7] and these have helped guide the development of the Monitoring Plan. In addition, science guidance and methodologies were developed throughout the regional planning process, such as through science guidelines and evaluations, and considerations regarding biogeographical regions, habitats, and species likely to benefit from MPAs.[8]
- ***Additional policies*** – The Monitoring Plan also reflects policies and programs related to the MLPA, including the MPA Partnership Plan, Marine Managed Areas Improvement Act, and the Marine Life Management Act.

Goals of the Marine Life Protection Act (MLPA)

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 values.

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.

To read the full text of the MLPA, please visit the DFW website.

[7] DFW (2016). California MLPA Master Plan for MPAs, Appendix C, Section 3.1.

[8] DFW (2016). California MLPA Master Plan for MPAs, Appendix A, Section 4.

REFLECTING POLICY GUIDANCE IN THE MONITORING FRAMEWORK

The broad set of policy guidance developed before and during the North Coast regional planning process established a complex landscape for designing MPA monitoring. As a first step in designing a monitoring framework that would appropriately incorporate and reflect this policy guidance, four key characteristics for MPA monitoring were identified:

- **Hierarchical** – allows collection and reporting of results at various scales, including the North Coast region as a whole, individual ecosystem types (such as kelp forests), individual MPAs (though not all sites may be monitored), and individual ecosystem components.
- **Efficient** – identifies the most important and useful information that can inform the evaluation of the MPA Network at meeting the goals of the MLPA. This approach allows clear prioritization of monitoring information to be collected, but does not preclude collection of additional data when feasible.
- **Synthesizable** – generates data that are readily synthesized and interpreted to aid development of decision tools , or conclusions, about MPA network performance that can be presented in clear, intuitive reports.
- **Adaptable** – can be adjusted as needed to reflect changing management needs, to make best use of available resources, and to evolve over time to take advantage of scientific advances in monitoring.

CORE ELEMENTS OF THE MPA MONITORING FRAMEWORK

These characteristics guided the selection and construction of the core elements of the MPA monitoring framework (Figure 1-2), briefly described below and applied to the North Coast region in subsequent sections.

ASSESSING ECOSYSTEM CONDITION AND TRENDS

Monitoring must reflect many different ecological, cultural, and socioeconomic aspects in order to meet the requirements of the policy guidance described above. The MPA monitoring framework adopts an ecosystems focus to provide a sufficiently broad umbrella to encompass these diverse aspects, facilitate integration of different types of monitoring results, and enable assessment of the performance of the MPA network. One of the core elements of the monitoring framework—assessing ecosystem condition and trends—allows for long-term tracking of the condition of key aspects of marine ecosystems, including human uses.

EVALUATING DESIGN AND MANAGEMENT DECISIONS

The North Coast MPAs were designed using the best readily available scientific information, which was used to guide key design decisions such as the siting, size, and spacing of individual MPAs. The other core element of the monitoring framework—evaluating MPA design and management decisions—provides for evaluation of these design decisions. Better understanding of the effects of MPA size, for example, would be valuable for making future management decisions, although such questions can be notoriously difficult to answer.

3. Developing an Ecosystems Approach

Monitoring of the North Coast regional MPAs must reflect many different aspects of the ecology, socioeconomics, and cultural uses of the region. Therefore, it is important to have an approach that can efficiently encompass and organize these many different aspects, and can be used as the top level of the monitoring framework. The MPA Monitoring Plan adopts an ecosystems approach in which ecosystems are the top level of the monitoring hierarchy; this provides the umbrella that encompasses species, communities, populations, habitats, and humans. Ecosystems selected for monitoring should reflect public priorities, be consistent with the MLPA policy guidance, and recognize important ecological attributes.

IDENTIFYING ECOSYSTEMS FOR MONITORING

During the planning process, 11 ecosystem features were identified by the North Coast Science Advisory Team (NCSAT) and used to evaluate the regional MPA proposals. Ecosystem features are a limited set of targets for monitoring that collectively represent and encompass a region. The following ecosystem features provide the overarching structure for MPA monitoring in this region:

- Rocky Intertidal Ecosystems
- Kelp and Shallow Rock Ecosystems (0-30 meters [m])
- Mid-depth Rock Ecosystems (30-100 m)
- Estuarine and Wetland Ecosystems
- Soft-bottom Intertidal and Beach Ecosystems
- Soft-bottom Subtidal Ecosystems (0-100 m)
- Deep Ecosystems, including Canyons (>100m)
- Nearshore Pelagic Ecosystems (i.e., the water column habitat within state waters, in depths >30m)
- Consumptive Uses
- Non-consumptive Uses
- Traditional Ecological Knowledge

A unique feature of the North Coast monitoring program—Traditional Ecological Knowledge (TEK)—was included in baseline monitoring to assess historical and present-day Tribal uses of marine resources in several of the ten other ecosystem features on the North Coast. Traditional Ecological Knowledge, encompassed by project researchers' preferred term of Tribal or Indigenous Traditional Knowledge (T/ITK), is the product of keen observation, patience, experimentation, and long-term relationships with the resources.[9] 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".

[9] Anderson, K. (2005). Tending the wild: Native American knowledge and the management of California's natural resources. Berkeley and Los Angeles, California: University of California Press.

MONITORING MPA EFFECTS ON ECOSYSTEMS

As MPAs limit or prohibit take of living marine resources, this will most likely have direct effects such as increases in the abundance and size of some fish and invertebrates inside MPA boundaries. Not all species should be expected to respond to MPA implementation equally or at the same rates. Faster growing and predatory species would be expected to show increases first, along with populations that are heavily fished. This initial effect of MPA implementation is one of the most widely demonstrated worldwide. The rates and magnitudes of population changes are also likely to be influenced by historical levels of fishing in areas subsequently designated as MPAs, as well as ongoing fishing activities allowed inside and outside MPA boundaries.

MPAs may also result in indirect effects on marine ecosystems. If abundances of functionally important fish and invertebrate herbivores and predators increase, cascading changes throughout the ecosystem may be expected as ecological processes and interactions shift. Additionally, MPAs may increase ecosystem resilience, which can improve the capacity of ecosystems to resist or recover from changes due to other influences (e.g., climate change, invasive species). Monitoring important aspects that contribute to ecosystem structure and function can facilitate detection and interpretation of such community- and ecosystem-level effects of MPAs.

DETECTING AND INTERPRETING CHANGE USING CONTEXTUAL INFORMATION

California's marine and coastal ecosystems are shaped by natural and human influences that act at a variety of temporal and spatial scales. Ecological and socioeconomic changes following MPA implementation will occur in the context of variation in these other factors; referred to as contextual factors or variables. In order to understand the effects of MPAs on these ecosystems, the analysis and interpretation of monitoring results will need to consider this contextual information.

For example, the highly dynamic physical oceanography of the area, including changes related to the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), dramatically affects many species and habitats. As another example, the irregular recruitment cycles of many species, including many rockfishes, significantly affect potential rates of population growth for those species. These and the many other sources of natural variability pose challenges to detecting ecological trends, and even greater challenges for determining the extent to which MPAs may be causing or contributing to such trends. The approach to MPA monitoring described in this plan is designed to first document the condition of the ecosystems at or near the time of MPA implementation, and then to collect data that will be needed to track changes over time and explore the causes of any changes observed.

Coastal ecosystems in the North Coast region and globally are also affected by a wide range of human influences other than those associated with fishing. These influences include water quality impairment, habitat alteration, invasive species, and, increasingly, climate change. Coastal ecosystems are also influenced by a wide range of management measures other than MPAs, including those relating to fisheries, land- and marine-based discharges, coastal development practices, and many others. Interpretation of changes in ecosystems in response to MPA implementation will also need to incorporate other contextual information such as economic conditions, which can affect patterns of human uses.

Analysis and interpretation of MPA monitoring results will also consider MPA regulations and available information on MPA compliance. For instance, illegal take of marine organisms can influence the rates and magnitudes of change in MPAs. Information about types and levels of non-compliance will be considered when interpreting documented trends.

These anthropogenic influences frequently impose dynamic changes on ecosystems that operate on differing spatial and temporal scales from MPA-related effects. As with natural variability, comparing long-term trend data between locations (e.g., locations with and without specific measurable human influences) is helpful when trying to separate the effects of MPAs from other human influences on ecosystems. Partnerships can provide information exchange, including data on these broad human influences, which can assist the analysis and interpretation of MPA monitoring results. Because of the diversity of these influences and their temporal and spatial variability, long-term monitoring at various spatial scales is required in order to assess MPA effects accurately.

4. Assessing Ecosystem Condition and Trends

The core element of the MPA Monitoring Program is the assessment of ecosystem condition and trends (Figure 1-2). This section describes the overarching framework, implementation, and recommended monitoring metrics to track the condition of the North Coast ecosystem features.

BUILDING ON MPA BASELINE MONITORING

Long-term assessments of ecosystem condition in the North Coast region are being designed to build upon the information generated through Phase 1 of the Statewide MPA Monitoring Program. Phase 1 in the North Coast region began in 2013 and concludes in 2018 with a five-year review. Phase 1 has two complementary purposes:

1. Characterization of key aspects of the ecology, socioeconomics, and cultural uses of the North Coast region at or near the time of MPA implementation; and
2. Assessment of initial ecological changes and the short-run net benefits or costs to consumptive and non-consumptive user groups and Tribes in California in the first two to three years following MPA implementation.

Baseline monitoring provided a robust assessment of the starting, or time-zero conditions, in key habitats in the region, as well as novel information on habitats that have not been widely studied across the North Coast such as estuaries, kelp forest and mid-depth rock ecosystems, and sandy beaches. New data and analyses also offer the first opportunity to evaluate and refine metrics proposed to track the region's ecosystem condition over long time periods.

LONG-TERM TRACKING OF ECOSYSTEM CONDITION

Assessing ecosystem condition over time will employ a 'status and trends' approach focused on the 11 ecosystem features. Two implementation options have been developed:

- **Ecosystem feature checkups** – These checkups may be used instead of, or in combination with, ecosystem feature assessments. The checkup option has been developed to take best advantage of community-based or citizen-scientist monitoring partnerships, and uses comparatively simpler sampling protocols and methods to monitor a set of vital signs.
- **Ecosystem feature assessments** – These require technically demanding or otherwise comparatively resource-intensive monitoring methods, and use a hierarchical system of key attributes and indicators or focal species (Figure 4-1). For each ecosystem feature, key attributes have been identified that will be used collectively to assess ecosystem condition. For each key attribute, selected indicators and focal species have been identified that collectively allow assessment of that attribute.

The monitoring metrics (key attributes, indicators, and vital signs) have been chosen first and foremost to best meet the requirements of the MLPA. However, consideration has also been given to providing potential benefit to other programs without compromising the ability to meet MLPA monitoring requirements. For example, some fished species have been chosen as metrics both because they will inform assessment of MPA effectiveness, and because information on these species may benefit fisheries management.

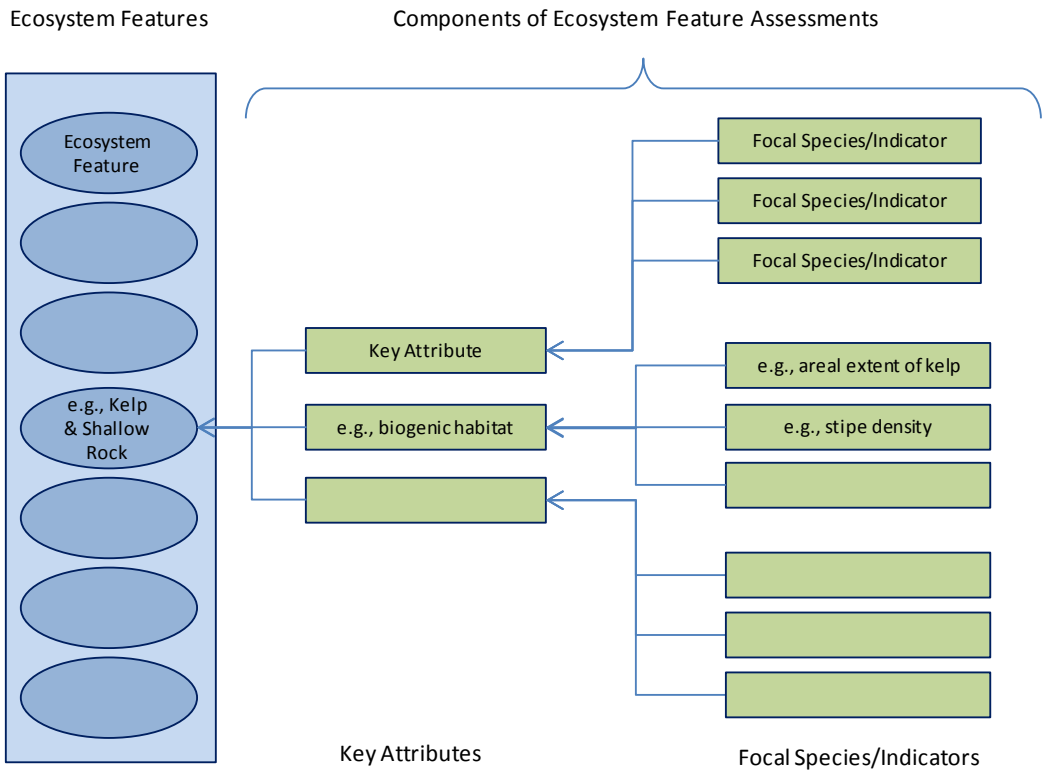


***Figure 4-1**. Conceptual diagram of the structure of the ecosystem feature assessment option for assessing the condition of ecosystem features. A limited set of focal species/indicators is selected to collectively assess the status of a key attribute. Collectively, the status of key attributes is used to assess the condition of the ecosystem feature.*

The recommended monitoring metrics for each ecosystem feature are described below. However, monitoring should be flexible to allow improvements as scientific knowledge increases and different monitoring methods and approaches are tested. Although long-term consistency in monitoring data is important, MPA monitoring must be responsive to changing management needs and environmental conditions to remain relevant.

METRICS FOR ECOSYSTEM FEATURE CHECKUPS AND ASSESSMENTS

The following section includes monitoring metrics for assessing the conditions and trends of the 11 ecosystem features identified for the North Coast. These metrics were recommended in the baseline monitoring technical reports and through consultations with scientists and other stakeholders. For each ecosystem feature, a summary list of the monitoring metrics is provided, including the metrics for the ecosystem feature checkup (orange) and assessment (green) options.

Vital signs have been selected to provide a cohesive set of metrics that collectively can provide a coarse-grained evaluation of ecosystem condition and trends. Therefore, if monitoring is implemented using the ecosystem feature checkup option, all vital signs must be included in monitoring. Likewise, if monitoring is implemented using the ecosystem feature assessment option, all key attributes and focal species/indicators must be included in monitoring. The assessments also include optional add-ons, some or all of which may be included in monitoring as resources and methods permit.

ROCKY INTERTIDAL ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Mussel bed cover (*Mytilus* spp.) ➢ Rockweed cover (multiple species) ➢ Surfgrass cover (*Phyllospadix* spp.) ➢ Sea palm (*Postelisa palmaeformis*) abundance ➢ Ochre sea star (*Pisaster ochraceus*) abundance and size frequency ➢ Marine bird richness and abundance ➢ Red abalone (*Haliotis rufescens*) abundance and size frequency ➢ Purple sea urchin (*Strongylocentrotus purpuratus*) abundance and size frequency ➢ Pinniped abundance (harbor seal, California sea lion, northern elephant seal)

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicator/Focal species
Biogenic Habitat	Percent cover of focal species: Mussels (*Mytilus* spp.) Barnacles (*Balanus* spp., *Chthamalus dalli*) Feather boa kelp *(Egregia menziesii*) Rockweed (*Fucaceae* spp.) Surfgrass (*Phyllospadix* spp.)
Trophic Structure: Predators	Ochre sea star (*Pisaster ochraceus*) density and size structure Piscivorous bird richness and abundance Shorebird richness and abundance
Trophic Structure: Herbivores	Density and size structure of focal species/species groups: Red abalone (*Haliotis rufescens*) Purple sea urchin (*Strongylocentrotus purpuratus*) Turban snails (*Tegula* spp.)

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSMENT

This set of information includes supplemental metrics that can be added as methods and resources permit.

Key Attribute	Indicator/Focal species
Biogenic Habitat: Macroalgae	Cover of focal groups: Turf algae Foliose red algae Encrusting algae
Diversity	Species richness (algae, invertebrates, and fish) Species diversity (functional groups of algae, invertebrates, and fish)

KELP AND SHALLOW ROCK ECOSYSTEMS (0-30M)

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Red and purple sea urchin (*Strongylocentrotus* spp.) abundance and size frequency ➢ Sea star (multiple species) abundance and size frequency ➢ Rockfish (*Sebastes* spp.) abundance and size frequency ➢ Lingcod (*Ophiodon elongatus*) abundance and size frequency ➢ Red abalone (*Haliotis rufescens*) abundance and size frequency

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	**Indicator/Focal species**
Biogenic Habitat: Macroalgae	Bull kelp (*Nereocystis luetkeana*) areal extent Stalked kelp (*Pterygophora californica*) stipe density and size structure
Strong Ecological Interactors	Density and size structure of focal species: Red sea urchin (*Strongylocentrotus franciscanus*) Purple sea urchin (*Strongylocentrotus purpuratus*) Sea stars (*Pisaster* spp./*Pycnopodia helianthoides*) Red abalone (*Haliotis rufescens*)
Trophic Structure: Predatory fishes	Density and size structure[1] of focal species: Black rockfish (*Sebastes melanops*) Lingcod *(Ophiodon elongatus)* Cabezon (*Scorpaenichthys marmoratus*)
Trophic Structure: Predatory invertebrates	Density and size structure of focal species: Sea stars (*Pisaster* spp., *Pycnopodia helianthoides*)
Trophic Structure: Planktivorous fishes	Density and size structure[1] of focal species: Blue rockfish (*Sebastes mystinus*) Striped surfperch (*Embiotoca lateralis*)
Trophic Structure: Omnivorous invertebrates	Density of focal species: Bat stars (*Patiria miniata*) California sea cucumber (*Parastichopus californicus*)

[1] Size structure includes young-of-the-year where feasible.

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSEMENT

This set of information includes supplemental metrics that can be added as methods and resources permit.

Key Attribute	Indicator/Focal species
Biogenic Habitat	Sub canopy kelp stipe density Sub-canopy and turf algae cover Surfgrass (*Phyllospadix* spp.) cover Sessile invertebrate percent cover Coralline (crustose and articulated) and foliose red algal percent cover
Trophic Structure: Omnivorous fishes	Density and size structure of focal species: Black-and-yellow rockfish (*Sebastes chrysomelas*) Kelp rockfish (*Sebastes atrovirens*) Brown rockfish (*Sebastes auriculatus*) Kelp greenling (*Hexagrammos decagrammus*)
Seabird Ecology	Foraging, diet, and breeding success: Brandt's cormorant (*Phalacrocorax penicillatus*) Pelagic cormorant (*Phalacrocorax pelagicus*) Pigeon guillemot (*Cepphus columba*)
Diversity	Species richness (invertebrates and fishes) Species diversity (functional groups of invertebrates and fishes)

MID-DEPTH ROCK ECOSYSTEMS (30-100M)

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Rock crab (*Cancer* spp.) abundance and size frequency ➢ Rockfish (*Sebastes* spp.) abundance and size frequency ➢ Lingcod (*Ophiodon elongatus*) abundance and size frequency ➢ Dwarf rockfish (*Sebastes rufinanus*) abundance and size frequency

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	**Indicator/Focal species**
Biogenic Habitat: Sessile invertebrates	Cover and density of structure forming Red Gorgonian (*Muricea*)
Trophic Structure: Mobile invertebrates	Density of focal species: Sea stars (multiple species) Basket stars (multiple species) California sea cucumber (*Parastichopus californicus*)
Trophic Structure: Predatory fishes	Density and size structure[1] of focal species: Canary rockfish (*Sebastes pinniger*) Copper rockfish (*Sebastes caurinus*) Vermilion rockfish (*Sebastes miniatus*) Yelloweye rockfish (*Sebastes ruberrimus*) Lingcod (*Ophiodon elongatus*) Rockfish (*Sebastes* spp.) size structure[1]
Community Structure: Dwarf rockfishes	Total kelp greenling abundance

[1] Size structure includes young-of-the-year where feasible.

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSMENT

This set of information includes supplemental metrics that can be added as methods and resources permit.

Key Attribute	**Indicator/Focal species**
Biogenic Habitat	Cover of focal species: *Metridium* spp.
Seabird Ecology	Foraging, diet, and breeding success: Brandt's cormorant (*Phalacrocorax penicillatus*) Common murre (*Uria aalge*) Pigeon guillemot (*Cepphus columba*)
Diversity	Species richness (invertebrates and fishes) Species diversity (functional groups of invertebrates and fishes)

ESTUARINE AND WETLAND ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Eelgrass (*Zostera* spp.) areal extent and shoot density ➢ Shore crab (*Hemigrapsus oregonensis*) abundance ➢ Marine/shorebird richness and abundance ➢ Sculpin density and size structure (multiple species) ➢ Clam abundance (multiple species) ➢ Pinniped abundance (harbor seal, California sea lion, northern elephant seal)

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicator/Focal species
Biogenic Habitat: Plants	Areal extent of focal species: Eelgrass (*Zostera marina*)
Trophic Structure: Infaunal assemblage	Abundance of focal species: Shore crab (*Hemigrapsus oregonensis* spp.) Dungeness crab (*Metacarcinus magister*) Pacific gaper clam (*Tresus nuttalli*) Common littleneck clam (*Protothaca staminea*) Geoduck clam (*Panopea generosa*) Pacific razor clams (*Siliqua patula*) Olympia oyster (*Ostrea lurida*)
Trophic Structure: Predatory birds	Piscivorous bird richness and abundance Shorebird richness and abundance
Trophic Structure: Predatory fishes	Density and size structure of focal species: Sculpins (multiple species) Three-spined stickleback (*Gasterosteus aculeatus*) Leopard shark (*Triakis semifasciata*)
Trophic Structure: Resident fishes	Density and size structure of focal species: Surfperch abundance (multiple species)
Trophic Structure: Transient fishes	Density and size structure of focal species: Salmonids (*Oncorhynchus* spp.) Top smelt (*Atherinops affinis*) Pacific herring (*Clupea pallasii*)

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSMENT

This set of information includes additional metrics that can be added as methods and resources permit.

Key Attribute	Indicator/Focal species
Biogenic Habitat	Areal extent of common pickleweed (*Salicornia virginica*) Areal extent of sea lettuce (*Ulva* spp.) Areal extent of red algae (*Gracilaria* spp.)
Trophic Structure: Benthic infauna	Abundance and foraging rates of shorebirds
Diversity	Species richness (invertebrates and fishes) Species diversity (functional groups of fishes and invertebrates)

SOFT-BOTTOM INTERTIDAL AND BEACH ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Sand crab (*Emerita* spp.) abundance ➢ Beach wrack composition and abundance ➢ Surfperch (Embiotocidae) abundance and size frequency ➢ Marine/shorebird richness and abundance

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicator/Focal species
Trophic Structure: Suspension feeders	Density and size structure of focal species: Sand crab (*Emerita analoga*)
Productivity: Beach wrack	Wrack composition and abundance
Productivity: Surf zone fish assemblage	Surfperch (Embiotocidae) abundance and size structure Surf smelt (*Hypomesus pretiosus*) abundance and size structure Piscivorous bird richness and abundance
Trophic Structure: Predatory birds	Shorebird species richness and abundance

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSMENT

This set of information includes additional metrics that can be added as methods and resources permit.

Key Attribute	Indicator/Focal species
Productivity	Wrack invertebrate diversity and biomass
Diversity	Species richness (invertebrates and fishes) Species diversity (functional groups of invertebrates and fishes)

SOFT-BOTTOM SUBTIDAL ECOSYSTEMS (0-100M)

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Dungeness crab (*Metacarcinus magister*) abundance and size frequency ➢ Starry flounder (*Platichthys stellatus*) and size frequency ➢ Flatfish total abundance and size frequency

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	**Indicator/Focal species**
Trophic Structure: Benthic infauna	Functional diversity of benthic infauna: Sea pens (multiple species) Sea whips
Trophic Structure: Mobile invertebrates	Density and size structure of focal species/species groups: Dungeness crab (*Metacarcinus magister*) Red octopus (*Octopus rubescens*) California sea cucumber (*Parastichopus californicus*)
Trophic Structure: Predatory fishes	Density and size structure of focal species/species groups: Starry flounder (*Platichytys stellatus*) Sanddab (*Citharichthys* spp.) Pacific halibut (*Hippoglossus stenolepis*)

OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

This set of information includes supplemental metrics that can be added as methods and resources permit.

Key Attribute	**Indicator/Focal species**
Seabird Diet	Brandt's cormorant (*Phalacrocorax penicillatus*) Pigeon guillemot (*Cepphus columba*)
Diversity	Species richness (invertebrates and fishes) Species diversity (functional groups of invertebrates and fishes)

DEEP ECOSYSTEMS, INCLUDING CANYONS (>100M)

ECOSYSTEM FEATURE CHECKUP

Deep ecosystems pose unique challenges for data collection, and sampling at these depths typically requires the use of methods such as remotely operated underwater vehicles (ROVs) and submersibles. At this time, methods that citizen-scientists or community groups could use have yet to be developed. Should this change, appropriate vital signs will be developed.

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicator/Focal species
Biogenic Habitat: Sessile invertebrates	Structure forming invertebrate cover and height: *Metridium* spp. Short red gorgonians (*Muricea*) Mushroom soft coral
Trophic Structure: Predatory fishes	Density and size structure[1] of focal species/group: Greenstriped rockfish (*Sebastes elongatus*) Thornyheads (*Sebastolobus* spp.) Sablefish (*Anoplopoma fimbria*) Flatfish (multiple species) Yelloweye rockfish (*Sebastes ruberrimus*)
Community Structure: Dwarf rockfishes	Total dwarf rockfish abundance (multiple species)

[1] Size structure includes young-of-the-year where feasible.

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSMENT

This set of information includes additional metrics that can be added as methods and resources permit.

Key Attribute	Indicator/Focal species
Diversity	Species richness (invertebrates and fishes) Species diversity (functional groups of invertebrates and fishes)

NEARSHORE PELAGIC ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Semi-pelagic/pelagic rockfish (*Sebastes* spp.) average and maximum size ➢ Brandt's cormorant (*Phalacrocorax penicillatus*) breeding success ➢ Common murre (*Uria aalge*) breeding success

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	**Indicator/Focal species**
Predators: Piscivorous/planktivorous fishes	Abundance and size structure of focal species: Widow rockfish (*Sebastes entomelas*) Shortbelly rockfish (*Sebastes jordani*) Yellowtail rockfish (*Sebastes flavidus*) Blue rockfish (*Sebastes mystinus*)
Trophic Structure: Predatory birds	Abundance (colony size) and fledgling rate of focal species: Common murre (*U. aalge*) Brandt's cormorant (*P. penicillatus*) Pelagic cormorant (*Phalacrocorax pelagicus*) Pigeon guillemot (*Cepphus columba*)

OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSMENT

This information includes supplemental metrics that can be added as methods and resources permit.

Key Attribute	**Indicator/Focal species**
Productivity: Ichthyoplankton	Total ichthyoplankton abundance Total abundance of rockfish larvae Ratio of fished species to unfished species
Trophic Structure: Forage base	Forage fish biomass (sardines, anchovies, other school bait fish)

CONSUMPTIVE USES

ECOSYSTEM FEATURE CHECKUP

Vital signs identified for Consumptive Uses are designed to be derived from existing DFW datasets and monitoring programs, and TEK of North Coast Tribes.

Vital Signs

- Reported landings (weight and value) of key species (nearshore rockfishes, Dungeness crab, red urchin and salmonids) per fishing block and port for the commercial fishery
- Reported catch per unit effort (CPUE) of key species (as above) per fishing block, port, and logbooks by commercial passenger fishing vessels (CPFVs)
- Total number of abalone harvested in the recreational fishery, reported on abalone report cards

ECOSYSTEM FEATURE ASSESSMENT

INDICATORS

Each consumptive use is monitored using the same indicators listed in the table below. Note, however, that not all indicators need to be implemented at the same time, or at the same frequency. For example, Knowledge, Attitudes and Perception (KAP) surveys may be most useful if conducted once every five or more years.

Consumptive Indicators

1. Number of people or vessels engaged in the activity
2. Level of activity
    a. Number of fishing trips per fishing location, vessel, port and region
    b. Landings of key species per trip, fishing location, vessel, port and region
    c. CPUE of key species per trip, fishing location, vessel, port and region
3. Economic value or quality of activity
    a. Landings value of key species per trip, fishing location, vessel, port and region
    b. Ex-vessel value of key species (commercial fisheries)
    c. Net revenue (commercial fisheries) or expenditures (recreational fisheries)
4. Knowledge, attitudes, and perceptions (KAP) of participants
    a. Motivation
    b. Satisfaction

CONSUMPTIVE USES TO BE MONITORED

For each consumptive use or activity, key fishery species for monitoring include those that are economically, ecologically, and culturally important.

Consumptive Uses to be Monitored
Commercial Fishing:
Nearshore rockfish (*Sebastes* spp.)
Salmonids (*Oncorhynchus* spp.)
Lingcod (*Ophiodon elongatus*)
Red sea urchin (*Stronglyocentrotus franciscanus*)
Dungeness crab (*Metacarcinus magister*)
Recreational Fishing – CPFVs and private vessels:
Nearshore rockfish (*Sebastes* spp.)
Dungeness crab (*M. magister*)
Lingcod (*O. elongatus*)
Salmonids (*Oncorhynchus* spp.)
Recreational Fishing – shore-based and diving
Surfperches (Embiotocidae)
Nearshore rockfishes (*Sebastes* spp.)
Red abalone (*Haliotis rufescens*)
Red urchin (*S. franciscanus*)

OPTIONAL CONSUMPTIVE USES TO BE MONITORED

This information includes supplemental Consumptive Use metrics, some or all of which can be monitored using the same indicators above, as methods and resources permit.

Optional Consumptive Uses to be Monitored
Recreational Fishing
Pacific gaper clams (*Tresus nuttalli*)
Common littleneck clams (*Protothaca staminea*)
Geoduck clams (*Panopea generosa*)
Seaweeds

NON-CONSUMPTIVE USES

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Number of diving trips and divers per access point and dive site ➢ Number of visitors engaging in recreational beach use ➢ Number of visitors to rocky intertidal ecosystems for tidepooling ➢ Number of boat-based wildlife viewing trips and visitors per port and viewing location ➢ Number of shoreline wildlife viewers to estuarine, wetland, and beach ecosystems

ECOSYSTEM FEATURE ASSESSMENT

INDICATORS

Each non-consumptive use is monitored by applying the same indicators listed in the table below. Note, however, that not all indicators need to be implemented at the same time, or at the same frequency. For example, KAP surveys may be most usefully conducted once every five or more years.

Indicators
1. Level of activity a. Number and location of trips (spatial use and intensity) 2. KAP of participants a. Motivation – including MPAs b. Satisfaction – e.g., travel distance, travel and activity costs, likelihood of return

NON-CONSUMPTIVE USES TO BE MONITORED

Non-consumptive Uses to be Monitored
Scuba diving
Recreational beach use
Tidepooling
Wildlife viewing – boating, including kayaking
Wildlife viewing – shore-based
Educational use

TRADITIONAL ECOLOGICAL KNOWLEDGE

ECOSYSTEM FEATURE CHECKUP

Traditional Ecological Knowledge (TEK) is unique to the North Coast baseline program monitoring. It was included to assess historical and present-day Tribal uses of marine resources in several of the other 10 ecosystem features on the North Coast. Three Native American Tribes and a Tribal consortium in the North Coast region led the baseline project to incorporate TEK (encompassed by the project researchers' preferred term of T/ITK) as part of understanding historical and current ocean conditions.

Vital Signs

- **Rocky Intertidal:** Abalone (*Haliotis* spp.), Mussel (*Mytilus californianus*), Seaweed (*Porphyra* spp.), Sea lettuce (*Ulva lactuca*), Sea palm (*Postelsia palmaeformis*)
- **Soft-bottom Intertidal Beach:** Clams (multiple species), Bay mussel (*Mytilus trossulus*), Smelt (*Hyposemus pretiosus*) and Night Fish (*Spirinchus starksi*)
- **Kelp and Shallow Rock:** Abalone (*Haliotis* spp.), Seaweed (*Porphyra* spp.), Sea lettuce (*Ulva lactuca*), Giant kelp (*Macrocystis pyrifera*), Bull kelp (*Nereocystis luetkeana*), and Stalked kelp (*Pterygophora californica*)

ECOSYSTEM FEATURE ASSESSMENT

T/ITK

1. Attitudes and perceptions of Native American Tribes on species use
2. Documented use of resources by Native American Tribes in California

ADVANCING ECOSYSTEM MONITORING THROUGH RESEARCH AND DEVELOPMENT

This monitoring framework is designed to assess the effectiveness of the North Coast regional MPAs in achieving the MLPA goals and facilitating adaptive management of MPAs and the MPA Management Program itself. Implementation strategies for research and monitoring, as outlined in the 2016 MLPA Master Plan, are an integral component of the MPA Management Program. Monitoring should be flexible to allow improvements based on increased scientific knowledge and experience with different monitoring methods and approaches. Priority research needs are identified to advance ecosystem monitoring and guide the development of research partnerships. Further considerations for establishing partnerships are included in Section 7, and considerations for funding and implementing research to advance ecosystem monitoring are discussed in Section 9.

RESEARCH PRIORITIES

Despite a long history of research in California and beyond, our understanding of marine ecosystem structure and functioning remains incomplete. Anthropogenic changes in marine ecosystems, such as loss of habitat and decreased abundances of many top-level predators, is well documented globally. However, understanding of the mechanisms of ecosystem recovery, or of the key processes and ecosystem elements that confer stability and resilience, is in its infancy. To be useful for advancing MPA monitoring, ecosystem studies must also be coupled with investigation of mechanisms, methods, and technologies that can be applied to efficiently and cost-effectively collect ecosystem-level monitoring data, such that the results will be relevant and applicable to management decisions.

Three priority research goals have been identified to guide future research to support MPA monitoring and evaluation, and to inform MPA adaptive management:

- Advanced monitoring methods, including developed and tested new approaches, tools, and technologies for efficient monitoring data collection, analysis and interpretation
- Advanced understanding of the interactions between socioeconomic, cultural, and ecological ecosystem elements
- Advanced understanding of marine ecosystem structure and function

These research goals are based on existing data in the North Coast region, and the current knowledge of ecosystems and monitoring. These research topics will be updated as our understanding advances, and will be reviewed as part of an ongoing evaluation of the monitoring program.

DEVELOPING RESEARCH PARTNERSHIPS

These research goals are complex and span a range of scientific disciplines. Successfully conducting research in support of these overarching goals will require inter- and multi-disciplinary research collaborations and partnerships. This research and development module may therefore be best implemented by using competitive proposal processes (e.g., Requests for Proposals, with merit reviews of submissions), or through use of monitoring funds as a match against larger research proposals from academic groups, non-governmental organizations and/or agencies. Given the likely size and complexity of the research teams necessary to address these research questions, it will be essential to collaborate, to share and use existing information, and to create partnerships that leverage existing or planned research programs.

5. Evaluating MPA Design and Management Decisions

The establishment and on-going management of MPAs involves a number of decisions, ranging from fundamental design decisions made during the planning process, such as MPA size and spacing, to day-to-day management decisions made to address ongoing and emerging issues (e.g., those related to compliance with MPA rules and regulations). This section describes the second core element of monitoring designed to evaluate the MPA design and management decisions (Figure 2-1).

STRUCTURING MPA DESIGN AND MANAGEMENT EVALUATIONS

Many recommendations regarding MPA design and management were made during the planning process, and were based on the best available science and potential MPA effects. Now that the MPAs are implemented and baseline monitoring has concluded, there will be an opportunity to refine these guidelines and recommendations based on actual, measured effects. The intention of the evaluations addressed by this side of the framework is not to question these science guidelines, but to instead facilitate adaptive management, through which management actions are refined and improved via testing and evaluation. Evaluating the effects and performance of the MPAs adopted for the North Coast region, through use of existing data and/or collection of new data, will provide important information to guide future MPA management decisions.

SHORT-TERM MPA DESIGN AND MANAGEMENT EVALUATIONS

The following bullets are the short-term evaluation questions that were repeatedly identified by stakeholders during the MLPA planning process. All of the questions have the potential to contribute to adaptive MPA management, even though some questions address activities that are beyond the administrative jurisdiction of the FGC. This list forms an initial inventory of potential questions for evaluation by comparing later changes against the benchmark established by baseline monitoring.

- What are the economic effects (e.g., fuel costs, time spent at sea) of MPA placement, specifically distance from ports and location relative to fishing grounds? What are the ecological and economic implications for siting MPAs to minimize adverse economic impacts and to prevent serial depletion?
- Are the identified key habitats represented and replicated in the implemented array of MPAs?
- Are there impacts (e.g., increased disturbance) of visitation in MPAs?
- What are the most effective tools and approaches to inform visitors of MPA rules and regulations and to improve visitor experience and education? What are some best practices to reduce visitor impacts?
- How frequently do targeted fish species spill over from MPAs to adjacent areas, and does the level of spillover differ between MPAs that encompass a reef and those that split a reef? What changes have occurred in the fisheries (e.g., fishing effort, catch) conducted on the portions of reefs left open to fishing?
- Does locating an MPA close to a boat ramp or other access point affect the level of enforcement and/or compliance with MPA regulations?
- Does locating an MPA close to a boat ramp or other access point affect the number of visitors engaged in non-consumptive recreation or education activities?
- How do allowed uses of SMCAs influence the distribution and intensity of fishing effort?

LONG-TERM MPA DESIGN AND MANAGEMENT EVALUATIONS

Long-term evaluations are those expected to take more than 10 years to answer, and thus will require more than one of the 10-year review cycles recommended in the 2016 MPA Master Plan.[10] Long-term monitoring will be performed to understand conditions and trends of marine populations, habitats, and ecosystems at a statewide network scale; monitoring activities will be designed to support management decisions within the context of the statewide adaptive management review process.[11]

Potential long-term evaluation questions have been arranged in MPA and network design categories, listed below. These categories reflect the guidance on MPA network design developed by the MLPA Science Advisory Team, science guidance during the North Coast MLPA planning process, and guidance developed in consultation with stakeholders during planning and development of the baseline monitoring approach in the North Coast. As with the short-term evaluations, this list forms an initial inventory of potential questions to be further evaluated and prioritized as a part of Phase 2 (long-term monitoring) of the Statewide MPA Monitoring Program.

SIZE

- Is "spillover" of fishery species affected by MPA size?
- If fishing occurs along the boundaries of MPAs, what are the effects on species and communities inside MPAs of different sizes?
- Are there differences in ecosystem responses (e.g., types and rates of changes observed) among MPAs of different sizes?
- What is the relationship between the alongshore span of an MPA and the protection afforded to organisms with different home range sizes, movement patterns, and pelagic larval durations (PLDs)?
- How are the MPAs used by species that inhabit shallow nearshore habitats when young and move to deeper habitats as adults?
- Do large SMRs provide higher or equivalent protection to ecosystems when compared to areas of equivalent size that are comprised of an SMR and contiguous SMCA (referred to as an SMR/SMCA cluster)?

SPACING

- What are the effects of different inter-MPA distances on connectivity between MPAs, either through larval exchange or movement of adults?
- How does the distance between an MPA and a 'source' influence the ecosystem's responses (e.g., types and rates of changes observed) inside an MPA?
- Is there a relationship between recruitment and the distance between replicate habitat types? Does the relationship differ for species with dissimilar pelagic larval durations (PLDs)?

[10] DFW (2016). California MLPA Master Plan for MPAs. Appendix C, Section 5.4.
[11] DFW (2016). California MLPA Master Plan for MPAs. Section 4.3.

HABITAT REPRESENTATION

- Are there differences in ecosystem responses (e.g., types and rates of changes observed) between MPAs in which habitats are contiguous and those with similar but patchily distributed habitats?
- Is 'spillover' of fishery species affected by habitat continuity across MPA boundaries, and what are the implications for designing MPAs to achieve ecosystem protection and potential benefits to fisheries?
- In MPAs that meet the minimum size guidelines, do species and communities associated with specific habitat types exhibit different responses based on how much of their preferred habitat is represented in the MPAs (e.g., types and rates of changes)?
- Do MPAs enclosing multiple habitat types harbor higher species abundances or more diverse communities than those that encompass only a single habitat type?
- Do the MPAs or identified key habitats miss any unique habitats that contribute significantly to the biodiversity of the region?

SITING

- What are the population effects of siting MPAs in larval source or sink locations?
- Are there different ecosystem responses (e.g., types and rates of changes) between MPAs that are and are not co-located with Areas of Special Biological Significance (ASBSs)?
- Are there differences in ecosystem responses (e.g., types and rates of changes) between MPAs that are close to stormwater or wastewater outfalls?
- What are the effects on visitation and associated recreational opportunities of siting MPAs adjacent to public versus private land?
- What are the socioeconomic effects of MPA placement, specifically distance from ports and location relative to fishing grounds?

LEVELS OF PROTECTION

- Are there differences in ecosystem responses (e.g., types and rates of changes) between MPAs with different levels of protection?
- Are there differences in ecosystem responses (e.g., types and rates of changes) between MPAs that do and do not allow take of pelagic species, including squid?
- Do SMR/SMCA clusters provide greater protection than stand-alone SMRs? Does the level of compliance differ between SMRs and SMCAs?
- What are the effects, if any, on ecosystem functioning of the removal of biomass from SMCAs, which occurs during extractive uses (e.g., while trolling for salmon within an MPA)?

6. Reporting Monitoring Results

The monitoring framework and approaches outlined in the plan have been designed to facilitate reporting of useful, understandable results, which will inform adaptive management of the regional MPAs. This section describes key characteristics and potential approaches for reporting useful monitoring results.

DESIGNING EFFECTIVE MONITORING REPORTING

Monitoring reports should include highly synthesized and interpretable results, presented as key conclusions or findings that can directly inform management decisions. Conclusions based on quantitative analyses are an essential component of monitoring reports. However, some analyses will necessarily include expert judgment due to lack of available quantitative data.

Increasing research effort is being directed towards improving frameworks for high-level assessment of ecosystems. Approaches that include expert opinion have already been successfully used in other programs (e.g., in the production of the National Marine Sanctuary Condition Reports[12]). Typically, these involve convening a technical panel, selected to encompass appropriate areas of expertise; the panel interprets detailed monitoring analyses and findings, and recommends synthesized results. This approach can garner input from the breadth of scientific disciplines needed to provide a scientifically robust interpretation of MPA monitoring results, and produce key messages useful for managers and decision-makers.

The data used to generate monitoring results and findings should be made available, consistent with a transparent approach to reporting and analysis. This is also essential to allow independent analysis and evaluations of findings, as desired. Moreover, having data widely available will facilitate research to improve understanding of marine systems, and will advance the science used for assessing ecosystem condition.

SHARING MONITORING INFORMATION

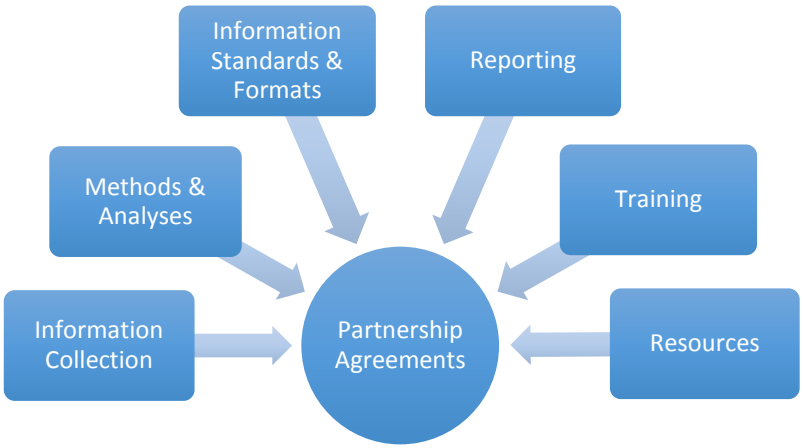
Timely and broad dissemination of monitoring results is an important step in adaptive management of the North Coast MPAs. Various options exist for sharing monitoring results. Baseline technical reports for each ecosystem feature became available online in May 2017. Other North Coast monitoring products include snapshot reports that highlight the unique research conducted during the baseline program; these were released during summer and fall of 2017. A *State of the California North Coast* report that highlights key findings of the 11 baseline monitoring projects was also released in the fall of 2017.Several community meetings were held in fall of 2017 to disseminate baseline monitoring results with North Coast stakeholders, and get community input on future direction of the Statewide MPA Management Program.

[12] The National Marine Sanctuary Program Condition Reports provide a summary of resources in each sanctuary, pressures on those resources, current sanctuary condition and trends, and management responses to pressures threatening the integrity of the marine environment.

7. Developing Monitoring Partnerships

The Monitoring Plan has been designed to facilitate development of partnerships to conduct and support long-term monitoring of the North Coast regional MPAs. Building from this and other regional monitoring plans, the State has developed a partnership-based model called the *California Collaborative Approach* (Partnership Plan), which takes advantage of overlapping government mandates, public interest, and science to provide support and create opportunities for potential partnerships.[13] There are many potential partners including state and federal agencies, Tribes, research institutions, and citizen-science and community programs and organizations. Partnerships offer the opportunity to share resources and to make efficient use of limited resources. This section describes considerations and potential opportunities for developing a partnerships approach.

BUILDING A PARTNERSHIPS APPROACH



Partnerships may greatly assist with the implementation of MPA monitoring, but must be carefully developed and maintained to be effective. Establishing these partnerships will also take time and attention to ensure they are effective. Standards, procedures, and policies for partnerships will be required, and these should be tailored to the roles of different potential partners, and reviewed and updated as required. Establishment of these operational policies can be initiated and guided through development of partnership agreements, which may, for example, include details of the information to be collected, methods to be employed, standards and formats for information collection and reporting, training of participants, and resources to be provided by each partner to an agreement.

PARTNERSHIPS FOR COLLECTING MONITORING DATA

There are many potential partners to assist with collecting MPA monitoring data in the North Coast region. Existing MPA monitoring programs, such as those conducted in Redwood National and State Parks by the Multi Agency Rocky Intertidal Network and the National Park Service, are obvious candidates. The mandates and monitoring requirements of each program are slightly different, and differ from those imposed by the MLPA. It will be important to determine how to share resources to best meet each program's needs. In addition, there are a variety of research programs and institutions, fisheries and water quality monitoring programs, and community-based and citizen-science programs that may also be valuable partners in long-term monitoring.

[13] OPC (2014). The California Collaborative Approach: Marine Protected Areas Partnership Plan.

PARTNERSHIPS FOR INTERPRETING MONITORING RESULTS

As described in Section 3, interpretation of MPA monitoring data will involve consideration of information from many other sources and programs. This external data is referred to as contextual information. Contextual information includes, for example, information about oceanographic conditions and trends, water quality, and economic trends and indices that will be important to understand the larger ecological and economic environment within which the MPAs are operating. Monitoring focused in support of other programs, such as fisheries management, water quality, invasive species, climate change impacts, and threatened species conservation, will generate more detailed and comprehensive coverage of these issues and thus can provide valuable supplemental information for interpreting MPA monitoring results (Figure 7-1).

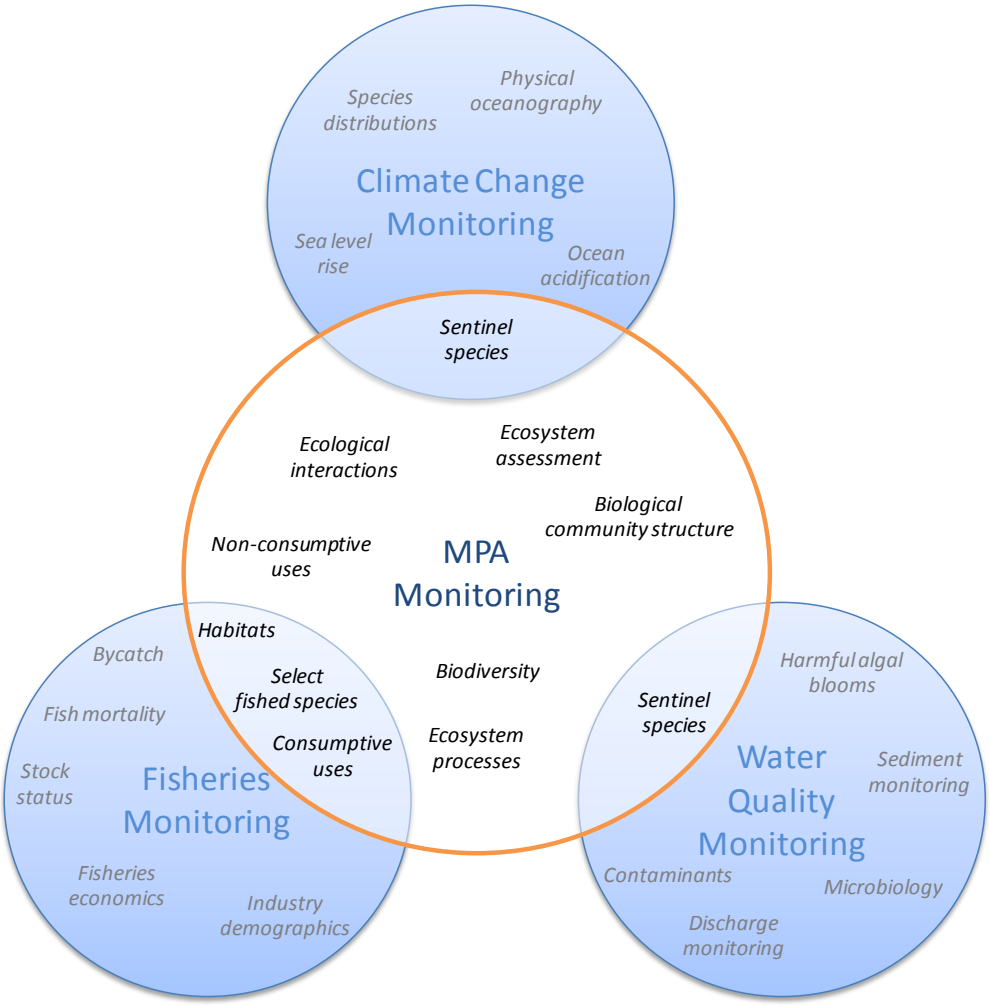


Figure 7-1. *Contextual information useful for MPA Monitoring. MPA monitoring prioritizes collection of information that is most important and useful for meeting MLPA requirements. This necessarily involves some overlap with information typically collected by other (non-MPA) monitoring programs, such those focused on monitoring fisheries management, water quality, or climate change. Partnerships and linkages with relevant programs can provide valuable supplemental information for interpreting MPA monitoring results.*

8. Funding Costs of MPA Monitoring Components

A key consideration for the implementation of the monitoring plan is financial cost. In this section, the costs for implementing the regional baseline monitoring programs, as well as California's current investment in long-term monitoring are provided.

CALIFORNIA'S INVESTMENT IN THE STATEWIDE MONITORING PROGRAM

Initially, California invested $16 million dollars of voter approved bond funds[14] in Phase 1 of the Statewide Monitoring Program. Each of the four planning regions were allocated $4 million dollars. As Phase 1 nears completion, Phase 2 of the monitoring program—long-term monitoring—is underway. Phase 2 reflects California's current statewide MPA network priorities and management needs, while building on the knowledge, capacity, and unique considerations for each region. Beginning in 2016, the State has committed an annual allotment of $2.5 million from the General Fund for statewide long-term monitoring. These investments are generating an unprecedented assessment of the ecological and socioeconomic conditions of California's MPA network.

PHASE 2 LONG-TERM FUNDING

Since 2016, investments in Phase 2 of the Statewide Monitoring Program have included the following:

- Maintaining data collection in priority ecosystems (rocky intertidal, kelp and rocky reef, and mid-depth rocky reef) in Southern, Central, and North Central regions through academic partnerships. Long-term data collection will expand to the North Coast region in 2017-2018.
- Improving the capacity of DFW to collect and synthesize data.
- Expanding science-management collaborations through funding post-doctoral positions co-mentored by UC Davis and DFW.
- Developing and launching a comprehensive information management system that will connect to existing data platforms, and will be publicly accessible.

The Statewide Monitoring Action Plan (Action Plan) currently in development (further described in chapter 9) will identify metrics and priority sites for MPA long-term monitoring, and will guide future spending. DFW and OPC are leading the development of the Action Plan, and plan to release it in mid-2018. There will be both a formal public comment and peer review process prior to the finalizing this Action Plan.

[14] Proposition 84: The Safe Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond of 2006.

9. Building an Effective MPA Monitoring Program

The preceding sections have detailed the elements of the MPA monitoring framework developed to meet the requirements of the MLPA: Assessing Ecosystem Condition and Trends (Section 4); and Evaluating MPA Design and Management Decisions (Section 5). As of 2017, regional baseline monitoring (Phase 1) is close to completion in all four coastal regions. California has now begun to broaden monitoring efforts to statewide long-term monitoring (Phase 2) through an adaptive management process. This section summarizes the elements that will inform Phase 2 and adaptive management strategies of the network moving forward.

AN ADAPTIVE MANAGEMENT PROCESS FOR LONG-TERM MONITORING

Adaptive management is a process that aims to learn from program actions to guide and improve management policies and effectiveness related to the MPA Network.[15] The MLPA requires the State to apply an adaptive management process to the MPA Management Program in order to help evaluate the effectiveness of the network at meeting the goals of the MLPA. An adaptive management strategy is well suited for cases where there is uncertainty surrounding the impacts of management actions, such as those applied to the MPA network. It also allows for responsive change in management measures based on emerging ecosystem stressors, such as climate change effects and water quality degradation. Adaptive management strategies tightly align with the goals of the MLPA and aim to:

- Protect the structure and function of marine ecosystems
- Improve native marine life populations, including those of economic value
- Ensure minimal disturbance while allowing for sustainable opportunities for recreation, education, and research
- Use learning acquired through administration of the MPA Management Program to adaptively manage the objectives, management measures, enforcement efforts, and scientific guidelines to inform management decisions
- Ensure MPAs function as a cohesive network

FGC plans to undertake a formal management review on a 10-year cycle that will emphasize ecological, socioeconomic, and governance aspects of the network of MPAs. FGC may choose to take long-term adaptive management actions that will remain ongoing in between review cycles, if data and other information gathered through the MPA Management Program support a change. The MPA Management Program is composed of four components: 1) outreach and education, 2) research and monitoring, 3) enforcement and compliance, and 4) policy and permitting. Building an effective statewide, MPA Monitoring Program which is nested under the research and monitoring component, will facilitate adaptive management by providing ongoing information on the biological, ecological, and socioeconomic metrics that feed into the evaluation of the network's efficacy.

[15] DFW (2016): California's MLPA Master Plan for MPAs. Section 4.1.

THE STATEWIDE LONG-TERM MONITORING PROGRAM

The Statewide MPA Monitoring Program, which drives the research and monitoring component of the MPA Management Program, is anchored by a framework that guides the monitoring of marine ecosystems and human uses both inside and outside of MPAs (Figure 9-1). The Monitoring Program is designed to evaluate the performance of the MPA network at meeting the goals of the MLPA, and is organized into three core elements necessary for efficient implementation and useful results: science, communication, and evaluation. Each component plays a critical role in tracking, communicating, and adapting the monitoring program to changing ocean conditions and management priorities over time so the State can effectively analyze the performance of the MPA Network. Phase 1 of the MPA Monitoring Program will conclude across all four regions in early 2018. Phase 2 began in three of the four regions in 2016 (the North Coast began in 2017), and will continue in order to inform the network's 10-year review cycle.

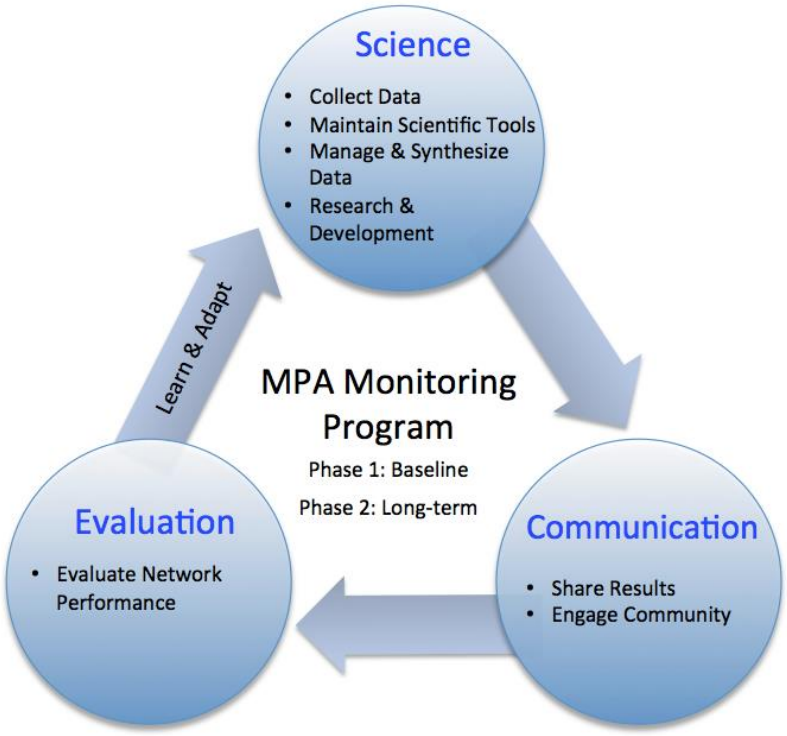


Figure 9-1*: The three core components of the Statewide MPA Monitoring Program. Each component plays a key role in adaptively managing the statewide MPA network.*

NEXT STEPS: GUIDING LONG-TERM MONITORING IMPLEMENTATION

This North Coast MPA Monitoring Plan provides options and recommendations for implementing long-term monitoring, but it is not an implementation plan. However, this Monitoring Plan can help inform statewide strategies for long-term monitoring moving forward including the Action Plan scheduled for mid-2018. Since the initiation of baseline monitoring, which characterized the conditions at or near the time of regional MPA implementation, there has been ongoing work to develop quantitative and expert informed approaches to long-term monitoring. With the critical foundational work completed, these approaches will be synthesized 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 network at meeting the goals of the MLPA. The Action Plan will aggregate and synthesize work to date, as well as novel

quantitative approaches and techniques for prioritizing monitoring sites and ecosystem indicators. When identifying long-term monitoring priorities, the Action Plan will account for resource limitations, ease of monitoring, and the ability to measure how ecosystems respond to protection.

The Action Plan will include approaches for the following:

- Selecting MPA sites for long-term monitoring, including: Quantitative approaches, connection to historic long-term sampling programs, and how monitoring design can inform other management priorities, such as fisheries management, to inform a tiered prioritization of monitoring sites.
- Identifying indicators and metrics: Resources such as regional monitoring plans, workshop outcomes, and expert recommendations from baseline monitoring will guide the selection of indicators and metrics to measure for each habitat and ecosystem feature.
- Developing a standardized and scheduled process for conducting long-term monitoring.
- Evaluating the Monitoring Program adaptively: Monitoring strategies should be evaluated and refined to ensure that the program continues to support an adaptive management strategy of the network.

The California Department of Fish and Wildlife is the agency charged with managing the statewide MPA network. To find out more about California's MPA Management Program visit: www.wildlife.ca.gov/Conservation/Marine/MPAs

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