mpa
MONITORING
ENTERPRISE

MPA MONITORING PLAN

OCTOBER 2010

About this Document

This document was developed to guide monitoring of marine protected areas established under the Marine Life Protection Act in California's North Central Coast region. Twenty-one marine protected areas have been designated in this region, which includes state waters from Alder Creek, near Point Arena, to Pigeon Point, including the Farallon Islands. This plan was adopted by the California Fish and Game Commission on April 7, 2010, shortly before the marine protected areas took effect on May 1, 2010. First released in April 2010, the plan has been updated to reflect regulatory changes to the marine protected areas up to September 30, 2010 and changes in terminology to ensure consistency with monitoring plans for other regions of California. This plan, and a summary version, *The North Central Coast MPA Monitoring Plan - In Brief*, are available from the Monitoring Enterprise website.

Citation: *North Central Coast MPA Monitoring Plan.* MPA Monitoring Enterprise, California Ocean Science Trust, Oakland, California, USA. October 2010.

About the MPA Monitoring Enterprise

The MPA Monitoring Enterprise was created in 2007 to lead the design and implementation of science-based, impartial and cost-effective monitoring of and reporting on the network of marine protected areas established in California under the Marine Life Protection Act. We develop monitoring that assesses and tracks the condition of ocean ecosystems and evaluates the effects of marine protected area design and management, in order to evaluate the performance of marine protected areas in meeting policy goals and inform future management decisions. We work closely with the California Department of Fish and Game and the California Ocean Protection Council and engage scientists and stakeholders to ensure monitoring is based on the best available science, reflects public interests, and meets management needs.

CALIFORNIA OST Ocean Science Trust
Connecting Science to Ocean Management

The MPA Monitoring Enterprise is housed within the California Ocean Science Trust, a non-profit organization established pursuant to the Coastal Ocean Resources Stewardship Act of 2000 to provide scientific guidance to the state on ocean policy issues. More information about the MPA Monitoring Enterprise can be found at monitoringenterprise.org.

North Central Coast MPA Monitoring Plan

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

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- Department of Fish & Game
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- Marine Life Protection Act Initiative
- Natural Resources Agency
- Ocean Protection Council
- State Coastal Conservancy

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EXECUTIVE SUMMARY

ROLE OF THIS PLAN

The 1999 California Marine Life Protection Act (MLPA, Chapter 10.5 of the California Fish & Game Code, §2850-2963) directs the state to complete a statewide network of marine protected areas (MPAs). The MLPA also requires monitoring of MPAs to facilitate adaptive management of MPAs and ensure that the MPA network meets the goals of the Act. On August 5, 2009, the California Fish and Game Commission adopted a regional MPA network for a section of California's waters called the North Central Coast region and these MPAs took effect on May 1, 2010. This region extends from Alder Creek, near Point Arena, to Pigeon Point, and includes waters surrounding the Farallon Islands. The regional MPA network includes 21 MPAs, of three different types (state marine reserves (SMRs), state marine parks (SMPs), and state marine conservation areas (SMCAs)), and additional special closures and state marine recreational managed areas (SMRMAs).

This plan has been developed to guide monitoring of MPAs in the North Central Coast region that will meet MLPA requirements. It presents a framework for MPA monitoring, and monitoring elements and approaches for implementing the framework. The plan provides a flexible, scalable approach to implementing MPA monitoring, to make best use of available resources and potential partners.

This is not a monitoring workplan, or a monitoring implementation plan. The framework and approaches described in this plan will be implemented in two complementary stages: 1) the North Central Coast MPA Baseline Program, which will begin in 2010 and continue through 2013; and 2) long-term monitoring, which will build on the foundation established through baseline monitoring. Implementation of long-term monitoring will require selecting the monitoring elements to implement and the levels at which to implement them, and designing the sampling or monitoring data collection plan accordingly. This plan provides guidance for making those decisions, and can serve as a foundation for developing a long-term monitoring implementation plan, building on the knowledge gathered through the Baseline Program.

This plan has been developed by the MPA Monitoring Enterprise, in close collaboration with the California Department of Fish and Game, and through consultations with stakeholders and scientists. This plan was adopted by the California Fish and Game Commission on April 7, 2010, and approved for inclusion in the MLPA Master Plan for Marine Protected Areas, thus formally establishing it as part of the policy guiding MLPA implementation. The primary intended audiences for this plan are the Department of Fish and Game and the Fish and Game Commission, as well as MPA stakeholders, existing and potential partners in conducting MPA monitoring, and existing and potential funders of MPA monitoring.

This plan is intended to be 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, and this plan updated accordingly.

SETTING THE SCOPE OF MPA MONITORING

Under the MLPA, the North Central Coast regional MPA network must meet six goals, which include both ecological and socioeconomic goals. The broad scope of the MLPA goals leads to an ecosystem-based focus to MPA monitoring, which allows assessment of effectiveness of the MPAs in protecting populations, species, habitats, and ecosystems and explicitly includes humans.

The MLPA Master Plan for Marine Protected Areas, the principal policy document guiding implementation of the MLPA, recommends reviews of the MPAs at five-year intervals following their establishment, and calls for monitoring designed to support these reviews, so that monitoring is useful to managers and stakeholders for improving MPA management. The

MLPA Master Plan further notes that to meet this role, the results of monitoring and evaluation must be communicated to decision makers and the public in terms that they can understand and act upon. Accordingly the monitoring plan has been designed to meet these requirements.

The North Central Coast MPA planning process included development of regional goals and objectives, as well as objectives for each individual MPA. Further, guidelines were developed for MPA size, spacing and other aspects of site and network design. These decisions also inform the scope of MPA monitoring.

Additionally, policies and programs closely related to the MLPA have been considered in designing MPA monitoring, and should be considered again during monitoring implementation. These include other marine managed area programs, such as those carried out by the State Park and Recreation Commission and the State Water Resources Control Board, and the California Marine Life Management Act (MLMA, Stats. 1998 Ch. 1052), which governs state-managed fisheries. MPA monitoring can and should benefit fisheries management. Accordingly, the MPA monitoring metrics in this plan have been selected to benefit fisheries management to the extent possible without compromising the ability to best meet MLPA requirements.

To reflect these various policy elements and considerations, MPA monitoring should incorporate several design characteristics. It should be hierarchical, efficient, designed to generate interpretable and synthesizable data, and adaptable to reflect available resources and evolving management priorities. The monitoring framework and approaches described in this plan have these features, and consist of two core monitoring elements: 1) assessing the condition of North Central Coast ecosystems and how conditions change over time (i.e., 'status and trends' monitoring); and 2) evaluating specific MPA design and management decisions (i.e., 'management effectiveness' monitoring).

This monitoring plan considers all North Central Coast MPAs, SMRMAs and special closures, and, because MPA assessment relies in part on comparing conditions inside and outside MPAs, the entire North Central Coast region. This monitoring plan includes guidance for the selection of MPAs to be monitored to provide coverage of the region and the regional network.

DEVELOPING AN ECOSYSTEMS APPROACH

Nine 'Ecosystem Features' have been selected to collectively represent and encompass the North Central Coast region's ecosystems, including their human inhabitants, for the purposes of MPA monitoring. The Ecosystem Features provide the overarching structure for MPA monitoring, and are:

- Kelp and Shallow Rock Ecosystems
- Mid-depth rock Ecosystems
- Rocky Intertidal Ecosystems
- Subtidal Soft-bottom Ecosystems
- Estuarine & Wetland Ecosystems
- Beaches and Soft-bottom Intertidal Ecosystems
- Nearshore Pelagic Ecosystems (i.e., the water column habitat within state waters)
- Consumptive Uses
- Non-consumptive Uses

The Ecosystem Features provide the basis for assessing the condition of North Central Coast ecosystems, and how conditions change over time. They also guide the evaluation of MPA design and management decisions.

By reducing fishing, MPAs can lead to increases in the abundance and size of some fish and invertebrates within their boundaries. Any increases in the density and size of fish inside MPAs are generally predicted to be observable first in faster

growing and predatory species, and with species or populations that previously were heavily fished; this initial effect of MPA implementation is one of the most widely demonstrated worldwide. The rates and magnitudes of population increases are also likely to be influenced by historical levels of fishing in areas subsequently designated as MPAs as well as ongoing fishing activities inside MPAs that allow fishing and outside MPA boundaries. Such effects are detected by examining population trends before and after MPA implementation inside and outside MPAs and taking into account historical and current information on fishing activities. These methods allow, for example, examination of the extent to which the MPAs (as compared to other factors such as fisheries management measures) may or may not be contributing to any observed increases in fish size or numbers.

Rates and magnitudes of population increases are also influenced by the level of compliance with MPA regulations. Non-compliance with MPA regulations is a challenge for MPAs worldwide. Illegal take of marine organisms, for example, can greatly undermine the effectiveness of MPAs. In the monitoring described in this plan, these potential effects are detected by examining differences in the size and local density of select species inside and outside of MPAs with comparable habitats and incorporating available information on legal and illegal fishing distribution and intensity.

Disentangling the effects of MPAs from those of large-scale ocean dynamics (such as the Pacific Decadal Oscillation, or PDO) and broader human influences (such as water quality impairment) will be achieved through the collection of data over long time scales to incorporate into time series analyses and interpretation. Additional insights will be garnered through comparisons of changes in fished and unfished species inside and outside MPAs with comparable habitats and ecosystems and at different locations throughout the region. However, while some changes may be observable fairly quickly, as has occurred with the Channel Islands MPAs, demonstrating that such changes are due to the MPAs is likely to take many years of monitoring.

The ecosystems approach and the specific ecosystem features selected have been designed to meet the requirements of MLPA, but may also directly benefit other programs, including fisheries management. As one example, MPA monitoring will generate new, detailed data on relative abundances and size distributions of fishery species, which may be useful as inputs for population modeling by fishery scientists.

ASSESSING ECOSYSTEM CONDITION & TRENDS

Tracking ecosystem conditions over time will employ a 'status and trends' monitoring approach focused on the nine Ecosystem Features. Accordingly, nine ecosystem condition monitoring modules have been developed, one for each Ecosystem Feature. For each module, two possible implementation options have been developed. Ecosystem Feature Assessments require technically demanding or otherwise comparatively resource-intensive monitoring methods, and use a hierarchical system of key attributes and indicators or focal species. For each Ecosystem Feature, key attributes have been identified that will be used collectively to assess Feature condition. For each key attribute, selected indicators and, where appropriate, focal species, have been identified that collectively allow assessment of that attribute. A second implementation option, which may be used instead of or in combination with Ecosystem Feature Assessment, is Ecosystem Feature Checkup. The Checkup option has been developed to take best advantage of potential community-based or citizen-scientist monitoring partnerships, and uses comparatively simpler sampling protocols and methods to monitor a set of vital signs.

These approaches are designed to build on the foundation of knowledge to be generated through the North Central Coast MPA Baseline Program. The Baseline Program began in 2010 and will extend through 2013, and has two complementary purposes: baseline characterization; and assessment of initial socioeconomic and ecological changes following MPA implementation.

The monitoring metrics 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 fishery 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. Examples include brown rockfish (*Sebastes auriculatus*) and copper rockfish (*Sebastes caurinus*), species for which stock assessments have not been conducted.

EVALUATING MPA DESIGN & MANAGEMENT DECISIONS

The establishment and on-going management of MPAs involve a number of decisions, ranging from design decisions made during the MPA planning process, such as MPA size and spacing, to day-to-day management decisions made to address ongoing and emerging issues, such as those related to managing visitors to MPAs. Monitoring includes assessing the effects of selected design and management decisions on ecosystems and their components. These evaluations, together with assessments of ecosystem condition and trends, should inform future management decisions, thus facilitating adaptive MPA management as required under the MLPA.

Evaluation of design and management decisions will employ a 'management effectiveness' monitoring approach that uses structured assessments of the effects of specific MPA and MPA network design and management decisions on Ecosystem Features or Feature components. This monitoring element consists of two monitoring modules. Short-term evaluations are those expected to generate conclusive findings within four years that can be used with confidence to inform MPA management decisions. Such evaluations can be completed within the five-year review periods recommended by the MLPA Master Plan. Many of the short-term evaluations are likely to focus on day-to-day MPA management decisions, such as those relating to visitor management, or on tightly focused evaluations of a particular MPA design decision on a specific and readily measured ecosystem component, such as the bycatch rates of a particular fishery that is allowed within an MPA. Long-term evaluations are those expected to take more than four years to generate conclusive findings, and are likely to include evaluations of fundamental site and network design decisions, such as those relating to MPA size and network connectivity. These evaluations will span multiple five-year review periods, and may need to be managed differently as a result.

Both short- and long-term evaluations must be carefully structured to ensure they generate conclusive results that can be used with reasonable confidence to inform management. Potential evaluations should be tested against this standard, and also ranked according to management urgency, direct relevance or applicability to management decisions, feasibility, time required for producing actionable results, and cost-effectiveness.

Initial possible short-term and long-term evaluations have been developed, including many that are based on input from stakeholders during the development of the monitoring plan. These evaluations form an initial inventory which should be further refined at the time of implementation.

REPORTING MONITORING RESULTS

To facilitate adaptive MPA management, monitoring reports should include highly synthesized and interpretable results, presented as key conclusions or findings that clearly pertain to MLPA requirements, including assessing the regional MPA network's effectiveness in meeting MLPA goals and facilitating adaptive MPA management. Monitoring reporting should present key findings in intuitive ways, appropriately incorporate expert judgment needed to interpret complex and multidisciplinary data, and be timely relative to MPA management decisions and processes, such as the five-year reviews recommended in the MLPA Master Plan. Analysis and reporting of monitoring results should be transparent, with analytical methods and assumptions, as well as supporting data, made available for independent analysis.

Example 'mock-ups' showing possible pages of future monitoring reports are included in the monitoring plan to illustrate aspects of the general reporting approach, designed to facilitate adaptive MPA management by presenting interpretable, relevant summary information in an intuitive way. Pages such as these would be accompanied by detailed supporting and technical information and analytical results.

The North Central Coast MPAs were adopted by the Fish and Game Commission in August, 2009, and took effect on May 1, 2010. The first North Central Coast MPA monitoring report should thus be made available in late 2014 or early 2015, assuming that the first of the five-year reviews recommended in the MLPA Master Plan will occur in mid- to late 2015.

Maintaining and making available MPA monitoring information, including data, reports, and other associated information will require the use of an MPA Monitoring Information Management System (IMS). The IMS should accommodate different types of users, including technically advanced users seeking to download data in order to conduct their own analyses, as well as users interested only in highly synthesized information products. The MPA Monitoring Enterprise is currently completing an analysis of user needs.

DEVELOPING MONITORING PARTNERSHIPS

This monitoring plan has been designed to facilitate development of partnerships to conduct and support monitoring of the North Central Coast regional MPA network. Potential partners are many, and include state and federal agencies, research institutions, and citizen-science and community programs and organizations, among others. Partnerships may greatly assist with conducting MPA monitoring, interpreting monitoring results, and disseminating monitoring information, but must be carefully developed and maintained to be effective. This will require the development of monitoring partnership agreements, to clearly document the roles and responsibilities of each partner. As appropriate, partnership agreements should specify the monitoring data to be collected, methods to be employed, standards and formats for information to be provided, content and timing of reports, training of data collectors, and other details necessary to protect information quality.

The plan outlines further considerations for partnerships, focusing on those established to collect monitoring data, which are likely to be initial top priorities for implementation.

ESTIMATING COSTS OF MONITORING COMPONENTS

A key consideration for the implementation of this monitoring plan is financial cost. Existing monitoring programs provide a basis for estimating some of the potential costs of monitoring North Central Coast MPAs. Many of the MPA monitoring activities conducted in the Channel Islands and Central Coast MPAs are similar to some that are included in this monitoring plan. Other MPA and non-MPA programs in California also conduct activities that are similar to some of those included in this plan.

The financial costs of implementing many of the potential monitoring components have been estimated based on information from these existing programs, adjusted as needed to apply to the North Central Coast region or to the specific array of adopted MPAs. These estimates include costs to collect, analyze, and report monitoring results for potential individual monitoring components. Cost estimates include standard components of funded projects such as overhead costs but do not include leveraged or matched funds. Leveraging resources and taking advantage of existing expertise and capacity in the region will be important in implementing monitoring cost-effectively. The cost estimates assume that leveraged funds will be available to provide additional support for monitoring activities, using existing programs and cost-sharing arrangements as a model.

These cost estimates for potential monitoring components are used to develop recommended monitoring priorities and guide development of an effective and coherent MPA monitoring program that will meet MLPA requirements in an efficient, cost-effective fashion.

BUILDING AN EFFECTIVE MPA MONITORING PROGRAM

The monitoring plan elements have been designed as stand-alone modules, including the nine ecosystem assessment modules (one for each Ecosystem Feature) and the two MPA design and management decision evaluation modules (short- and long-term evaluations). Each module may be scaled to reflect available resources, and implementation may prioritize a limited number of modules.

Two example monitoring programs have been developed, illustrating the selection and scaling of monitoring modules. The programs have been designed to reflect two hypothetical regional MPA monitoring budget scenarios, of $1,000,000 and $2,000,000 annually. A 'spending plan' has been developed for each scenario, depicting the monitoring activities to be conducted in each of four data collection years, leading to analysis and reporting in the fifth year, in order to inform the five-year reviews recommended by the MLPA Master Plan.

The spending plans reflect all guidance provided in this monitoring plan, and also reflect priorities identified during consultations with stakeholders in the region. The spending plans assume implementation of MPA monitoring using the partnerships approach and reflecting the cost estimates developed from existing monitoring programs. The spending plans allocate the available budget ($1,000,000 or $2,000,000 annually) to collect, analyze and report monitoring results, but do not include all possible costs of monitoring implementation. As noted earlier, the cost estimates for individual components of monitoring assume leveraging of funds comparable to MPA monitoring programs conducted to date, such as in the Channel Islands and Central Coast region. Additionally, Department of Fish and Game core costs, such as for staff, are not included. Nonetheless, the spending plans include the majority of anticipated new costs of MPA monitoring in the North Central Coast region, tailored to take best advantage of the two hypothetical budget scenarios.

Both spending plans implement only strategically selected portions of the full scope of MPA monitoring included in this monitoring plan. Nonetheless, both include assessment of priority Ecosystem Features and provide for select short- and long-term evaluations of MPA design and management decisions. Thus both spending plans meet MLPA requirements, as they will enable assessment of the MPA network's effectiveness in meeting MLPA goals and facilitate adaptive MPA management.

FREQUENTLY ASKED QUESTIONS

1. What is the role of this document?

This document provides a scientifically based framework and approach to guide monitoring of MPAs in the North Central Coast region, along with options and recommendations for implementation. The approach and framework form the basis of the North Central Coast MPA Baseline Program and are designed to guide implementation of long-term MPA monitoring in the region.

This document is not a workplan or implementation plan for MPA monitoring. Baseline monitoring is being implemented through the North Central Coast MPA Baseline Program (see Question 5). For long-term monitoring, decisions about which parts of this monitoring plan to implement, and at what levels, will be made during implementation. This plan includes guidance for making those decisions.

2. Who are the intended audiences for this document?

This document has been developed to provide guidance to the Department of Fish and Game, as the agency with statutory authority for implementing the Marine Life Protection Act (MLPA), and for the Fish and Game Commission, as the decision-making entity designated under MLPA. Other key audiences for this document include MPA stakeholders, existing and potential partners in conducting MPA monitoring, and existing and potential funders of MPA monitoring.

3. How and when will this plan be implemented?

The approach and framework forming the core of this monitoring plan are being implemented initially though the North Central Coast MPA Baseline Program, which will began in 2010 and will continue through 2013, then through development of long-term monitoring. Long-term monitoring will follow, and build on the foundation established by, the Baseline Program (see Question 5) and will be implemented when resources become available. Long-term monitoring has been designed to be implemented through cooperative efforts and partnerships, to make efficient use of available resources.

4. Who will oversee and manage MPA monitoring?

Under the MLPA, the Department of Fish and Game has statutory authority for implementing MPAs. The Department has an existing infrastructure in place within its Marine Region's MPA Project that will be a source for the oversight and management of the MPA monitoring. Additionally, the Department, through potential future partnerships, could augment its existing resources for MPA monitoring.

5. Is this monitoring plan related to the North Central Coast MPA Baseline Program?

Yes. This plan describes the approach and framework for monitoring that underpins both the Baseline Program and long-term monitoring. Long-term monitoring will build on the foundation of information and knowledge to be developed through the Baseline Program, which will begin in 2010 and continue through 2013. The Baseline Program was developed to address the most time-sensitive aspects of MPA monitoring, specifically: (1) characterization of key aspects of the ecology and socioeconomics of the North Central Coast region near the time of MPA implementation, and; (2) documentation of initial changes after MPAs take effect. Findings from the Baseline Program will be used to refine the long-term monitoring metrics and inform implementation of long-term monitoring.

The Ocean Protection Council has authorized $4M to support the North Central Coast MPA Baseline Program. A Request for Proposals (RFP) to implement the program was released by California Sea Grant in July, 2009. Proposals received in response to the RFP were subjected to rigorous review of their scientific and technical merits, alignment with the purposes of the Baseline Program, and cost. Eleven projects were selected for funding. More information is available on the California Sea Grant website at www.csgc.ucsd.edu.

6. What are the core elements of MPA monitoring?

The MPA monitoring plan adopts an ecosystem-based approach to provide a broad umbrella to encompass habitats, marine life populations, diversity and abundance, and human activities, including consumptive and non-consumptive uses of marine resources and ecosystems. This enables assessment of the performance of the regional MPA network against the full range of MLPA goals. The monitoring plan adopts a hierarchical framework to allow collection and reporting of results at various scales including the North Central Coast region, individual MPAs, individual ecosystem types (e.g., kelp forests), and selected species.

Nine Ecosystem Features, selected in consultation with stakeholders and scientists to collectively represent and encompass the North Central Coast marine ecosystems and human uses, provide the overarching structure for MPA monitoring. The Ecosystem Features provide the top level of the monitoring framework, which includes two core monitoring elements: long-term tracking of ecosystem condition; and evaluation of specific MPA design and management decisions. Each component of the monitoring plan is designed to be adaptable to best fit with available resources and capacity at the time of implementation. For example, two options have been included for monitoring ecosystem condition through time: Ecosystem Feature Checkups are designed to be implemented through partnerships with citizen-science groups and community organizations, while Ecosystem Feature Assessments are designed to take advantage of technically robust monitoring partnerships such as among state agencies and with federal agencies and research institutions.

The plan also recognizes the importance of other types of information, referred to as contextual information, for correctly interpreting monitoring results. Contextual information includes, for example, oceanographic, water quality, and economic information. Linkages and information exchanges with programs collecting contextual information are explicitly provided for in the plan.

7. Does this plan include monitoring of MPA enforcement and compliance?

No, not directly. Information about MPA compliance will be essential for correctly interpreting monitoring data, along with information about economic trends, oceanographic conditions, water quality and other vital information. MPA enforcement and compliance monitoring is the responsibility of the Department of Fish and Game and will be conducted by the Department and its potential partners, and all available compliance information will be used during analysis and interpretation of monitoring results.

However, the monitoring framework and approaches described in this plan have been designed to include assessment of the effects of consumptive and non-consumptive human uses on marine ecosystems and ecosystem components. This includes, for example, possible illegal taking of marine organisms.

8. Does this plan include fisheries monitoring as part of MPA monitoring?

Yes. Fisheries monitoring is required to assess the effectiveness of the MPAs and to meet the requirements of the MLPA. The monitoring plan incorporates monitoring of socioeconomic and ecological aspects of consumptive human

activities, including commercial and recreational fishing. For example, monitoring of the spatial distribution, landings, catch per unit effort (CPUE), and economic value of commercial and recreational fisheries is included, focusing on economically and ecologically important species predicted to respond to MPA implementation. The monitoring plan incorporates use of existing fisheries information as well as collection of new data at the spatial resolution necessary to detect potential MPA effects. In addition, monitoring of ecological characteristics, such as density and size structure, of selected fishery species is also included. For example, 10 of the 19 species in the Nearshore Fishery Management Plan are included as Tier 1 or Tier 2 metrics within Ecosystem Feature Assessments. However, MPA monitoring does not encompass all monitoring that may be required for fisheries management purposes.

9. Will information collected through MPA monitoring also inform fisheries management?

Yes. MPA monitoring metrics have been chosen that will benefit fisheries management as much as possible without compromising the ability to meet MLPA requirements For example, many of the focal species selected for monitoring are fished species, including some unassessed species. Both the North Central Coast MPA Baseline Program and long-term monitoring will generate ecological data, including abundances and size distributions, for important fishery species, as well as the status of and changes in commercial and recreational fisheries. The plan also includes monitoring of key aspects of commercial and recreational fisheries to assess socioeconomic changes following MPA implementation. These data can inform fisheries management. However, MPA monitoring is not intended to be sufficient to support fisheries management.

10. Does this plan consider water quality?

Yes. Some species that are sensitive to water quality are included in the monitoring plan. Direct measurement of pollutant or contaminant levels and other, more comprehensive water quality monitoring is beyond the scope of this monitoring plan. However, water quality information will be essential for correctly interpreting monitoring results. Linkages with programs monitoring water quality in the North Central Coast region are provided for in the plan to ensure exchange of information and inform analysis of MPA monitoring data.

11. Does this plan consider climate change?

Yes. Some species that are expected to be sensitive to possible climate change effects (such as by changing range) are included in the monitoring plan. Direct monitoring of possible climate change effects, such as ocean acidification and changes in the strength or timing of upwelling events, is beyond the scope of this monitoring plan. However, such information will be important for correctly interpreting monitoring results, and available information will be used during the analysis of monitoring data.

12. Does this plan consider the dynamic nature of marine ecosystems?

Yes. The monitoring plan recognizes the natural spatial and temporal variation in ecosystems and ecosystem components, and this has been considered in the design of monitoring and the selection of monitoring metrics. Collection and analysis of time series data will be essential to reveal trajectories of ecosystem change inside and outside MPAs, and to assess potential MPA effects in a naturally variable system. In addition, analysis of monitoring data will take into account contextual information on oceanographic conditions and trends.

13. How many MPAs will be monitored and how often?

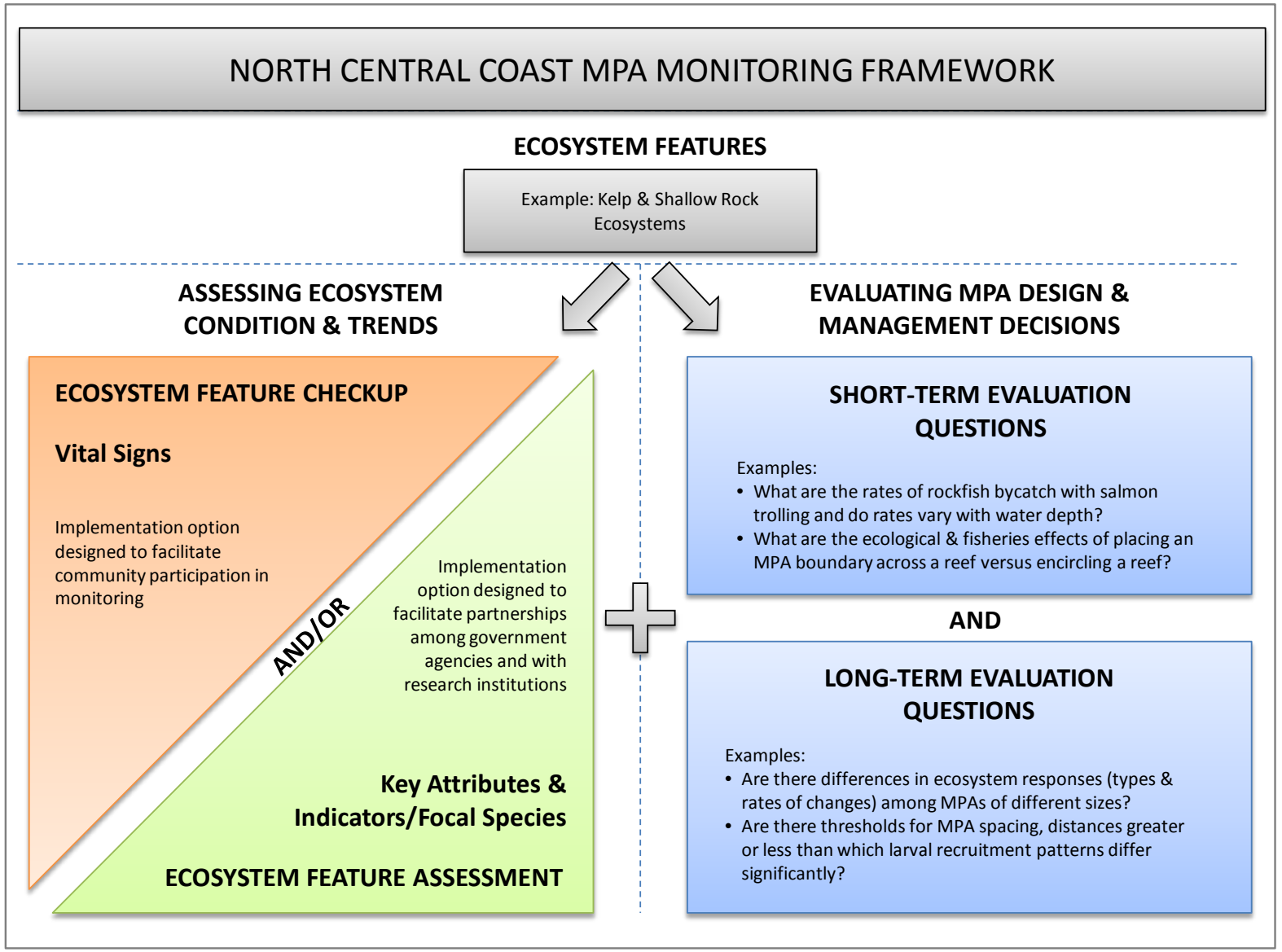
The number of MPAs that will be monitored and the frequency of monitoring will depend on available resources, management priorities at the time of implementation, and the specific monitoring methods employed.

The Baseline Program (see Question 5) will encompass as many MPAs as possible and will include projects of up to three years in duration to provide a robust foundation to inform and support long-term monitoring. For long-term monitoring, specific MPAs to be monitored will be selected when long-term monitoring is implemented. The monitoring plan includes two example monitoring spending plans based on monitoring six MPAs and six reference sites for each of the nine Ecosystem Features. Because not all Ecosystem Features are found in all MPAs, this would include sampling of approximately 12-15 MPAs.

14. What is the cost of MPA monitoring?

For baseline monitoring, the Ocean Protection Council has provided $4M to help support collection and analysis of baseline data (see Question 5).

For long-term monitoring, this plan includes two example MPA monitoring spending plans, reflecting two hypothetical regional MPA monitoring budget scenarios of $1,000,000 and $2,000,000 annually. These budget scenarios are for illustration purposes only. The spending plans are based on costs of MPA monitoring and related activities currently occurring in California, adjusted and augmented as needed to implement North Central Coast MPA monitoring that will meet MLPA requirements. The spending plans include collecting, analyzing, and reporting monitoring results, assume leveraging of resources consistent with existing programs and partnerships, and do not reflect all possible costs of monitoring implementation (for example, Department of Fish and Game staff costs are not included). However, the spending plans include the majority of anticipated new costs of MPA monitoring in the North Central Coast region, tailored to take best advantage of the two hypothetical budget scenarios. Either spending plan would enable assessment of the effectiveness of the regional MPA network in meeting MLPA goals and would facilitate adaptive MPA management, as required by the Act.



Schematic diagram of the North Central Coast MPA Monitoring Framework showing the two principal monitoring elements: Assessing Ecosystem Condition & Trends; and Evaluating MPA Design & Management Decisions. Ecosystem condition and trends may be monitored using Ecosystem Feature Checkups, which employ monitoring metrics called Vital Signs, or through Ecosystem Feature Assessments, which employ Key Attributes and Indicators or Focal Species as monitoring metrics. MPA design and management decisions are evaluated through answering targeted questions, including both short-term questions, expected to be answered within four years (one monitoring and reporting cycle), and long-term questions, expected to take longer than four years to answer. Monitoring is focused using nine Ecosystem Features, which collectively represent and encompass the North Central Coast ecosystems, including humans, and is designed to deliver useful results in advance of the five-year MPA reviews recommended by the MLPA Master Plan.

MONITORING PLAN COLOR GUIDE

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1. Introduction

- Role of this plan
- Scope of this plan
- How this plan was developed

The Marine Life Protection Act (MLPA) was passed by the California legislature in 1999 (Chapter 10.5 of the California Fish & Game Code, §2850-2963) and directs the state to reevaluate and redesign California's system of marine protected areas (MPAs). The MLPA also requires monitoring of MPAs, specifically "monitoring, research, and evaluation at selected sites to facilitate adaptive management of MPAs and ensure that the [MPA] system meets the goals stated in this chapter".[1] The MLPA Master Plan for Marine Protected Areas (the MLPA Master Plan), the principal policy document guiding implementation of the MLPA, directs that MPA monitoring programs be developed sequentially as planning is completed for each region.[2] The regional MPA network for the North Central Coast region was adopted by the California Fish and Game Commission on August 5, 2009, and the MPAs took effect on May 1, 2010[3]. Accordingly, this plan has been developed for monitoring MPAs in the North Central Coast region to meet MLPA requirements.

ROLE OF THIS PLAN

This plan has been prepared by the MPA Monitoring Enterprise, currently a program of the non-profit California Ocean Science Trust, in close collaboration with the California Department of Fish and Game, scientists, and stakeholders. It is intended as guidance for the Department of Fish and Game and others involved in conducting or supporting MPA monitoring in the North Central Coast region. It has been developed to meet the requirements of the MLPA, including assessing the performance of the regional MPA network in meeting MLPA goals, regional goals and objectives, and site-level objectives. This plan has been adopted by the California Fish and Game Commission, establishing it as part of the policy guiding implementation of the MLPA.

Under the MLPA, monitoring must facilitate adaptive management of MPAs, which means it must lead to the development of monitoring results and reports that are timely and useful for policy-makers, resource managers, stakeholders, scientists, and other participants in MPA management decisions and processes. In particular, monitoring should be designed to provide useful information to support the five-year reviews of the MPAs that are recommended in the MLPA Master Plan.

This monitoring plan has been designed to meet these requirements. It presents a framework for MPA monitoring, and guidelines for implementing that framework. Included are recommended approaches to setting monitoring priorities, including prioritizing the elements of monitoring to be implemented, and selecting the scale at which prioritized elements will be implemented.

This is not a monitoring workplan, or a monitoring implementation plan. The framework and approaches described in this plan will be implemented in two complementary stages: 1) the North Central Coast MPA Baseline Program, which began in 2010 and will continue through 2013 (see below); and 2) long-term monitoring, which will build on the foundation established through baseline monitoring. Implementation of long-term monitoring will require selecting the monitoring elements to implement and the levels at which to implement them, and designing the sampling or monitoring data collection plan accordingly. This North Central Coast MPA Monitoring Plan provides guidance for making those decisions, setting monitoring priorities, and implementing coherent long-term MPA monitoring that will meet MLPA requirements.

[1] Fish and Game Code section 2853(c)(3). See also sections 2852(a) and 2856(a)(2)(H).
[2] California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008, p. 73.
[3] Following a decision on June 24, 2010 by the California Fish & Game Commission, Stewarts Point State Marine Reserve was amended to create the shoreline Stewarts Point State Marine Conservation Area. Further details are on the Department of Fish & Game website.

This plan can thus provide the foundation for developing a long-term monitoring implementation plan, building on the knowledge and information generated through the Baseline Program.

The primary intended audiences for this plan are the Department of Fish and Game and the Fish and Game Commission, as well as MPA stakeholders, existing and potential partners in MPA monitoring, and existing and potential funders of MPA monitoring.

This plan is intended to be 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 priorities, approaches, and methods should evolve as appropriate to reflect increasing knowledge and respond to changes in the environment or management priorities. Each recommended five-year review will provide a good opportunity to evaluate the effectiveness of monitoring and make any necessary updates to this plan.

While this plan has been designed explicitly to guide MPA monitoring in the North Central Coast region, the underlying principles and concepts have been developed to be applicable more broadly, in order to facilitate future comparisons among MLPA regions and to contribute to assessment of the statewide MPA network, once complete.

SCOPE OF THIS PLAN

This plan has been designed for the monitoring of MPAs implemented in the North Central Coast region, which includes all state waters along the California coastline from Alder Creek, near Point Arena, to Pigeon Point, including the Farallon Islands (see map in Appendix C-1). The regional MPA network includes 21 MPAs, of three different types (state marine reserves (SMRs), state marine parks (SMPs), and state marine conservation areas (SMCAs)), and additional special closures and state marine recreational managed areas (SMRMAs)[4]. SMRs prohibit fishing and other extractive uses, while allowing research, education and non-consumptive uses consistent with the protection of marine resources**.** SMPs and SMCAs allow a range of uses, including specified fishing and other extractive activities. Special closures are year-round or seasonal closures to human access designed to help protect sea bird nesting, breeding, and roosting areas and/or marine mammal rookeries, haul-outs, and breeding colonies. Finally, SMRMAs are marine or estuarine areas designed to protect, enhance or restrict recreational activities. In the North Central Coast region, designated SMRMAs prohibit all extractive uses except waterfowl hunting. This plan considers all MPAs, special closures and SMRMAs in the region, providing for monitoring inside and outside MPAs. It includes all major marine and estuarine ecosystem types within the region, and explicitly considers humans as part of ecosystems.

This plan has been designed to reflect the scope of the MLPA. It includes fisheries monitoring components needed to allow assessment of the regional MPA network's effectiveness in meeting MLPA goals. It considers water quality, invasive species, and climate change through inclusion of some monitoring metrics expected to be sensitive to these influences. However, this plan is intended to complement, and not duplicate, monitoring capacities and responsibilities that are beyond the remit of the MLPA and are resident in other programs. Linkages and information exchanges with other programs will nonetheless be essential for effective MPA monitoring and assessment. During analysis of monitoring results, information from other monitoring programs, such as fisheries and water quality monitoring, will be critical for correctly interpreting MPA information. MPA monitoring findings may also provide useful information for those programs. Two-way information exchanges with these programs will be developed to ensure the best use of information collected.

[4] Definitions of each MPA classification are available in the Public Resources Code (PRC) Section 36700 and 36710.

BUILDING ON THE NORTH CENTRAL COAST MPA BASELINE PROGRAM

This plan provides the framework for both the North Central Coast MPA Baseline Program and for subsequent, long-term monitoring of the regional network component. Much of the detailed guidance in this plan focuses on providing options for long-term monitoring, building on the foundations of information and knowledge to be developed through the Baseline Program, which began in 2010 and will extend through 2013. Additional details of the Baseline Program and its purposes are provided in Chapter 4 and in the Program Request for Proposals (Appendix C-2), but, in brief, the Program was developed to address the most time-sensitive aspects of MPA monitoring, which are:

1. Characterizing key aspects of the ecology and socioeconomics of the North Central Coast region near the time of MPA implementation,
2. Documenting initial changes in the initial years after the MPAs take effect.

The Baseline Program draws upon the same framework as will long-term monitoring, thus, these two components will be coordinated and complementary. Findings from the baseline projects, once complete, will contribute to the evaluation and refinement of this plan, which is anticipated to occur in association with the first of the five-year reviews of the North Central Coast MPAs recommended in the MLPA Master Plan, currently expected to occur in 2015.

BUILDING ON ESTABLISHED FOUNDATIONS, KNOWLEDGE & EXPERIENCE

California is home to long-standing MPA monitoring programs that include university, and local, state, and federal government programs, as well as citizen science programs. For example, an MPA monitoring program was developed in the northern Channel Islands after new MPAs were implemented there in 2003. The Channel Islands MPA monitoring program was designed to address the goals of the Channel Islands MPAs, which were not implemented under the MLPA and have different goals from those designated under the Act. Additionally, the design of the Channel Islands MPA monitoring program focused on building on existing monitoring projects to include the new MPAs. Nonetheless, the knowledge and experience gathered through Channel Islands MPA monitoring have helped shaped the recommendations in this plan.

This plan has also built upon experience with monitoring conducted in the Central Coast region. The Central Coast regional MPA network, implemented under the MLPA, was established in 2007. Monitoring has begun in this region, through baseline projects involving a socioeconomic assessment and two years of ecological data collection. Although final reports from those projects are not yet available, valuable information has been gained and has helped shape monitoring planning for the North Central Coast.

HOW THIS PLAN WAS DEVELOPED

On June 11, 2008, the MLPA Blue Ribbon Task Force transmitted its recommendation for the North Central Coast regional MPA network to the Fish and Game Commission, beginning the regulatory process that led to the adoption of the MPAs on August 5, 2009. In July 2008, the MPA Monitoring Enterprise began designing a process to develop this monitoring plan. To gather initial information about stakeholder perspectives on monitoring MPAs in the region, we began conversations with members of the former North Central Coast Regional Stakeholder Group (NCCRSG). To ensure this plan would reflect the science used to guide design of the North Central Coast MPAs, we also engaged members of the former North Central Coast Science Advisory Team (NCCSAT)[5].

[5] For information on the North Central Coast MPA planning process, including the NCCRSG, NCCSAT, and BRTF recommendation to the Fish and Game Commission, see www.dfg.ca.gov/mlpa/northcentralhome.asp

On October 22-23, 2008, we held a workshop with members of the former NCCRSG and NCCSAT, as well as additional scientists, to identify preliminary priorities for monitoring (see Workshop 1 Report, Appendix C-3). Over the next several months, we analyzed and refined these priorities and worked with former NCCSAT members and other scientists to develop a preliminary, scientifically based monitoring framework to address the priorities in a cohesive and efficient way. On March 11-12, 2009, we held a second workshop with many of the same participants to present the revised priorities and the preliminary framework (see Workshop 2 Report, Appendix C-4). The framework was revised to reflect comments received, and then sent to approximately 20 additional scientists from California, elsewhere in the U.S., and other countries who had been little involved or not involved at all in our previous discussions and workshops, in order to obtain additional technical comments on the overall approach and specific monitoring metrics (see Summary of Additional Technical Comments, Appendix C-5).

The monitoring framework was further revised following receipt of the additional technical comments, and then incorporated into an initial draft of the full North Central Coast MPA Monitoring Plan. The initial draft was provided to the Department of Fish and Game to seek comments on the consistency of the monitoring plan with the Department's mandate under the MLPA and to gather further technical comments on proposed monitoring approaches.

After additional revisions arising from the technical comments provided by the Department of Fish and Game, the Draft North Central Coast MPA Monitoring Plan was released to seek broad public input. Further revisions were made reflecting public submissions received during the comment period. The plan was submitted to the California Fish and Game Commission on February 3, 2010, and adopted on April 7, 2010 for inclusion in the MLPA Master Plan, thus formally incorporating it into the policy guiding MLPA implementation. As discussed above, the plan should be considered a living document, revised as needed to reflect increasing scientific knowledge, changing environmental conditions, evolving management needs and priorities, or other considerations.

Table 1-1. *Major steps in the development of the North Central Coast MPA Monitoring Plan.*

Timing	Monitoring plan development step
Jul. 2008	Planning process design
Aug. – Sep. 2008	Initial conversations with former North Central Coast Regional Stakeholder Group and North Central Coast Science Advisory Team members
Oct. 2008	Initial priority-setting workshop with regional stakeholders and scientists
Nov. 2008 – Mar. 2009	Consultations with scientists to develop monitoring approaches and identify key metrics
Mar. 2009	Follow-up workshop with regional stakeholders and scientists
Mar. – Jun. 2009	Refinement of proposed monitoring approaches following workshop input
Jun. – Jul. 2009	Additional technical comments obtained on draft monitoring framework
Aug. – Sept. 2009	Revision in response to additional technical comments and completion of full draft North Central Coast MPA Monitoring Plan
Sept. – Oct. 2009	Submission of draft plan to Department of Fish and Game for comment on policy, operational, and technical content
Oct. – Nov. 2009	Revision of monitoring plan in response to Department of Fish and Game input
Nov. – Dec. 2009	Public comment period for draft plan
Jan. 2010	Revision of plan in consideration of public comments
Feb. 3 2010	Submission of plan to California Fish and Game Commission
Apr. 7 2010	Adoption of plan by California Fish and Game Commission
Sept 30, 2010	Monitoring plan updated to reflect changes in MPA regulations and some monitoring terminology

2. Setting the scope of MPA Monitoring

- MPA monitoring within an adaptive management framework
- Policy guidance for the scope of MPA monitoring
- Design requirements for MPA monitoring
- Recommended scope of MPA monitoring

A central purpose of this monitoring plan is to provide clear and specific recommendations about what should be monitored, and why. Before choosing the specific indicators and other metrics that should be monitored, however, it is necessary first to define the scope of monitoring, including the scope of information to be collected, the spatial and temporal scope of monitoring, and potential monitoring participants and partners.

MPA MONITORING WITHIN AN ADAPTIVE MANAGEMENT FRAMEWORK

MPA monitoring is one step in a larger cycle of MPA implementation and management. It follows MPA establishment and provides feedback on the effects of MPA management. Thus, as management actions are evaluated, the results are used to improve management over time. Attention to this context ensures that monitoring does not happen for its own sake, but is deliberately designed and timed to feed into the adaptive management loop. An example of an adaptive management cycle is shown in Figure 2-1, annotated to indicate application to the context of the MLPA.

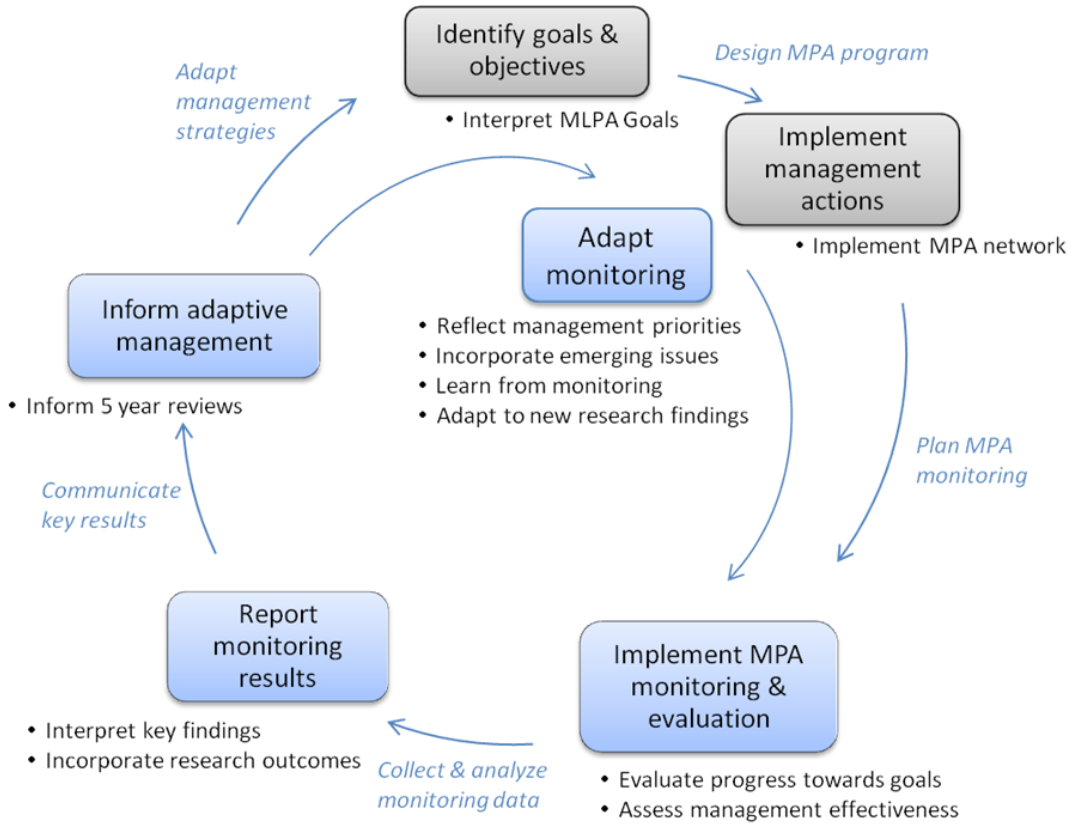


***Figure 2-1**. An illustration of the adaptive management process, annotated to show application to the MLPA context. Monitoring must be designed to evaluate management actions in order to inform management review and adaptation. And monitoring itself must be adapted periodically to remain relevant and useful.*

The scope of monitoring for the North Central Coast regional MPA network is guided by the MLPA, the MLPA Master Plan, and the guidance developed and decisions made during the MPA planning process for the region. The implications of each are discussed below. This information is applied initially to develop design requirements for MPA monitoring, which are then used to set the scope of monitoring in the North Central Coast region.

POLICY GUIDANCE FOR THE SCOPE OF MPA MONITORING

THE MARINE LIFE PROTECTION ACT (MLPA)

The MLPA requires "…monitoring, research, and evaluation at selected sites to facilitate adaptive management of MPAs and ensure that the [MPA] system meets the goals stated in this chapter".[6] The effectiveness of the North Central Coast regional MPA network in meeting MLPA goals will be assessed by comparing indicators and other metrics inside and outside MPAs, at varying distances from MPA boundaries, and by documenting changes over time.

The specific MLPA goals and their implications for monitoring are discussed below.

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

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

Goals 1 and 2 clearly require ecological monitoring using indicators and other metrics chosen to provide information about populations, species, and ecosystems. Of these, ecosystems provide the overarching umbrella, as the highest level of organization of the system, and thus provide the top level of the monitoring hierarchy.

MLPA 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 3 requires a type of socioeconomic monitoring to determine whether and to what extent opportunities have improved, with a linkage to ecological monitoring to assess the effectiveness of management in protecting biodiversity.

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

Goal 4, as interpreted through the MPA planning process, requires that habitats be monitored. This will be achieved through selecting indicators and other metrics to assess habitats identified for protection in MPAs by the North Central Coast Science Advisory Team during the planning process for the region.

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

[6] California Marine Life Protection Act, Statutes 1999, Chapter 1015, Fish and Game Code section 2853(c)(3). See also sections 2852(a), and 2856(a)(2)(H).

The MPA planning process included definition of objectives for each MPA, and development of scientific guidance for the design of individual MPAs and the North Central Coast regional network. The effectiveness of management measures will be evaluated through assessment of the performance of the regional MPA network in meeting its goals. Enforcement will be implemented by the Department of Fish and Game with assistance from appropriate partners. Information on MPA compliance will be used to help evaluate and assess monitoring results.

MLPA Goal 6: Ensure the State's MPAs are designed and managed, to the extent possible, as a network.

The MPA planning process explicitly focused on designing a North Central Coast regional MPA network, as a step in establishing the statewide MPA network required under MLPA. The monitoring approaches recommended in this plan have been designed to allow assessments of the performance of the regional network as a whole, as well as of the individual MPAs that will be monitored. Approaches for assessing specific network functions, such as connectivity, are also included in this plan.

THE MLPA MASTER PLAN FOR MPAS

The MLPA Master Plan states that MPA monitoring and evaluation should be:

- useful to managers and stakeholders for improving MPA management
- practical in use and cost
- balanced to seek and include scientific input and public participation
- flexible for use at different sites and in varying conditions
- holistic through a focus on both natural and human perspectives.[7]

This monitoring plan meets these requirements by:

- enabling assessment of the effectiveness of the North Central Coast regional MPA network in meeting its goals, thus providing essential information to managers and stakeholders for future management decisions
- providing recommended monitoring priorities that can be tailored to make best use of available resources, including through development of monitoring partnerships
- reflecting stakeholder input gathered through workshops (see Workshop 1 Report and Workshop 2 Report, Appendices C-3 and C-4, respectively) and comments provided by scientists in California, elsewhere in the U.S., and the world who reviewed the draft monitoring framework (see Summary of Additional Technical Comments, Appendix C-2)
- including assessments of individual MPAs throughout the region and of the regional network as a whole, which will ultimately contribute to assessment of the statewide MPA network, when complete
- including both ecological and socioeconomic monitoring, and by explicitly considering humans as part of the ecosystem.

The MLPA Master Plan also states “To achieve the purpose of informing adaptive management, the results of monitoring and evaluation must be communicated to decision makers and the public in terms that they can understand and act upon”, and that “a comprehensive analysis of monitoring results should be conducted approximately every five years”.[8] This monitoring plan has been designed to result in clear and understandable reports that will be provided in advance of the five-year reviews of the MPAs recommended in the MLPA Master Plan.

[7] California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008, p. 74.
[8] Ibid. p. 75.

THE NORTH CENTRAL COAST MPA PLANNING PROCESS

During the MPA planning process, goals and objectives for the North Central Coast regional MPA network were developed, based on the statewide goals expressed in the MLPA (see Appendix C-6). These regional goals and objectives have helped guide the development of this monitoring plan, and led to several specific planning steps and monitoring elements, including:

- stakeholder workshops and public comments on the draft monitoring plan (see for example Goal 5, Objective 2)
- inclusion of socioeconomic monitoring of consumptive and non-consumptive human uses inside and outside MPAs (see for example Goal 5, Objective 1)
- specific provisions for potential citizen-science or community-based contributions to monitoring (see for example Goal 3, Objective 4).

In addition, site-specific objectives were developed for each individual MPA, linked to the regional goals and objectives (Appendix C-6). As monitoring activities and programs are being carried out in specific MPAs, measurable site-level objectives for the MPAs will be cross-referenced with site-level monitoring protocols to ensure maximum feasible coverage of the objectives in monitored sites.

This monitoring plan was also informed by the list of species 'most likely to benefit' from the MPAs (Appendix C-7). The North Central Coast Science Advisory Team identified these species as likely to show a detectable change in local population as a result of MPA implementation. This list was used to identify and select species for monitoring that contribute to assessment of ecosystem condition and trends.

During the planning process, scientific guidelines were developed to shape design of the regional network, including guidelines for the size of individual MPAs, the distance between adjacent MPAs, and levels of protection of MPAs (Appendix C-8) that reflect the allowed activities in a given site. The regional MPA network adopted by the Fish and Game Commission includes "clusters" of MPAs, with two or more adjoining MPAs of different types (e.g., a State Marine Reserve contiguous with a State Marine Conservation Area). This monitoring plan includes approaches to evaluating these different design guidelines and decisions. Such assessments will take time and careful design to generate results that are sufficiently robust to guide future management decisions.

ADDITIONAL POLICY CONSIDERATIONS

This monitoring plan has been designed to meet the requirements of the MLPA and associated policies and guidance. However, it also reflects consideration of other policies and programs that are closely related to the MLPA, and these should be considered again during monitoring implementation. For example, in addition to the Fish and Game Commission, the State Park and Recreation Commission and the State Water Resources Control Board also have the authority to designate specified state marine managed areas.[9] Marine managed areas include a variety of different designations, including not only MPAs designated under MLPA but also, for example, state marine cultural preservation areas and state water quality protection areas. While these designations serve different mandates, they are all intended to protect, conserve, or otherwise manage a variety of resources and their uses.[10] During implementation of MPA monitoring, the selection of specific sites to be monitored should consider the locations of such sites within the North Central Coast region, and opportunities to maximize information exchange and resource sharing among various programs should be explored, while ensuring the ability to meet MLPA requirements is not compromised.

[9] California Marine Managed Areas Improvement Act, Public Resources Code sections 36600-36900. See §36602(b).
[10] Ibid. PRC §36602(d).

In addition, during the design of the monitoring approaches described in this plan, particular consideration has been given to the relationship between the MLPA and the Marine Life Management Act (MLMA). This is described further below.

MPAS AND THE RELATIONSHIP BETWEEN THE MLPA AND THE MARINE LIFE MANAGEMENT ACT

The California Marine Life Management Act (MLMA, Statutes 1998, Chapter 1052) became law on January 1, 1999. The MLMA mandated several significant changes in the way California's marine fisheries are managed and regulated.[11] The MLMA sets sustainability as an overall goal for the fishery management system (FGC §7056). Within the definition of sustainability, the MLMA includes not only the maintenance of fishery populations, but also the fullest possible range of present and long-term benefits, ecological benefits, and biological diversity (FGC §99.5). The MLMA calls for achieving its primary goal of sustainability by meeting several objectives:

- preventing overfishing
- rebuilding depressed stocks
- ensuring conservation
- promoting habitat protection and restoration.

MPAs are recognized as playing a potential role in contributing to achieving the goals of the MLMA. For example, the Nearshore Fishery Management Plan, developed under the MLMA and completed in August 2002, "uses marine protected areas (MPAs) to ensure that the MLMA's objectives for protection of habitat and ecosystem integrity as well as sustainable fisheries are met" and "recognizes the authority of the Marine Life Protection Act (MLPA) to design a Master Plan for MPAs in California".[12]

The MLMA, like the MLPA, also specifically requires monitoring (e.g., FGC §7081) and adaptive management (FGC §7056(g)). The MLMA includes an emphasis on collecting essential fisheries information (EFI) and recommends the use of monitoring to provide this information.

Thus, although there is clear overlap, the primary purposes of the MLMA and MLPA differ, and monitoring to meet the goals of MLPA is necessarily designed and implemented differently from monitoring conducted to meet the goals of MLMA. Nevertheless, monitoring to meet MLPA requirements necessarily will include some fisheries monitoring, including both ecological and socioeconomic elements of fisheries. Moreover, given the close relationship between the two acts, MPA monitoring can and should benefit fisheries monitoring. For example, many species important to fisheries are also important components of marine ecosystems, such as many groundfish species. Thus, monitoring of select fisheries species is essential to effective monitoring of MPAs. Similarly, the North Central Coast Regional Goals and Objectives developed during the MPA planning process include "minimiz[ing] negative socio-economic impacts and optimize positive socio-economic impacts for all users, to the extent possible, and if consistent with the Marine Life Protection Act and its goals and guidelines" (see Appendix C-6, Goal 5, Objective 1).

The monitoring approaches described in this plan therefore include ecological and socioeconomic elements of fisheries monitoring in order to assess the effectiveness of the regional MPA network in meeting MLPA goals and to support adaptive MPA management. This information may inform fisheries management and may contribute to meeting the goals of MLMA. Similarly, monitoring conducted to support fisheries management and meet the goals of MLMA may provide information that is useful to augment and interpret MPA monitoring information. During implementation of MPA

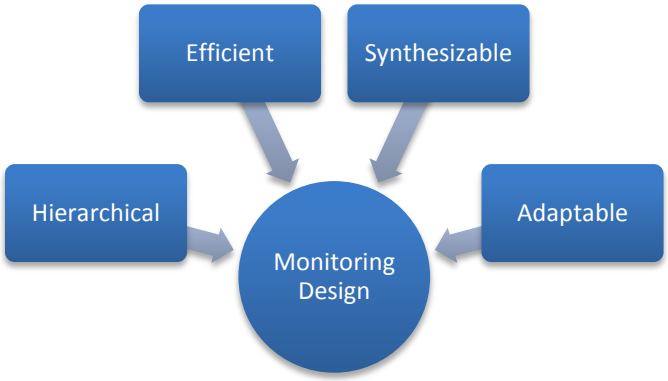
[11] The Master Plan: A Guide for the Development of Fishery Management Plans, as Directed by the Marine Life Management Act of 1998. December 2001, p. i.
[12] Nearshore Fishery Management Plan. August 2002, p. iii.

monitoring, there are likely to be valuable opportunities to seek efficiencies and leverage resources by integrating some aspects of MPA and fisheries monitoring activities.

However, it is important to recognize that the fisheries monitoring elements included in this plan are not intended to be sufficient for fisheries management purposes, because the monitoring goals are those of the MLPA, rather than the MLMA. Nonetheless, the MPA monitoring metrics described in this plan have been selected to benefit fisheries management to the extent possible without compromising the ability to best meet MLPA requirements. If desired, it is also possible to supplement MPA monitoring with additional monitoring to further explore the overlap between MPAs and fisheries management (see Appendix A).

DESIGN REQUIREMENTS FOR MPA MONITORING

A wide range of ecological and socioeconomic information is required to assess the effectiveness of the North Central Coast regional MPA network in meeting policy goals. This information must allow assessments of effectiveness at a variety of scales, for example from selected individual MPAs through the entire regional network, and from selected habitats and species through entire ecosystems. Yet to be useful for informing future management decisions, all this information must lead to monitoring results that are interpreted and presented in a way that is clear and informative for diverse audiences including decision-makers, managers, and stakeholders. These various needs have been addressed in this plan through identifying and meeting key monitoring design requirements.



A HIERARCHICAL FRAMEWORK

The first design requirement is that monitoring must fit a hierarchical framework, to allow collection and reporting of results at various scales, including the North Central Coast region as a whole, individual ecosystem types (such as kelp forests), individual MPAs (that are monitored, as not all sites may be monitored), and individual ecosystem components, such as selected species. Implementation of a hierarchical approach means that monitoring indicators and other metrics at each level of the hierarchy are chosen so that they, collectively, allow assessment of the next higher level of the hierarchy, which contains metrics that collectively allow assessment of the next higher level, and so forth.

EFFICIENT DESIGN & IMPLEMENTATION

The second design requirement is that monitoring be as efficient as possible, both in design and in implementation. Thus, at each level in the hierarchy and for each monitoring question or approach, a key design criterion is identifying the most important and useful information that should be collected. Throughout this monitoring plan, priority is placed on identifying information that is sufficient to allow specific assessments, rather than on identifying all information that could possibly be

collected. This approach allows clear prioritization of information to be collected through monitoring, but does not preclude collection of additional information when feasible and desirable.

INTERPRETABLE & SYNTHESIZABLE DATA

The hierarchical framework, implemented through efficient information collection, helps to meet the third design requirement, which is that monitoring data must be readily synthesizable and interpretable. To be useful to policy makers, resource managers, stakeholders, and others involved in future MPA management decisions, monitoring data must facilitate development of overarching conclusions about network performance and of key, "take home" messages, which can be presented in clear, intuitive reports (see Chapter 6 for illustrative examples). At the same time, the full range of technical information underpinning the information syntheses must be made readily available to support further analyses, review or uses of the data at any level of detail desired.

ADAPTABLE DESIGN & PRIORITIES

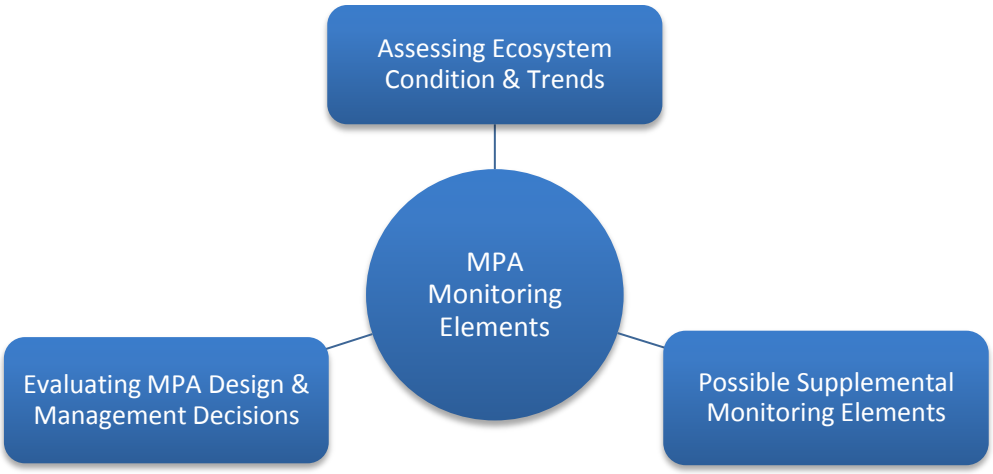
The final design requirement is that monitoring must be adaptable, so that it can be adjusted as needed to reflect changing management needs and make best use of available resources, and can evolve over time to take advantage of scientific advances, new or improved methods and approaches, and other opportunities to increase monitoring accuracy and effectiveness. Accordingly, this monitoring plan has been developed as a series of nested modules. Each module is designed as a stand-alone unit focused on monitoring aspects of ecosystems, resources, resource use, or management decisions. Monitoring can thus be adapted by choosing the desired modules to implement. In addition, each module can be scaled, or adjusted in magnitude or intensity. Guidelines for choosing and scaling modules are provided in this monitoring plan to ensure a coherent monitoring program and maximize the utility of collected information. To encourage evolution and refinement of monitoring, the modules include research and development components to identify and prioritize opportunities to improve monitoring through research collaborations.

Additionally, this entire plan should be considered a living document, subject to regular review so that monitoring itself can be managed adaptively. The five-year reviews of the North Central Coast MPAs that are recommended in the MLPA Master Plan would provide excellent opportunities to periodically evaluate and refine monitoring, and update this plan as needed.

RECOMMENDED SCOPE OF MPA MONITORING

SCOPE OF INFORMATION TO BE COLLECTED

These design requirements, coupled with the policy guidance described above, guided the selection and construction of the basic monitoring elements that comprise the recommended monitoring approach, and collectively set the scope of information to be collected. These basic MPA monitoring elements are briefly described below, and are discussed in detail in subsequent chapters.



ASSESSING ECOSYSTEM CONDITION & TRENDS

Monitoring of the North Central Coast regional MPA network must reflect many different ecological and socioeconomic aspects in order to meet the requirements of the policy guidance discussed above. Habitats, marine life populations, marine life diversity and abundance, socioeconomic trends, and recreational uses are just a few of the aspects specifically referenced in the various policy elements. The MPA monitoring plan adopts an ecosystems focus for monitoring to provide a sufficiently broad umbrella to encompass these diverse aspects, to promote cohesion of different monitoring elements within an ecosystems framework, to facilitate integration of different types of monitoring results, and to enable assessment of the performance of the MPA network against the full range of MLPA goals. The central focus of the approach is to collect monitoring information that can be interpreted at an ecosystem level, that can provide information about the condition of, and trends within, ecosystems over long time scales. One of the elements of this monitoring plan is designed to allow long-term tracking of the condition of, and trends in, key aspects of marine ecosystems, including ecological and human elements of ecosystems and resource use. This monitoring element is described in detail in Chapter 4.

EVALUATING MPA DESIGN & MANAGEMENT DECISIONS

The North Central Coast regional MPA network was designed using the best readily available scientific information, which was used to guide key design decisions such as the siting of individual MPAs, the size of MPAs, and the distance between MPAs. In addition, the MPAs were designed to meet specific objectives. For example, special closures were designed by stakeholder participants in the planning process to reduce or prevent disturbance to wildlife, such as seals or seabirds. One of the elements of this monitoring plan 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, as noted earlier, such questions can be notoriously difficult to answer. This monitoring element is described in detail in Chapter 5.

POSSIBLE SUPPLEMENTAL MONITORING ELEMENTS

The monitoring modules focused on assessing ecosystem condition and trends and evaluating MPA design and management decisions have been developed to work together to meet the requirements of the MLPA. They incorporate the best available science and reflect the interests of stakeholders. However, because the goals of the MLPA are broad, these modules necessarily provide broad coverage of many aspects of ecosystems, resources, resource uses, or management impacts, rather than comprehensive monitoring of any single element. Thus it may be desirable to supplement this MPA monitoring with additional, intensive monitoring of specific ecosystem elements, human activities, or

pressures on the system, even if such additions are not necessary to meet MLPA requirements. Currently, a scalable supplemental fisheries monitoring module has been developed as one such possible addition, but this approach may also be extended to develop supplemental modules addressing other possible management priorities such as those related to climate change, water quality or invasive species. This is discussed further in Appendix A.

SPATIAL SCOPE OF MONITORING

As noted in Chapter 1, this monitoring plan considers all North Central Coast MPAs and special closures. However, because MPA assessment relies in part on comparing conditions inside and outside MPAs, and at varying distances from MPAs, this plan applies to the entire North Central Coast region, and not just the MPAs. However, this still leaves the question of where within the region, and in which MPAs, monitoring should occur. From a scientific perspective, this depends largely on the questions monitoring is seeking to answer, for example on which monitoring modules are implemented and at what scale.

The MLPA specifically references "…monitoring, research, and evaluation at selected sites."[13] The MLPA Master Plan notes that "this does not mean that other MPAs should not also be monitored and evaluated in accordance with their own objectives and regional goals, but that the performance of selected MPAs might be used to guide future decisions over a wider area."[14] This is the approach taken within this monitoring plan, consistent with the design requirement to ensure monitoring efficiency while meeting MLPA requirements.

This monitoring plan includes guidance for the selection of MPAs to be monitored to provide specific information. A key tool in MPA monitoring and evaluation is comparing selected indicators and other metrics inside MPAs and outside, and at varying distances from MPA boundaries. It is also important to provide adequate spatial distribution of monitoring efforts to draw conclusions about the effects of the regional network as a whole, and across the North Central Coast region. Considerations and guidance for selecting the MPAs and other sites for monitoring are discussed in Chapter 8. The spatial distribution of monitoring is likely to be refined over time, reflecting changing management needs and environmental conditions, and increasing experience with monitoring that is likely to lead to opportunities to improve monitoring efficiency and possibly reduce monitoring intensity.

TEMPORAL SCOPE OF MONITORING

The temporal scope of monitoring describes both the anticipated longevity of monitoring and the frequency of monitoring. Monitoring of the North Central Coast MPAs should continue for as long as the MPAs are in effect, although the form of monitoring is expected to change over time to reflect changing management needs and environmental conditions and increasing experience with monitoring. The frequency of monitoring should be based on the specific information sought, i.e., on the monitoring modules chosen and the scale at which they are being implemented. Of course, different elements of monitoring may be conducted at different time intervals, depending on the information sought and the variability and expected rate of change of that information. Monitoring frequency is discussed further in Chapter 9.

MONITORING PARTICIPANTS & PARTNERS

A fundamental consideration for setting the scope of this monitoring plan is the large number of potential participants and partners in monitoring. There is considerable potential in California, including in the North Central Coast region, for a partnerships-based approach to MPA monitoring, whereby monitoring activities are conducted not only by the Department

[13] California Marine Life Protection Act, Statutes 1999, Chapter 1015, Fish and Game Code section 2853(c)(3).
[14] California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008, p. 73.

of Fish and Game, as the agency with statutory authority for managing state MPAs, but also in partnership with a variety of other entities. These may include:

- Other state agencies
- Federal agencies
- Universities and research institutions
- Research/citizen collaborations (such as with fishermen)
- Citizen-scientist programs
- Community groups and associations (such as birdwatching, fishing, or boating clubs)

The monitoring framework and implementation approaches have been designed to take advantage of this potential monitoring capacity. Specifically, some monitoring components have been developed to be less technically or methodologically demanding to seek to accommodate citizen scientists, while recognizing that training, coordination, and data quality assurance/quality control programs will nonetheless be essential. In addition, monitoring programs established for other purposes, for example fisheries management, water quality assessment, ocean observing, and research also provide valuable information. Forging appropriate linkages among these programs will also help defray costs and improve the quality of information available for MPA management. Further information on establishing potential monitoring partnerships is provided in Chapter 7.

3. Developing an Ecosystems Approach

- Identifying ecosystems for monitoring
- Monitoring MPA effects on Ecosystem Features
- Applying the Ecosystem Features
- Additional potential benefits of ecosystems approach

As discussed in Chapter 2, meeting the requirements of the MLPA means taking an ecosystems approach to monitoring, using ecosystems as the top level of the monitoring hierarchy to provide the umbrella that also encompasses species, populations, habitats, and humans. To do this, it is necessary to identify and characterize ecosystems at an appropriate scale to support feasible, useful assessments of selected individual MPAs, the regional MPA network component as a whole, and, as appropriate, the entire region. The selected ecosystems should reflect public priorities and understanding of the North Central Coast region, be consistent with the MLPA policy guidance, and recognize important ecological commonalities within, and distinctions among, systems.

IDENTIFYING ECOSYSTEMS FOR MONITORING

FOCUSING MONITORING USING ECOSYSTEM FEATURES

During the MPA planning process, the North Central Coast Science Advisory Team identified eight key habitats to be represented in the regional MPA network (see Figure 3-1, left column). These provided a possible starting point for selecting ecosystems to serve as the top level of the monitoring hierarchy. However, it is essential that the top level of the hierarchy represents and encompasses the North Central Coast region for the purposes of monitoring, and that it explicitly includes humans, in order to fully meet MLPA requirements. To meet these requirements and take a holistic approach to selecting ecosystems considered by stakeholders to adequately encompass the region, while maintaining a sound scientific foundation for monitoring, an initial priority-setting workshop was held (see Workshop 1 Report, Appendix C-3). We invited former members of the North Central Coast Regional Stakeholder Group and North Central Coast Science Advisory Team, along with additional scientists, to identify a limited number of 'Ecosystem Features' for the North Central Coast region. Participants were asked to identify major ecosystem types or components in the region that they consider important in the context of MPA monitoring, and to explicitly include humans in their suggestions. After initial suggestions had been put forward, participants conducted a sorting and combining exercise to choose a limited number (eight to ten) of Ecosystem Features that collectively represent and encompass the North Central Coast region for the purposes of MPA monitoring.[15]

The initially selected Ecosystem Features were:

- Kelp ecosystems
- Rocky intertidal ecosystems
- Rocky sub-tidal ecosystems (deep and shallow)
- Estuarine ecosystems
- Soft-bottom intertidal and beach ecosystems
- Soft-bottom subtidal ecosystems
- Open ocean ecosystems
- Apex predators

[15] This approach is adapted from a monitoring and evaluation methodology developed by Foundations of Success (FOS), a non-profit organization with experience supporting planning, monitoring, and adaptive management of conservation and resource management projects in California and worldwide. Ecosystem Features are modeled on the FOS 'Conservation Targets', but extended to explicitly include human elements. For more information on FOS, see www.fosonline.org

- Viable coastal communities
- Consumptive use
- Non-consumptive use

These initial Ecosystem Features were refined through further scientific and stakeholder input, and cross-referenced against the key habitats for the North Central Coast region identified during the MPA planning process. The following refinements were made:

- Rocky subtidal ecosystems were separated into shallow (0-30m depth) and mid-depth (30-100m depth) ecosystem features in recognition of the distinct differences in these ecosystems
- Kelp ecosystems and shallow rock ecosystems were combined into a single Kelp and Shallow Rock Ecosystem Feature because many of the same species are found in shallow rocky habitats regardless of the presence of kelp
- Open ocean ecosystems were defined to include the overlying water column at all depths within state waters and encompassed in the Nearshore Pelagic Ecosystem Feature
- Apex predators are best assessed as important components of the other Ecosystem Features, and were thus removed as a separate feature
- The viable coastal communities feature was considered to incorporate and depend on factors far beyond the scope of MLPA, and was thus removed as a separate feature, but the concept of viability is included in the Consumptive Uses and Non-consumptive Uses Ecosystem Features

ECOSYSTEM FEATURES SELECTED FOR MPA MONITORING IN THE NORTH CENTRAL COAST REGION

The following Ecosystem Features have thus been selected to form the top level of the MPA monitoring hierarchy for the North Central Coast regional MPA network[16]:

- Kelp & Shallow (0-30m depth) Rock Ecosystems
- Mid-depth (30-100m) Rock Ecosystems *(formerly Deep Rock Ecosystems)*
- Rocky Intertidal Ecosystems
- Soft-bottom Subtidal (0-100m) Ecosystems
- Estuarine & Wetland Ecosystems *(formerly Estuarine Ecosystems)*
- Soft-bottom Intertidal & Beach Ecosystems
- Nearshore Pelagic Ecosystems (i.e., the water column habitat within state waters, *formerly Pelagic Ecosystems*)
- Consumptive Uses
- Non-consumptive Uses

These Ecosystem Features align well with the key habitat types used in planning the North Central Coast regional MPA network (see Figure 3-1), provide comprehensive coverage of the region, and consequently allow assessment of progress toward all MLPA goals within a clear and structured monitoring framework. The Ecosystem Features are described further below.

[16] Three Ecosystem Features were relabeled in August 2010 for consistency with Ecosystem Features in other MLPA regions. This is a change in the Ecosystem Feature name only; it does not change the definition or scope of any of the Ecosystem Features. Throughout this plan Deep Rock has been relabeled as Mid-depth Rock, Estuarine Ecosystems has been relabeled Estuarine & Wetland Ecosystems, and Pelagic Ecosystems has been relabeled as Nearshore Pelagic Ecosystems.

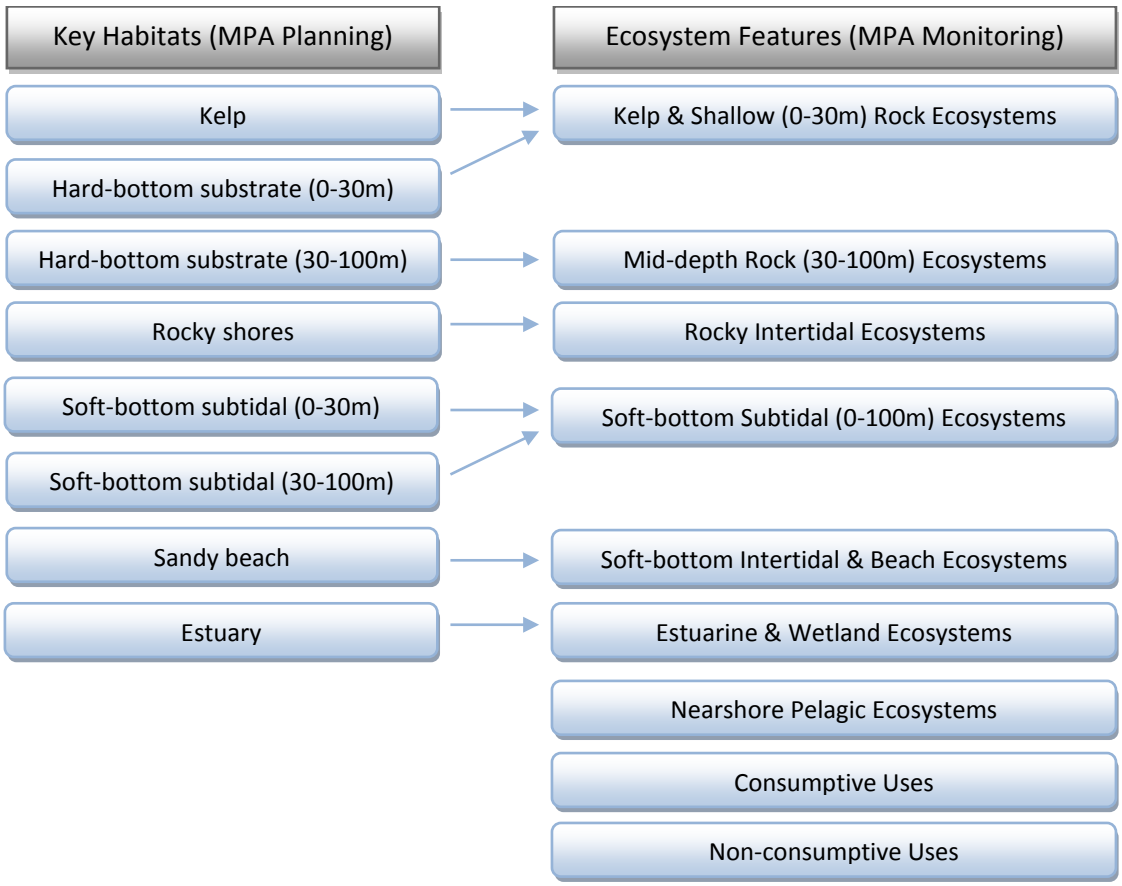


Figure 3-1. *North Central Coast key habitats, used in MPA planning, and Ecosystem Features, which guide MPA monitoring. The ecological Ecosystem Features provide complete coverage of the habitat types, as shown by the arrows. The two human uses Ecosystem Features are essential to enable monitoring to address all MLPA goals.*

MONITORING MPA EFFECTS ON ECOSYSTEM FEATURES

Understanding how the regional MPA network may protect ecosystem structure, function, and integrity (one of the goals of the regional MPA network under MLPA), is important for evaluating MPA progress towards goals and appropriately structuring monitoring activities. This requires appropriately focusing monitoring on potential effects of MPAs, taking into account other natural and anthropogenic influences on ecosystems, and understanding spatial and temporal scales of change within dynamic systems.

POTENTIAL MPA EFFECTS

MPAs implemented under MLPA limit or prohibit take of living marine resources, and thus their direct effects are most likely to reflect changes associated with the reduction or elimination of living marine resource removal inside MPA boundaries. MPAs may also confer indirect benefits. For example, MPAs can increase ecosystem resilience, which can improve the capacity of ecosystems to resist, or recover from, changes due to other types of influences (e.g., climate change impacts).

By reducing fishing, MPAs can lead to increases in the abundance and size of some fish and invertebrates within their boundaries. Not all species should be expected to respond equally, or at the same rates, to MPA implementation. Increases in the density and size of fish inside MPAs are generally predicted to be observable first in faster growing and predatory species, and with species or populations that previously were heavily fished; this initial effect of MPA implementation is one of the most widely demonstrated worldwide. The rates and magnitudes of population increases are also likely to be influenced by historical levels of fishing in areas subsequently designated as MPAs as well as ongoing fishing activities inside MPAs that allow fishing and outside MPA boundaries. Such effects are detected by examining population trends before and after MPA implementation inside and outside MPAs and taking into account historical and current information on fishing activities. Rates and magnitudes of population increases are also influenced by the level of compliance with MPA regulations. Non-compliance with MPA regulations is a challenge for MPAs worldwide. Illegal take of marine organisms, for example, can greatly undermine the effectiveness of MPAs. For the purposes of MPA monitoring, these effects are detected by examining differences in the size and local density of select species inside and outside of MPAs with comparable habitats and incorporating available information on legal and illegal fishing distribution and intensity. Monitoring of local species abundances will reveal changes in predicted fast- and slow-responding species and in species that play key ecological roles within particular ecosystems. These monitoring data will be analyzed considering contextual information relating to oceanographic conditions and trends, water quality data, information on broad economic trends, and information on MPA enforcement and compliance levels.

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. Monitoring important aspects of ecosystems that contribute to ecosystem structure and function facilitates detection and interpretation of such community- and ecosystem-level effects of MPAs. Ultimately, MPAs may also lead to fishery benefits through adult and larval spillover. Adult spillover occurs when increased fish production within MPA boundaries causes individuals to move outside the MPA, where they contribute more broadly to the structure and function of ecosystems in the region and also support associated fisheries. Detection of these effects is challenging given that many species range over large geographic areas. However, analytical models which incorporate spatially explicit fishing data, including effort and catch, combined with ecological data illustrating species densities and movement patterns, can reveal contributions of MPAs to ecosystems and fisheries outside their boundaries. This latter effect of MPA implementation, however, may take many years to realize and detect.

DETECTING CHANGE WITHIN DYNAMIC SYSTEMS

California's dynamic marine and coastal ecosystems present other challenges for assessing MPA effects. For example, the highly dynamic physical oceanography of the area, including changes related to the El Niño Southern Oscillation (ENS0) 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 variability pose challenges to any efforts to detect statistically significant changes or uncover ecological trends, and even greater challenges for determining the extent to which MPAs may be causing or contributing to such changes or trends. The approach to MPA monitoring described in this plan is designed to first document changes (or lack of changes), and over time accumulate the amount and distribution of data that will be needed to explore the causes of changes observed.

Disentangling the effects of MPAs from these large-scale dynamics will be achieved through the collection of data over long time scales to incorporate into time series analyses and interpretation. Additional insights will be garnered through comparisons of changes in fished and unfished species inside and outside MPAs with comparable habitats and ecosystems. Experience from MPA monitoring in the Channel Islands shows that some predicted changes are detectable relatively

quickly, for example in the first five years. However, attributing the observed effects to the establishment of the MPAs with reasonable certainty is likely to take many additional years of monitoring. This can be expected to be true also in the North Central Coast region, and indeed throughout the state.

TAKING ACCOUNT OF BROADER HUMAN INFLUENCES

Marine and coastal ecosystems, in the North Central Coast region and globally, have been affected by a wide range of anthropogenic influences other than those associated with fishing, including water quality impairment, habitat alteration, invasive species, and, increasingly, climate change. In addition, they are 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.

These human influences frequently impose dynamic changes on ecosystems that operate on differing spatial and temporal scales from MPA-related effects. As with natural dynamics, separating the effects of MPAs from other human influences on ecosystems is facilitated by gathering and analysis of long-term trend data. Through development of partnerships for information exchange (see also chapters 6 and 7), data on these broad human influences will be considered in analysis and interpretation of MPA monitoring results.

APPLYING THE ECOSYSTEM FEATURES

Following are brief summaries of the selected Ecosystem Features. Each summary provides a brief description and definition of the Ecosystem Feature together with considerations for monitoring that Ecosystem Feature. As noted above, these ecosystems will be influenced by factors other than MPAs, and these other influences, or system drivers, will be considered during analysis of monitoring results. The important system drivers for each Ecosystem Feature are included within each summary.

Although the Ecosystem Features are considered individually, this is obviously an artificial distinction and many effects of MPA implementation may be revealed through relationships among features and between socioeconomic and ecological ecosystem elements. Accommodation of such potential links is provided at multiple points in the monitoring plan, including selection of monitoring metrics, design of data collection programs, and analysis and reporting of monitoring data.

KELP & SHALLOW (0-30M) ROCK ECOSYSTEMS

Shallow rocky reefs in the North Central Coast region are diverse ecosystems, hosting a wide variety of marine plants, fish and invertebrate species as well as many marine birds and mammals, including, in the southern part of the region, sea otters. Large, canopy-forming kelps colonize rocks in some areas, while others are covered with smaller algal species and invertebrates. Many of the same fish and invertebrate species, including economically important species, are found in shallow rocky habitats regardless of the presence of kelp, thus these similar ecosystems are considered together in this Ecosystem Feature. Where kelp forests exist in the North Central Coast, they are typically dominated by bull kelp (*Nereocystis leutkeana*) although some contain giant kelp (*Macrocystis pyrifera*) in areas of lower wave energy. These kelps play an important role as habitat and food for many fish and invertebrates.

Among the ecologically and economically important species in these ecosystems is a variety of rockfishes. Many rockfishes are included on the list of species most likely to benefit from MPAs (Appendix C-7) and have also been identified as monitoring indicators. However, many rockfish species are long-lived – some species live more than 70 years – and individuals often don't reach maturity until six to eight years of age. These life history characteristics increase the predicted time to observe increases in population sizes that may follow MPA implementation. Implementation of monitoring

therefore focuses initially on detection of local density differences inside and outside of MPAs. Gradual accumulation of data will help reveal the broader ecological role of these species as well as the broader population consequences of local protection. In addition, potential ecological cascade effects following MPA implementation include increases to kelp canopy and understory algae as abundances of functionally important fish and invertebrate herbivores and predators increase. Integrated analyses of changes in habitat, invertebrate herbivores, and predatory fish will allow investigation of such potential community and ecosystem-wide effects.

Many of the possible effects of MPA implementation on this Ecosystem Feature are likely to be complicated by other ecosystem drivers and processes, often acting at large geographic and long temporal scales. Kelp forests in particular are dynamic systems; storms and waves can cause rapid changes by removing large numbers of kelp plants. Across seasons and years, differences in the amount of cold, upwelled water supplying vital nutrients to the kelp can cause natural increases or declines in this key habitat, affecting the fish and invertebrates that rely on kelp for food and shelter. Further, anthropogenic influences on climate are already resulting in changes to the frequency and intensity of storms, El Niños, and upwelling events. Interpretation of observed ecosystem changes and detection of MPA-specific effects can be achieved through the collection of data over long time scales for incorporation into trend analyses.

MID-DEPTH (30-100M) ROCK ECOSYSTEMS

A wide variety of fish and invertebrates inhabit mid-depth rock ecosystems. In the North Central Coast, mid-depth rocky habitats occur as rocky reefs or rock outcrops, and the majority of this habitat occurs shallower than 50m. Large kelps are not found here and other photosynthetic algae are rare in these deeper waters, so much of the habitat is made up of sessile invertebrates such as sea anemones, sponges, bryozoans, and hydrocorals. In this system, these animals serve as the structuring habitat for other, more mobile, species.

As in the Kelp & Shallow Rock Ecosystem Feature, many of the ecologically and economically important species are rockfishes and other predatory fishes that are long-lived and take a long time to reach sexual maturity. Thus potential population recoveries for these species following MPA implementation are unlikely to occur rapidly. In addition, in particular in deep rock ecosystems, habitat-forming sessile invertebrates, such as hydrocorals, are very slow-growing and fragile, and susceptible to physical damage, such as may occur by bottom-tending fishing gear. Thus, increases in some biogenic habitats (i.e., habitat formed by the growth and architecture of particular species) are predicted to occur and this potential effect will be assessed through analysis of trend data collected over long time periods for key species.

Through partnerships with other monitoring programs, MPA monitoring results interpretation will also take into account trends in climatic and oceanographic drivers, which result in shifts in the timing and magnitude of upwelling. Consideration of such data will be important for accurately evaluating the effectiveness of MPAs in mid-depth rock ecosystems.

ROCKY INTERTIDAL ECOSYSTEMS

Rocky intertidal ecosystems are defined, for the purposes of MPA monitoring, as areas of rock substrate occurring within the zone between mean high tide and mean lower low tide. In the North Central Coast region, this includes exposed rocky cliffs, boulder rubble, exposed wave-cut platforms and sheltered rocky shores. Although the underlying geology affects ecosystem structure, intertidal ecosystems are typically characterized by multiple zones which are primarily revealed in the species forming biogenic habitat. At the upper (landward) end of the intertidal zone, physical processes are the dominant regulators of community composition and communities are typically dominated by barnacles and other encrusting species. In the mid-intertidal zone, fucoid algae and mussels provide structure and habitat. Kelps, other fleshy seaweeds, and seagrass make up much of the habitat in the low intertidal zone, and at some sites purple urchins are important as

bioeroders and habitat. In the mid and lower zones, ecological processes such as competition and predation play an increasingly important role in community structuring.

This Ecosystem Feature is expected to be among the more challenging within which to detect and interpret changes that may occur following MPA designation. Reduced take of marine organisms such as seaweeds can lead to increases in habitat availability and ultimately this habitat may provide important food and shelter for other fish and invertebrates. However, physical disturbance is a natural process in rocky intertidal systems that results in complex and patchy species distributions, complicating detection of MPA-related effects. Such disturbance effects particularly confound detection of MPA effects via inside-outside MPA comparisons. Thus monitoring of rocky intertidal ecosystems emphasizes establishing robust temporal trends through an appropriate spatial sampling design.

Rocky Intertidal ecosystems are one of several Ecosystem Features (together with the Estuarine & Wetland and Soft-bottom Intertidal & Beach Ecosystem Features) that span the boundary between marine and estuarine, or terrestrial, habitats and consequently are influenced by many different factors. These habitats are among the most frequently visited by people, for example for wildlife viewing and coastal recreation, thus MPA monitoring has been structured to facilitate interpretation of ecological-human linkages in these ecosystems. Monitoring of human uses will be aligned with rocky intertidal monitoring in the monitoring sites selected and analytical techniques employed.

SOFT-BOTTOM SUBTIDAL (0-100M) ECOSYSTEMS

This Ecosystem Feature encompasses the areas of sediment substrate occurring between mean lower low tide and 100m depth. These soft-bottom subtidal habitats predominate on the continental shelf and slope throughout the North Central Coast region. Although seemingly simple, unstructured habitats, the species living in these areas must contend with dramatic changes as waves and currents shift sand and sediment across large areas. Commercially important species including Dungeness crab and flatfish are typically found in these habitats.

Despite covering the largest area of any benthic habitat type in the region, very little knowledge exists about the drivers, components, and processes maintaining this ecosystem. Key species and their ecological roles have yet to be identified and the relative importance of physical drivers versus biological interactions in shaping communities has not been determined. MPA monitoring is constrained by this lack of ecosystem knowledge, but will play an important role in increasing understanding of this system. Many of the fish and invertebrate species within these habitats are wide-ranging and individuals are likely to move between several protected and unprotected locations. Detecting effects of MPA designation on these species is challenging, but insights will be garnered through combining ecological data with information on the spatial patterns of fishing occurring outside MPAs.

As with many of the other Ecosystem Features, MPA implementation is likely to alter only a subset of the dominant human influences on these ecosystems, and will occur within the context of broader natural regimes of variation. Decadal-scale shifts in the California Current affect the sediment-inhabiting communities in this ecosystem, with warm regimes and associated declines in planktonic production resulting in species and community declines. On shorter timescales, El Niño events, which increase wave activity and storms (leading to sedimentation), can cause major, though short-term, disturbances to these communities. The effects of MPA designation can be assessed over time through integrated analyses of trend data that facilitate separation of MPA effects from other anthropogenic and natural drivers.

ESTUARINE & WETLAND ECOSYSTEMS

Estuarine & Wetland ecosystems within the North Central Coast region encompass soft-sediment habitats, including tidal mudflats, eelgrass beds and areas of open water. The shoreward boundary of this Ecosystem Feature is drawn at the extent

of tidal reach and salt-water-associated vegetation, consistent with the MPA planning process. Habitat formed by eelgrass and other plants plays an important functional role as foraging and nursery areas for a diverse range of fish and invertebrate species, many of which inhabit estuaries as juveniles before moving to kelp and other offshore habitats as adults. The estuaries, coastal bays and beaches of the North Central Coast region are also an important part of the Pacific Flyway and host thousand of migrating shorebirds, as well as being important foraging and nesting areas for resident bird populations. Estuarine & Wetland ecosystems in the region are also important areas for consumptive uses including fishing and clam digging, and non-consumptive activities such as bird watching, boating, and kayaking.

Along with rocky intertidal and soft-bottom intertidal ecosystems, estuarine & wetland ecosystems are expected to be among the most challenging ecosystems within which detect and interpret MPA effects. By reducing extractive take, and reducing benthic habitat disturbance through reductions in bottom-tending fishing gear, MPA implementation may lead to increases in the abundances and sizes of harvested species and increases in the area or quality of habitat.

However, estuaries also provide important habitat linkages among marine, aquatic and terrestrial ecosystems and thus their condition is closely tied to that of the surrounding watershed. This is particularly manifest in water quality characteristics. In addition, invasive species in estuaries in the North Central Coast region have dramatically altered species compositions and ecosystem functioning. For example, invasive cordgrass (*Spartina* spp.) has aggressively altered the physical structure of tidal marshes and mudflats throughout the region while invasive snails have resulted in dramatic native oyster declines in Tomales Bay. These broader influences will be incorporated into analyses of MPA monitoring results to facilitate detection and interpretation of MPA-related effects.

An additional challenge for the monitoring of this Ecosystem Feature is that the estuaries in the North Central Coast region differ from one another in significant ways. Driven by physical differences in the estuary shape, geomorphology, seawater input, freshwater input and nutrient supply, estuaries in the region also harbor different habitat-forming species and ecological communities. The recommended monitoring approaches for this Ecosystem Feature therefore focus on generation of trend data to examine changes in ecosystem indicators through time. Interpretation of trends within individual monitored estuaries can be used to estimate and assess changes in the North Central Coast region as a whole.

SOFT-BOTTOM INTERTIDAL & BEACH ECOSYSTEMS

Soft-bottom intertidal and beach ecosystems are defined as wave-dominated areas of sand and gravel substrate occurring below mean high tide and above mean lower low water. In the North Central Coast region, this includes continuous expanses of sandy shores as well as enclosed or pocket beaches. Many of these areas are culturally important and contribute economic benefits to the region as people enjoy consumptive and non-consumptive activities associated with beach environments.

Species assemblages inhabiting sandy beaches are often supported almost entirely by external nutrient input. In these ‘open’ systems, beach wrack is an important source of food and nutrients. Natural increases or decreases in the extent of wrack are partly driven by the changes occurring offshore in kelp-dominated habitats, thus linking the ecologies and functioning of these two habitats. By comparison, in ‘closed’ systems, high diatom productivity drives microbial food chains in surf waters and sediments, supporting macro-consumers such as zooplankton, fishes, and seabirds. Akin to the approach with kelp ecosystems, these natural dynamics are taken into account in monitoring in this Ecosystem Feature through an emphasis on collecting temporal trend data that can reveal MPA effects superimposed on natural system fluctuations.

Like the rocky intertidal ecosystems and estuarine ecosystems described above, these ecosystems occurring at the interface between marine and terrestrial habitats are often strongly influenced by a myriad of different natural and human factors. These range from the indirect influences of coastal development, such as freshwater or polluted run-off, to the more direct

influences of human visitation, which can result in disturbance or extraction of organisms. By aligning ecological data with information on human uses, analyses of monitoring results can reveal interpreted trends in ecosystem condition and can also be used to inform MPA design and management.

NEARSHORE PELAGIC ECOSYSTEMS

For the purposes of MPA monitoring, nearshore pelagic ecosystems are defined here as the water column overlaying the continental shelf in state waters. In the North Central Coast, this includes oceanographic features such as upwelling zones and retention areas, and a pelagic food web supported by phytoplankton, zooplankton and forage fishes, and including apex fish, seabird and marine mammal predators.

The processes structuring nearshore pelagic ecosystems frequently occur on spatial scales much larger than the adopted MPAs, and indeed much larger than the whole region. Many fish and invertebrate species characteristic of pelagic ecosystems are transient and wide ranging. The Nearshore Pelagic Ecosystem Feature also occurs within the broader California Current ecosystem: a coastal upwelling biome extending from Alaska to Baja and structured by large-scale climate and oceanographic regimes including the Pacific Decadal Oscillation (PDO) and El Niño Southern Oscillation (ENSO). Disentangling the effects of MPAs from these large-scale dynamics can be achieved through the collection of data over long time scales to incorporate into time series analyses and interpretation. In addition, focusing monitoring indicators in part on pelagic fish species which have relatively smaller home range sizes and were previously fished (including those species within the list of species most likely to benefit from MPAs) allows detection of trends in local abundances and size structures. Ultimately, these effects may be scaled up to detect network-level MPA effects on more wide-ranging species.

CONSUMPTIVE USES

Two categories of human uses have been recommended as focuses for MPA monitoring in the North Central Coast region. Consumptive Uses encompasses those activities involving extraction of living marine resources. In the North Central Coast region, Consumptive Uses include commercial and recreational fishing using a variety of methods (on shore, or by boat) and collecting of species by hand, on shore or via snorkeling or scuba diving. Collecting of organisms for scientific research also occurs, and requires permits. Illegal take of marine resources is a challenge for MPAs worldwide, and can greatly undermine MPA effectiveness. Accordingly, monitoring must be designed to facilitate detection of the effects of such activities, and must also consider available information on types and levels of non-compliance with MPA regulations.

MPA monitoring has been designed to assess both the effects of consumptive uses on MPAs and ecosystems, and the effects of MPAs on consumptive uses. The effects of consumptive uses on MPAs and ecosystems are assessed primarily using the ecological Ecosystem Features, and considering contextual information, including information on fisheries occurring in the region. Specific questions about the effects of consumptive uses on MPAs and ecosystems, such as the effects of salmon trolling in waters of 50m depth and greater on juvenile rockfish, may also be answered through targeted evaluations of MPA design and management decisions (see Chapter 5).The effects of MPAs on consumptive uses will be assessed through targeted monitoring of key aspects of consumptive uses that focus on understanding the socioeconomic and use impacts and effects of MPA implementation. These effects may be seen in the spatial patterns of human use, either through active shifts in resource use or through displacement effects, and may also be reflected in aspects of the quality or economic value of the activity.

Although defined as a separate Ecosystem Feature, trends in many consumptive uses are obviously related to, and in some cases dependent upon, trends in key aspects of the ecological Ecosystem Features and the broader oceanographic and climatic environment. Forging appropriate links between the ecological and human use Ecosystem Features during the selection of monitoring metrics, data collection and analyses, allows assessment of the relationships between these

ecosystem elements and the consequences for MPA effectiveness in achieving MLPA goals. Further, as with the ecosystems in the region, a broad range of external drivers influences the patterns and intensity of human uses associated with MPA implementation. Perhaps most importantly, broad economic drivers also strongly influence commercial and recreational fishing activities. This is evidenced in the recent declines in coastal economies and increases in fuel prices that have directly influenced commercial and recreational fishing ventures. In addition, MPA regulations are part of a broader suite of fishery management regulations and tools that control fishing activity inside and outside MPA boundaries. This suite of information will be incorporated into integrated analyses to examine trends in consumptive uses with respect to individual MPAs, key ports and access locations, and across the region as a whole.

NON-CONSUMPTIVE USES

In the North Central Coast region, large numbers of residents and visitors enjoy shore-based and/or on-water non-consumptive recreational activities including beach-going, diving, kayaking, and wildlife viewing. An explicit goal of the adopted MPA network is to increase recreational, study and educational opportunities in ways consistent with protection of biodiversity. Illegal non-consumptive activities can also be a challenge, particularly for coastal MPAs featuring accessible populations of charismatic wildlife. MPA monitoring must be designed to facilitate detection of the effects of such activities, and be informed by available information on non-compliance with MPA regulations.

MPA monitoring has been designed to assess both the effects of non-consumptive uses on MPAs and ecosystems, and the effects of MPAs on non-consumptive uses. The effects of non-consumptive uses on MPAs and ecosystems are assessed primarily using the ecological Ecosystem Features. Specific questions about the effects of non-consumptive uses on MPAs and ecosystems, such as the effects of MPA visitors on seabird fledging rates, may also be answered through targeted evaluations of MPA design and management decisions (see Chapter 5).

The effects of MPAs on non-consumptive uses will be assessed through targeted monitoring of key aspects of non-consumptive uses that focus on understanding the socioeconomic and use impacts and effects of MPA implementation. Like consumptive uses, many of the non-consumptive uses in the region are closely tied to trends in marine ecosystems. Monitoring will establish links between these Ecosystem Features. Patterns of non-consumptive uses in the region are also the result of numerous other drivers that range from economic circumstances to natural environmental conditions, such as weather. The specific effects of MPA implementation are likely to differ among specific non-consumptive uses and may include a complex suite of changes in patterns of recreational activity that also differ among locations within the MPA network. Integrated analyses will be required to examine the effects of multiple system drivers and influences in order to reveal MPA-related changes in patterns of non-consumptive uses. These analyses can reveal patterns occurring on local scales (e.g., access points or ports), within individual MPAs, and across the region.

ADDITIONAL POTENTIAL BENEFITS OF ECOSYSTEMS APPROACH

The ecosystems approach and the specific ecosystem features selected have been designed to meet the requirements of MLPA. However, this approach may also directly benefit other aspects of marine and coastal resource management, including fisheries management. Both the specific data streams generated through MPA monitoring and the assessment of ecosystem condition and trends may have application beyond MPA assessment and adaptive MPA management. The approach can also be supplemented to provide additional information specific to particular management mandates.

For example, MPA monitoring will generate new, detailed data on the abundance and biology of many species targeted by fisheries. Information on relative abundances and size distributions of fishery species generated through MPA monitoring may be useful as inputs for population modeling by fishery scientists. Also, in recognition of the establishment of California's MPA network, fishery scientists have begun exploring new ways to inform fishery managers of the status of

fished populations, based upon differences in density inside and outside MPAs. Many nearshore species are targeted by fisheries, and are also unassessed due to a lack of data. Management of these species in particular may benefit from the information generated through MPA monitoring, as the new data streams become available to fishery managers.

Additionally, the assessment of ecosystem condition and trends may benefit other mandates and programs. Many marine resource management policies and programs now incorporate ecosystem-based elements, and the approaches described in this plan may contribute to such efforts. For example, fisheries policies frequently reference "ecosystem-based fishery management" (EBFM). Some of the underlying data needed to support EBFM may be obtained through MPA monitoring, such as assessments of ecosystem condition. For example, the Marine Life Management Act requires conservation of the health and diversity of marine ecosystems and marine living resources.[17]

Finally, the MPA monitoring approaches described in this plan are amenable to the addition of possible supplemental monitoring modules to provide additional, detailed information to support management and research priorities beyond the immediate requirements of the MLPA. Many different topics, such as supplemental fisheries, water quality or invasive species monitoring, may be appropriate for supplemental monitoring modules, building off the ecosystems approach developed to implement monitoring of MPAs. The MPA monitoring approaches described in this plan include monitoring of many fished species and fisheries and provide some insight into water quality, invasive species, and other issues in order to inform MPA assessment and management under MLPA. But if additional information is desired for MPA or other management mandates, then the addition of supplemental monitoring modules may be warranted. Appendix A of this plan explores possible supplemental monitoring modules, focusing on those that inform the intersection of MPAs and other management mandates, such as fisheries management. Supplemental fisheries monitoring could, for example, be designed to test and refine new methods of stock assessment or new fishery control rules. In time, it could also address emerging concepts such as effective trophic level, maximum food chain length, connectance, species richness, evenness, or redundancy, all of which could inform fisheries management and possibly support implementation of EBFM.

[17] California Marine Life Management Act, Statutes 1998, Chapter 1052, Fish and Game Code section 7050(b)(1).

4. Assessing Ecosystem Condition & Trends

- Long-term tracking of ecosystems
- Ecosystem Feature Checkups
- Ecosystem Feature Assessments
- Metrics for Ecosystem Feature Checkups & Assessments
- Advancing ecosystem monitoring through research & development

As described in Chapter 3, assessing the effectiveness of the North Central Coast regional MPA network in meeting MLPA goals and facilitating adaptive MPA management requires two distinct, but complementary, monitoring elements: long-term tracking of the condition of, and trends in, marine and coastal ecosystems (this chapter) and evaluation of specific MPA design and management decisions (Chapter 5). This chapter describes the overarching framework, implementation options, and recommended monitoring metrics to track the condition and trends of the North Central Coast Ecosystem Features.

LONG-TERM TRACKING OF ECOSYSTEM CONDITION

APPLYING STATUS & TRENDS MONITORING TO ECOSYSTEM FEATURES

Regular assessment and long-term tracking of ecosystems or ecosystem components – often referred to in other monitoring programs as 'status and trends monitoring' – is accomplished through monitoring of the nine Ecosystem Features selected to collectively represent and encompass the North Central Coast region for the purposes of MPA monitoring (see Chapter 3). To meet MLPA requirements, this monitoring includes repeated assessments of key ecological and human aspects of ecosystems that collectively describe the condition of the ecosystems, how they vary inside and outside MPAs, and how they change over time.

BUILDING A BODY OF KNOWLEDGE TO STRENGTHEN MPA MANAGEMENT

The approaches described here are designed to guide, and then build on the foundation of knowledge to be generated through, the North Central Coast MPA Baseline Program. The Baseline Program has two complementary purposes: baseline characterization; and assessment of initial changes following MPA implementation.

Baseline characterization is designed to provide a frame of reference to support subsequent assessment of MPA network performance against MLPA goals and facilitate future adaptive management. It includes:

a. *Description of North Central Coast ecosystems inside and outside MPAs*
   Describe ecosystem structure and function, habitats, species assemblages and socioeconomic patterns at specific sites, inside and outside MPAs, and across the study region.
b. *Initial data points for long-term tracking of condition and trends in North Central Coast ecosystems*
   Establish the initial or "time zero" point(s) to begin long-term monitoring of changes in ecological and socioeconomic elements of the system, inside and outside MPAs, after MPA implementation.
c. *Assessment of ecosystem condition at MPA implementation*
   Interpret ecological and/or socioeconomic data and results in the context of historical trend data, physical and other system drivers, and data from other protected or unprotected locations to understand the context of the implementation conditions.
d. *Long-term monitoring recommendations*
   Inform long-term monitoring planning and implementation, for example through:
   i. Assessment and recommendation of new approaches to broad ecosystem assessment;

ii. Initial examination of monitoring indicators provided in the framework, recommendation of refinements or alternatives to these indicators, and recommendation of a minimum or sufficient set of indicators to assess long-term status and trends for one or more Ecosystem Features (defined later in this document);
iii. Surveys of sites inside and outside MPAs to identify and characterize appropriate test and reference or control sites for long-term monitoring, or;
iv. Pilot testing of new or improved methods (analyses, technologies, etc.) for long-term monitoring.

Assessment of initial changes following MPA implementation focuses on identifying and measuring socioeconomic and ecological changes considered likely to be rapid and important effects of the MPAs and investigating the extent to which such changes can or cannot be attributed to the establishment of the MPAs or other causal or contributing factors. Priorities for assessing initial changes following MPA implementation are:

a. Description of changes in commercial and recreational fishing
Describe changes in commercial and recreational fishing effort, catch and value that are or seem likely to be attributable to MPA implementation.

b. Description of changes in non-consumptive recreational use
Describe changes in recreational boating, shore/beach visitation, marine wildlife viewing, scuba diving, and other recreational activities that are or seem likely to be attributable to MPA implementation.

c. Description of changes in selected ecological components of North Central Coast marine ecosystems
Identify and select habitat, species, or other ecosystem elements considered to be sensitive and rapid in responding to MPA implementation and describe any changes observed that may or seem likely to be due to the MPAs.

The Baseline Program includes projects of up to three years in duration. For more details, see the North Central Coast MPA Baseline Program Request for Proposals, Appendix C-2.

Long-term monitoring will build upon the information gathered through the Baseline Program. Both the Baseline Program and long-term monitoring employ monitoring metrics. The monitoring metrics have been selected to provide useful insights into important components and functions of each Ecosystem Feature. They have been selected to encompass the different timeframes over which different changes may occur following MPA implementation, and in consideration of the regular reviews of the MPAs recommended in the MLPA Master Plan. In addition, the monitoring metrics have been designed to lead to strategic growth of our understanding of marine ecosystems, of our ability to detect changes in those ecosystems, and ultimately of our ability to attribute observed changes to establishment of MPAs. Thus some metrics have been chosen because they are likely to detect straightforward potential MPA effects, such as increases in the abundance and size of selected species. Other chosen metrics (e.g., kelp canopy areal extent) may be less immediately responsive to potential MPA effects, but provide important insights into the structure or functioning of ecosystems.

The benefits of monitoring for MPA management will thus increase over time as better and more detailed information is accumulated on ecosystem condition and trends, in turn allowing improved explanations and predictions to be made. All ecosystems are influenced by a variety of natural and anthropogenic impacts, and by multiple management measures. Long-term tracking of ecosystems provides the information needed to begin to understand how ecosystems respond to these many influences, and the role that MPAs are playing, which in turn will inform future adaptive management decisions aimed at improving the MPAs' effectiveness.

The MPA monitoring metrics may also benefit other (non-MPA) management priorities and mandates, such as fisheries management. To the extent possible, monitoring metrics have been chosen that will benefit other programs without compromising the ability to meet MLPA monitoring requirements. For example, some fishery 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. Examples include brown rockfish (*Sebastes auriculatus*) and copper rockfish (*Sebastes caurinus*), species for which stock assessments have not been conducted.

Monitoring of ecosystems is a new science, and monitoring metrics and approaches will be tested and refined over time. Targeted research programs and partnerships will be essential to evaluate and improve monitoring over time. To this end, this chapter also identifies key topics for research to advance our knowledge of ecosystem structure and function and to develop new efficient methods and technologies for implementing long-term monitoring.

INTERPRETING CONDITION & TRENDS OF ECOSYSTEM FEATURES

Analysis and interpretation of the results generated through long-term tracking of North Central Coast ecosystems will incorporate additional information from other monitoring programs and data sources. Ecological and socioeconomic changes following implementation of MPAs will occur in the context of variation in many other physical, economic, and management factors. There are many sources of information on such factors, whether relating to water quality, oceanography, or aspects of land use. Further information regarding important contextual information and means to garner and incorporate this information into monitoring analyses is provided in Chapters 6 and 7.

Analysis and interpretation of ecosystem condition data will also consider MPA regulations and available information on MPA compliance. The MPAs adopted for the North Central Coast region differ in the activities allowed within them. For example, some prohibit all fishing while others allow specific types of fishing. MPA monitoring must be designed to consider differences in MPA regulations, and to facilitate detection of the effects of illegal activities (as well as legal activities) on MPAs. Effects of some illegal activities can be relatively easy to detect, such as unauthorized removals of sessile organisms from sites that are regularly surveyed. Other effects are extremely difficult to detect, for example those resulting from unauthorized removals of mobile species. The assessment of Ecosystem Feature condition and trends over time has been designed considering the potential for illegal activities. In addition, analysis of monitoring data will consider available information about types and levels of non-compliance with MPA regulations obtained through MPA enforcement and surveillance activities.

IMPLEMENTATION OPTIONS

As previously described, this plan provides options and recommendations for MPA monitoring in the form of a series of modules. In this section of the monitoring plan, a stand-alone monitoring module is described for the long-term tracking of the condition and trends of each Ecosystem Feature. Implementation of all nine modules, covering all nine Ecosystem Features, provides comprehensive coverage of the major marine and coastal ecosystems of the North Central Coast region and potential MPA effects on those ecosystems. However, given that some Ecosystem Features may be more responsive to potential MPA effects than others; that management priorities may emphasize some Ecosystem Features over others; and that monitoring resources may be limited, it may be appropriate to select a subset of the modules for monitoring implementation. Guidance for choosing among modules, should resource limitations or other considerations argue against implementation of all modules, is provided in Chapter 9.

In addition to designing this element of monitoring to allow choice of modules, choice is also provided in how each module may be implemented. Two implementation options are presented for each module:

1. Ecosystem Feature Checkup, and
2. Ecosystem Feature Assessment.

Both options retain an ecosystem-level focus and have been designed to efficiently leverage different types of existing or potential capacity to contribute to MPA monitoring within the region. For each module, one or both options may be used, in the same or different MPAs; the two options have been designed to provide compatible information, although at different levels of resolution.

ECOSYSTEM FEATURE CHECKUPS

The Ecosystem Feature Checkup option is designed to provide a coarse-grained evaluation of ecosystem condition and trends. This option is primarily designed to take best advantage of the potential role that citizen-science groups and community organizations may play in contributing to monitoring the North Central Coast regional MPA network. This type of monitoring uses simplified sampling protocols and methods and includes well-developed training programs for data collectors and formalized data quality assurance and quality control (QA/QC) procedures.

For each Ecosystem Feature, a set of three to six vital signs is selected that collectively will evaluate feature condition and trends inside and outside select MPAs and thus across the region as a whole. Emphasis has been placed on selecting vital signs that do not require technically demanding monitoring metrics and equipment-intensive methods, and, where appropriate, on use of existing monitoring programs.

IDENTIFYING VITAL SIGNS OF ECOSYSTEM FEATURE CONDITION

Vital signs were selected using the MLPA policy guidance (see Chapter 2), including the list of species most likely to benefit from MPAs (Appendix C-7), and the requirement to facilitate assessments at a variety of spatial scales, from the individual MPA through the regional MPA network as a whole.

For the ecological Features, many vital signs were chosen to reflect commonly observed changes to marine and coastal ecosystems, emphasizing those that may be sensitive to MPA effects. These changes include loss of habitat (particularly biogenic habitat), decreased size of fish species, decreased abundance of top-level predators, and the consequent simplification of food webs within marine ecosystems. Currently, many of the vital signs only indirectly link to these overarching trends in marine ecosystems. This is in part due to a deliberate focus on selecting vital signs that may be assessed with minimal technological and other resource requirements in order to best tap into potential community-based or citizen-science MPA monitoring programs. However, it also reflects the limited scientific knowledge of the critical elements and processes maintaining marine ecosystems in the region. As scientific understanding of these ecosystems increases, the vital signs will be refined and adapted accordingly.

For the human uses Features, priority was accorded to selecting vital signs that can be monitored using existing datasets and monitoring programs. For consumptive uses, there are several fisheries monitoring programs that collect information suitable for conducting a Checkup of this Ecosystem Feature. However, there are few, if any, existing programs that collect relevant information for non-consumptive uses. Such programs could of course be developed, and possible vital signs are provided to guide development of potential programs.

IMPLEMENTING ECOSYSTEM FEATURE CHECKUPS

Vital signs have been designed as a cohesive set of metrics and all vital signs for a specific Checkup should be included if that Ecosystem Feature is being evaluated. Given the large spatial variation in ecosystem components and human uses, the necessarily coarse-grained nature of Ecosystem Feature Checkups will be best suited to evaluating MPA performance through detecting trajectories of change over time, and less conclusive for making small-scale, inside-outside comparisons for individual MPAs.

For ecological Features, vital signs data will be periodically collected inside and outside select MPAs and this information will be synthesized to identify regional trends in Ecosystem Features condition inside and outside MPAs. For the Consumptive Uses Ecosystem Feature, the vital signs have been selected to draw on data currently available through existing databases and programs, and are thus constrained by the limited geographic resolution within these data sources. Thus, as with the ecological vital signs, interpretation of this information will be most useful, and most robust, at a region-wide scale. Vital signs for Non-consumptive Uses have been suggested to guide future implementation of data collection programs. To be most useful, implementation of this Ecosystem Feature Checkup should draw upon the experience garnered through data collection as part of Ecosystem Feature Assessments (described further below).

ECOSYSTEM FEATURE ASSESSMENTS

The Ecosystem Feature Assessment option is a scalable method for implementing monitoring of Ecosystem Features that is more detailed and technically demanding than the Ecosystem Checkup option. Ecosystem Feature Assessments build upon and adapt well-tested monitoring methods often employed in status and trends monitoring.[18] The condition and trends of each Ecosystem Feature are assessed by identifying a limited set of key attributes of the feature and evaluating the condition of these key attributes using a small number of strategically selected focal species or indicators.

Ecosystem Feature Assessments are designed to take advantage of technically robust monitoring partnerships, such as those with state and federal agencies or research programs and institutions. If the Assessment option is chosen for implementation, all the key attributes and focal species/indicators should be monitored. These metrics encompass attributes and focal species/indicators considered adequate to collectively assess the condition and trends of the feature, and comparatively feasible to implement and interpret.

Optional add-on attributes and focal species/indicators have also been identified. These may be selected as desired. They provide additional insights, but are more difficult or expensive to implement, and more challenging to interpret. Optional add-on metrics should be added to monitoring only if or to the extent that resources permit, and used in addition to the Assessment metrics. Research programs aimed at improving understanding of marine ecosystems and approaches to MPA monitoring may make metrics currently included in the optional add-ons more useful or feasible to implement in future, and Ecosystem Feature Assessment metrics will then be updated accordingly.

Ecosystem Feature Assessments differ somewhat between ecological and human uses Ecosystem Features. The approaches to each are described below.

ELEMENTS OF ECOSYSTEM FEATURE ASSESSMENT – ECOLOGICAL FEATURES

Ecosystem Feature Assessments of the seven ecological Features are conducted via key attributes and indicators or focal species. Figure 4-1 provides a conceptual diagram illustrating these monitoring components.

For each ecological Feature, a limited set of key attributes is identified. Key attributes are designed to capture fundamental aspects of the structure and functioning of the Feature that are critical for maintaining its condition through time. They are not meant to provide an exhaustive characterization of each Ecosystem Feature, but to give an indication of the general condition of the Feature and trends over time inside and outside MPAs and throughout the region.

[18] For example, this approach is consistent with that developed by Foundations of Success (FOS), a non-profit organization with experience supporting planning, monitoring, and adaptive management of conservation and resource management projects in California and worldwide. This approach extends the FOS methodology, which incorporates Key Ecological Attributes and Indicators. For more information on FOS see www.fosonline.org.

Each key attribute is assessed using three to five focal species or indicators. Indicators are monitoring metrics known to relate to a broader ecosystem aspect. Focal species do not indicate broader ecosystem condition, but as a group collectively give insight into an aspect of community or trophic structure. Indicators are generally preferable as, by definition, they directly signify attribute condition. However, specific indicators of the condition or trends in key attributes are frequently unknown. In these cases a limited set of focal species has been selected to provide insight into the condition of the attribute. Collectively, the focal species/indicators will provide an indication of the condition of the corresponding key attribute and how it changes over time.

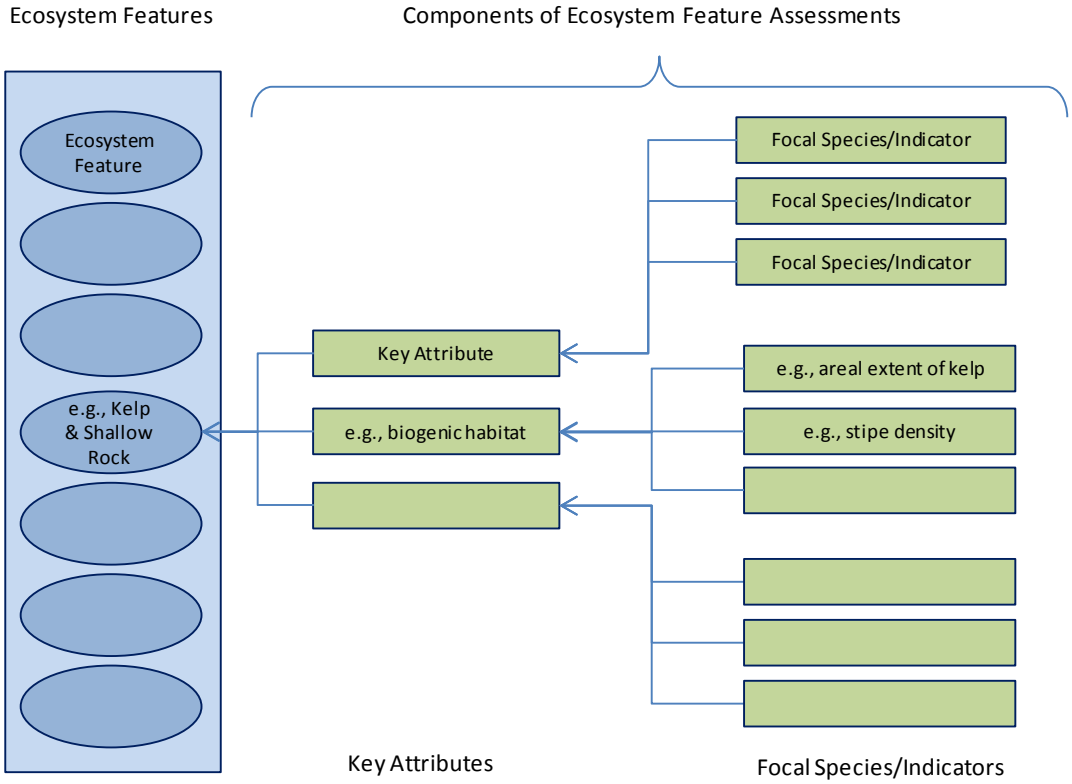


***Figure 4-1**. Conceptual diagram of the structure of the Ecosystem Feature Assessment option for tracking the condition of Ecosystem Features. A limited set of focal species/indicators is selected to collectively assess the status of a key attribute. Collectively, the status of key attributes is used to assess the condition of the Ecosystem Feature. An illustrative example is provided here for the Kelp and Shallow Rock Ecosystem Feature.*

IDENTIFYING KEY ATTRIBUTES

Ecosystems are complex systems comprising many different components held together by an intricate set of ecological and physical processes. Ideally, key attributes for assessing ecosystem condition would focus on system properties, processes, and functions, such as resilience, trophic structure, or nutrient cycling. However, the science guiding the measurement and interpretation of such metrics is in its infancy, and they are expensive to implement using current methods. Thus they are, for now, best explored through research partnerships, rather than being included as monitoring metrics. The currently selected key attributes include aspects of biogenic habitat together with functional species groups (e.g., piscivorous fishes) within each ecosystem. As scientific understanding of ecosystem structure and function increases, monitoring approaches, including selected key attributes, will be appropriately refined and adapted.

To facilitate this improvement, and to provide rationale for each selected key attribute, each attribute has been split into two components. The first of these describes the broad ecosystem attribute under consideration. The second describes how this attribute is being assessed within the Ecosystem Feature, taking into account current knowledge and feasibility of monitoring. For example, one key attribute for assessing the Kelp and Shallow Rock Ecosystem Feature is 'biogenic habitat: macroalgal assemblage'. In this case, biogenic habitat is the key ecosystem attribute, which is assessed through monitoring of the macroalgal assemblage within this ecosystem. Increasing experience with using this key attribute, and targeted research, may lead to improvements in how the attribute is assessed or replacement of the attribute itself.

IDENTIFYING FOCAL SPECIES/INDICATORS

Indicators for assessing key attributes capture aspects of the spatial distribution and size or extent of each attribute (such as the amount and distribution of biogenic habitat). In the future, as scientific understanding of ecosystem functions and processes advances, indicators of key attribute functioning or quality will be incorporated.

To the extent they are known, specific indicators of the condition of key attributes have been included. Where this is impossible due to the current limits of scientific knowledge, a limited set of focal species has been selected to collectively provide insight into components of the key attribute and, by extension, into the key attribute itself. Sets of focal species were identified and recommended using existing knowledge and taking into account the following considerations and criteria:

- Species which play a known and important ecological role
- Likely fast and slow MPA responders
- Species with different life history characteristics
- Fished species which may be likely to show an MPA response, and unfished species for comparison

ELEMENTS OF ECOSYSTEM FEATURE ASSESSMENT – HUMAN USES FEATURES

Two human uses Ecosystem Features are included: Consumptive Uses and Non-Consumptive Uses. The Ecosystem Assessment monitoring metrics for these two Ecosystem Features are structured differently from those for the ecological Features. The selected structure reflects well-established monitoring methods for these subject areas and will facilitate making analytical and interpretive links between the ecological and human uses Ecosystem Features.

Analogous to the key attributes previously defined, key consumptive and non-consumptive uses have been identified for monitoring. A recommended minimum set of key human uses for focusing monitoring activities is described, as well as additional human uses that can be included where resources and methods permit. Indicators have been identified to assess these human uses and track changes in them over time.

IDENTIFYING INDICATORS

For both the Consumptive and Non-Consumptive Uses Ecosystem Features, an overarching set of indicators has been developed. These are tailored for each Ecosystem Feature to identify the most useful monitoring metrics, taking into account the standard methods employed to monitor patterns of human uses and socioeconomic trends. These indicators can be applied, with appropriate modifications, to each consumptive or non-consumptive use identified for monitoring. As with the ecological elements, the recommended monitoring metrics are not meant to provide an exhaustive characterization of the Ecosystem Feature, but to give an indication of the general status of the feature and trends over time.

The indicators are structured as a list of indicator categories. These categories are included in rank order of descending importance and offer a mechanism to scale implementation of data collection. All categories are necessary to conduct a comprehensive assessment of Ecosystem Feature condition and interpret trends through time, however further guidance is provided in Chapter 9 for approaches to scale implementation in ways that produce useful sets of results should resource limitations preclude full implementation.

IMPLEMENTING ECOSYSTEM FEATURE ASSESSMENTS

Ecosystem Feature Assessment approaches are implemented by collecting data inside and outside select MPAs distributed though the North Central Coast regional MPA network. Where resources and methods permit, a stratified approach may be adopted in which sampling is conducted at increasing distances inside and outside MPA boundaries, thus providing increased resolution in data collected and improved insight into MPA functioning together with patterns of ecosystem change and human uses.

Where Ecosystem Feature Assessments are chosen to assess Ecosystem Features, all metrics should be monitored to robustly assess the feature. When feasible and desirable, some or all of the optional add-ons for Ecosystem Feature Assessments can be selected and added to provide more comprehensive information.

METRICS FOR ECOSYSTEM FEATURE CHECKUPS & ASSESSMENTS

The following sections of this chapter describe the selected metrics for long-term tracking of condition and trends of the nine Ecosystem Features identified for the North Central Coast region. 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. Further detail describing the rationale for selection of each metric is provided in Appendices B-1 & B-2, the Guide to Vital Signs and Guide to Attributes and Indicators respectively. The monitoring metrics also draw upon the general information provided for each Ecosystem Feature in Chapter 3.

KELP & SHALLOW (0-30M) ROCK ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Red sea urchin abundance & size frequency ➢ Purple sea urchin abundance & size frequency ➢ Red abalone abundance & size frequency ➢ Rockfish average & maximum size ➢ Lingcod abundance & size frequency

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	**Focal Species/Indicators**
Biogenic Habitat: Macroalgal assemblage	Areal extent of surface kelp canopy (*Macrocystis pyrifera* & *Nereocystis luetkeana*)
	Kelp stipe density & size structure
Strong Ecological Interactors: Invertebrates	Density & size structure of focal species: Purple sea urchin (*Strongylocentrotus purpuratus*) Red sea urchin (*Strongylocentrotus franciscanus*) Red abalone (*Haliotis rufescens*) Sea stars (*Pisaster spp./Pycnopodia helianthoides*)
Predators: Piscivorous fishes	Density & size structure of focal species: Black rockfish (*Sebastes melanops*)[1] Lingcod (*Ophiodon elongatus*) Cabezon (*Scorpaenichthys marmoratus*)
Trophic Structure: Planktivorous fishes	Density & size structure of focal species: Blue rockfish (*Sebastes mystinus*)[1]

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

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This set of information includes supplemental metrics, some or all of which can be added as methods & resources permit.

Key Attribute	**Focal Species/Indicators**
Biogenic Habitat	Sub-canopy & turf algae cover
	Compound tunicate (multiple species) cover
	Diversity of habitat-forming species
Trophic Structure: Omnivorous fishes	Density & size structure of focal species: Black & yellow rockfish (*Sebastes chrysomelas*)[1] AND Gopher rockfish (*Sebastes carnatus*)[1] Kelp rockfish (*Sebastes atrovirens*)[1] Brown rockfish (*Sebastes auriculatus*)[1] Kelp greenling (*Hexagrammos decagrammus*)
Trophic structure: Unfished fishes	Density & size structure of painted greenling (*Oxylebius pictus*)
Diversity	Species richness (fishes & invertebrates)
	Species diversity (functional groups of fishes & invertebrates)

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

MID-DEPTH (30-100M) ROCK ECOSYSTEMS*

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Rock crab abundance & size frequency ➢ Rockfish average & maximum size ➢ Lingcod abundance & size frequency ➢ Dwarf rockfish abundance & size frequency

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Focal Species/Indicators
Biogenic Habitat: Sessile invertebrates	Cover and density of structure forming invertebrates
Trophic Structure: Mobile invertebrates	Density of focal species: Rock crabs (*Cancer spp.*) Sheep (spider) crabs (*Loxorhynchus grandis*) Box crabs (*Lopholithodes foraminatus*)
Predators: Piscivorous fishes	Density & size structure of focal species: Bocaccio (*Sebastes paucispinis*)[1] Yelloweye rockfish (*Sebastes ruberrimus*)[1] Vermilion rockfish (*Sebastes miniatus*)[1] Lingcod (*Ophiodon elongatus*)
Community Structure: Dwarf rockfishes	Total dwarf rockfish abundance (multiple species)

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

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This set of information includes supplemental metrics, some or all of which can be added as methods & resources permit.

Key Attribute	Focal Species/Indicators
Biogenic Habitat: Sessile invertebrates	Cover of encrusting invertebrates
	Metridium spp. bed cover
	Hydrocoral density
	Diversity of habitat-forming species
Trophic Structure: Omnivorous fishes	Density & size structure of focal species: China rockfish (*Sebastes nebulosus*)[1] Gopher rockfish (*Sebastes carnatus*)[1] Canary rockfish (*Sebastes pinniger*)[1] Copper rockfish (*Sebastes caurinus*)[1]
Community Structure: *Sebastomus* spp.	*Sebastomus* spp. rockfish diversity
Diversity	Species richness (fishes & invertebrates)
	Species diversity (functional groups of fishes & invertebrates)

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

* formerly Deep Ecosystems

ROCKY INTERTIDAL ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Mussel bed cover ➢ Purple sea urchin abundance & size frequency ➢ Owl limpet abundance & size frequency ➢ Ochre sea star abundance & size frequency ➢ Black abalone abundance & size frequency ➢ Red abalone abundance & size frequency ➢ Black oystercatcher abundance ➢ Harbor seal abundance (colony size)

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicators/Focal Species
Biogenic Habitat	Cover of focal species: Turf algae Foliose red algae Fucoids (fleshy brown algae) Mussels (*Mytilus* spp.) Feather boa kelp *(Egregia menziesii*) Surf grass (*Phyllospadix* spp.)
Strong Ecological Interactors: Invertebrates	Density & size structure of focal species/species groups: Black abalone (*Haliotis cracherodii*) Red abalone (*Haliotis rufescens*) Sea stars (*Pisaster ochraceus, Pycnopodia helianthoides*) Purple sea urchin (*Strongylocentrotus purpuratus*) Giant/owl limpet (*Lottia gigantea*)

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This set of information includes supplemental metrics, some or all of which can be added as methods & resources permit.

Key Attribute	Indicators/Focal Species
Predators: Predatory birds	Total abundance of piscivorous birds and shorebirds
	Diversity of piscivorous birds and shorebirds
	Abundance of black oystercatchers (*Haematopus bachmani*)
Habitat Provisioning: Juvenile fishes	Total YOY (young-of-the-year) rockfish abundance
Trophic Structure: Intertidal fishes	Density & size structure of focal species: Monkeyface prickleback (*Cebidichthys violaceus*) Rock prickleback (*Xiphister mucosus*)
Diversity	Species richness (fishes & invertebrates)
	Species diversity (functional groups of fishes & invertebrates)

SOFT-BOTTOM SUBTIDAL (0-100M) ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Dungeness crab abundance & size frequency ➢ Starry flounder abundance & size frequency ➢ Halibut abundance & size frequency ➢ Flatfish total abundance & size frequency

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicators/Focal Species
Biogenic Habitat	Total cover of biogenic habitat
	Biogenic habitat diversity
Trophic Structure: Benthic infauna	Functional diversity of benthic infauna (feeding guilds)
	Sand dollar (*Dendraster excentricus*) abundance & size structure
Predators: Benthic invertebrates	Density & size structure of focal species/species groups: Dungeness crab (*Cancer magister*) Sea stars (*Pycnopodia helianthoides/Pisaster* spp.)
Predators: Demersal fish predators	Density & size structure of focal species/species groups: California halibut (*Paralichthys californicus*) Starry flounder (*Platichthys stellatus*) Sanddab (*Citharichthys* spp.)

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This set of information includes supplemental metrics, some or all of which can be added as methods & resources permit.

Key Attribute	Indicators/Focal Species
Diversity	Species richness (fishes & invertebrates)
	Species diversity (functional groups of fishes & invertebrates)

ESTUARINE & WETLAND ECOSYSTEMS*

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Eelgrass areal extent ➢ Ghost & mud shrimp abundance ➢ Clam abundance & size frequency (geoduck, gaper, and littleneck clams) ➢ Starry flounder abundance & size frequency ➢ Marine birds diversity & abundance ➢ Harbor seal abundance (colony size)

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicators/Focal Species
Biogenic Habitat	Areal extent of eelgrass (*Zostera marina*)
Trophic structure: Infaunal assemblage	Abundance of focal species: Mud shrimp (*Upogebia pugettensis)* Ghost shrimp (*Neotrypaea californiensis*) Fat innkeeper worm (*Urechis caupo*) Pacific gaper clam (*Tresus nuttalli*) Littleneck clam (*Protothaca staminea*)
Productivity: Resident fishes	Shiner (*Cymatogaster aggregata*) & striped (*Embiotoca lateralis*) surfperch abundances
Predators: Marine birds	Total abundance & diversity of piscivorous birds & shorebirds
Predators: Piscivorous fish	Abundance of focal species: Leopard shark (*Triakis semifasciata*) Bat ray (*Myliobatis californica*)
Habitat Provisioning: Harbor seal haulout sites	Harbor seal (*Phoca vitulina richardsi*) abundance (colony size)

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This set of information includes supplemental metrics, some or all of which can be added as methods & resources permit.

Key Attribute	Indicators/Focal Species
Biogenic Habitat	Eelgrass (*Zostera marina*) shoot density
	Areal extent of common pickleweed (*Salicornia virginica*)
	Areal extent of sea lettuce (*Ulva* spp.)
	Native oyster abundance
Trophic Structure: Infaunal assemblage	Abundance & foraging rates of shorebirds
Productivity: Resident fishes	Starry flounder (*Platichthys stellatus*) abundance & size structure
	California halibut (*Paralichthys californicus*) density & size structure
Diversity	Species richness (fish & invertebrates)
	Species diversity (functional groups of fish & invertebrates)

* formerly Estuarine Ecosystems

SOFT-BOTTOM INTERTIDAL & BEACH ECOSYSTEMS

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Sand crab abundance ➢ Marine bird diversity & abundance ➢ Harbor seal abundance (colony size)

ECOSYSTEM FEATURE ASSESSMENT

Key Attribute	Indicators/Focal Species
Trophic Structure: Suspension feeders	Abundance and size structure of focal species: Sand crab (*Emerita analoga*) Razor clam (*Siliqua patula*)
Productivity: Surf zone fish assemblage	Surfperch abundance (Embiotocidae, multiple species)
	Surf smelt (*Hypomesus pretiosus*) abundance & size structure
Predators: Marine birds	Total abundance of predatory birds
	Predatory birds species diversity

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This set of information includes supplemental metrics some or all of which can be added as methods & resources permit.

Key Attribute	Indicators/Focal Species
Diversity	Species richness (fish & invertebrates)
	Species diversity (functional groups of fish & invertebrates)

NEARSHORE PELAGIC ECOSYSTEMS*

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Semi-pelagic/pelagic rockfish average & maximum size ➢ Brandt's cormorant abundance (colony size) ➢ Pelagic cormorant abundance (colony size) ➢ Pigeon guillemot abundance (colony size) ➢ Cassin's auklet breeding success

ECOSYSTEM FEATURE ASSESSMENT

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

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This information includes supplemental metrics, some or all of which can be added as methods & resources permit.

Key Attribute	**Indicators/Focal Species**
Productivity: Ichthyoplankton	Total ichthyoplankton abundance
	Total abundance of rockfish larvae
	Ratio of fished species to unfished species

* formerly named Pelagic Ecosystems

CONSUMPTIVE USES

ECOSYSTEM FEATURE CHECKUP

Vital Signs
➢ Landings (weight & value) of key species (nearshore rockfish, Dungeness crab, red urchin & California halibut) per fishing block & port for the commercial fishery ➢ Landings (number & weight) of key species (rockfish, lingcod & California halibut) per fishing block & port by CPFVs ➢ CPUE of key species (as above) per fishing block & port by CPFVs ➢ Total number of abalone harvested

ECOSYSTEM FEATURE ASSESSMENT

CONSUMPTIVE USES TO BE MONITORED

For each consumptive use or activity, key fishery species for monitoring include economically and ecologically important species predicted to respond MPA implementation.

Consumptive Uses to be Monitored
Commercial Fishing: Nearshore rockfish (*Sebastes* spp.) Dungeness crab (*Cancer magister*) California halibut (*Paralichthys californicus*) Red sea urchin (*Strongylocentrotus franciscanus)*
Recreational Fishing – Commercial passenger fishing vessels (CPFVs): Rockfish (*Sebastes* spp.) Lingcod (*Ophiodon elongatus)* California halibut (*Paralichthys californicus*)

INDICATORS

Each consumptive use is monitored using the same indicators. 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 years, or even more infrequently. Indicators for each consumptive use are:

1. Number of people or vessels engaged in the activity
2. Level of activity
    a. Number of fishing trips per fishing location, vessel, port & region
    b. Landings of key species per trip, fishing location, vessel, port & region
    c. CPUE (catch per unit effort) of key species per trip, fishing location, vessel, port & region
3. Economic value or quality of activity
    a. Landings value of key species per trip, fishing location, vessel, port & 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

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This information includes supplemental consumptive uses, some or all of which can be monitored using the same indicators above as methods & resources permit.

Consumptive Uses to be Monitored
Recreational Fishing – Private vessels Dungeness crab (*Cancer magister*) Rockfish (*Sebastes* spp.) Lingcod (*Ophiodon elongatus)* California halibut (*Paralichthys californicus*)
Recreational Fishing – Clamming Pacific gaper clams (*Tresus nuttalli*) Littleneck clams (*Protothaca staminea*)
Scientific collecting (indicators to be developed)

NON-CONSUMPTIVE USES

ECOSYSTEM FEATURE CHECKUP

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

ECOSYSTEM FEATURE ASSESSMENT

NON-CONSUMPTIVE USES TO BE MONITORED

The indicators below can be applied to each non-consumptive use or activity.

Non-consumptive Uses to be Monitored
Scuba diving Wildlife viewing – boating & kayaking Wildlife viewing – shore-based Tidepooling

INDICATORS

Each non-consumptive use is monitored by applying the same indicators listed below. Note, however, that not all indicators need to be implemented at the same time or with the same frequency. For example, KAP surveys are typically conducted once every five years, or less frequently.

Indicators:

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

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

This information includes supplemental non-consumptive uses, some or all of which can be monitored using the same indicators above, as methods & resources permit.

Non-consumptive Uses to be Monitored
Recreational beach use Educational use

ADVANCING ECOSYSTEM MONITORING THROUGH RESEARCH & DEVELOPMENT

The MLPA defines adaptive management as "a management policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning. Actions shall be designed so that, even if they fail, they will provide useful information for future actions, and monitoring and evaluation shall be emphasized so that the interaction of different elements within marine systems may be better understood."[19] As noted in the MLPA Master Plan, "adaptive management requires learning from current experience to improve the process of achieving the goals of the MLPA over time."[20]

This monitoring plan is designed to meet this requirement, enabling assessment of the effectiveness of the North Central Coast regional MPA network in achieving MLPA goals, and facilitating adaptive management of MPAs whereby the effectiveness of the MPAs may be improved over time. However, an adaptive management approach should be taken not only for the MPAs, but for monitoring itself. Although long-term consistency in monitoring data is important, MPA monitoring must be responsive to changing management needs and environmental conditions to remain relevant. Monitoring should also be flexible to allow improvements based on increased scientific knowledge and experience with different monitoring methods and approaches. Here, priority research needs are identified to advance ecosystem monitoring and guide the development of research partnerships. Further considerations for establishing partnerships are included in Chapter 7 and considerations for funding and implementing research to advance ecosystem monitoring are discussed in Chapter 9.

RESEARCH PRIORITIES

Despite a long history of research, our understanding of marine ecosystem structure and functioning remains incomplete. Anthropogenic changes in marine ecosystems have been well documented globally, such as loss of habitat and decreased abundances of many top-level predators. 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. While increasing research effort is targeting these questions, further support will be necessary to adapt and understand the results and conclusions in light of ongoing and increasing climate and oceanographic changes and influences on marine ecosystems. To be useful for advancing MPA monitoring, this increased knowledge of ecosystems 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 that will be relevant and applicable to management decisions.

To guide research to support MPA monitoring and evaluation and inform MPA management, three priority research goals have been identified:

1. Advanced monitoring methods, including developed and tested new technologies for efficient monitoring data collection and analysis
2. Advanced understanding of the interactions between socioeconomic and ecological ecosystem elements
3. Advanced understanding of marine ecosystem structure and function

Draft potential focuses for research within these core topics are identified and briefly listed below. These priorities represent initial candidates for research topics based on existing data in the North Central Coast region, and the current state of knowledge of ecosystems and monitoring. Implementation of this research module should take into account continually improving scientific knowledge to focus resources most appropriately. Priority research topics are likely to

[19] California Marine Life Protection Act, Statutes 1999, Chapter 1015, Fish and Game Code section 2852(a).
[20] California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008, p. 73.

change, first in response to improved knowledge in the region through the North Central Coast MPA Baseline Program (see Appendix C-2), and also through ongoing scientific research. These research topics will be updated as understanding advances and reviewed as part of an ongoing schedule of evaluation of the monitoring program.

ADVANCING MONITORING METHODS & TECHNOLOGIES

- Application of existing and new modeling frameworks to:
    - Analyze monitoring data and increase our understanding of the drivers and mechanisms of ecosystem condition and trends
    - Evaluate the performance and relationships among selected indicators to inform management about predicted magnitude and timing of responses, effects of co-variables and potential alternative indicator choices
    - Assess the role of MPAs in ecosystem conservation given different scenarios of climate change and recommend improved monitoring approaches
    - Predict the effectiveness of MPAs in ecosystem conservation inside MPA boundaries and beyond given different scenarios of future fishing distribution and intensity
    - Model connectivity and effects of MPA sizes to inform future adaptive management decisions
- Development and testing of novel statistical frameworks, including Bayesian approaches, for analysis of ecosystem trends, including trends in ecosystem characteristics such as resilience and stability
- Investigation into, and testing of, new technologies (or technology not commonly applied to MPA monitoring) to increase the efficiency and effectiveness of MPA monitoring. Potential examples include:
    - Remote sensing including acoustics
    - Stable isotopes
    - Genetics and genomics applications

UNDERSTANDING SOCIOECONOMIC & ECOLOGICAL INTERACTIONS

- Development of frameworks to explicitly link ecological and socioeconomic monitoring results through coordinated identification of monitoring priorities and approaches

UNDERSTANDING MARINE ECOSYSTEM STRUCTURE & FUNCTION

- Increase understanding of ecosystem resilience and application for MPA monitoring including:
    - Ecological mechanisms conferring increased resilience, including the roles of robustness, resistance to change, recovery rates and reversibility of change, and methods to monitor these ecological processes
    - Role of non-linear dynamics, synergies or thresholds in ecosystem resilience and approaches to monitor these dynamics
    - Links between resilience and diversity or productivity measures and applications for MPA monitoring
- Development of indicators of ecosystem condition including:
    - Indicators of trophic structure
    - Indicators of ecological functioning including ‘strong interactors’ and key processes

DEVELOPING RESEARCH PARTNERSHIPS

The research goals and associated focal topic areas above 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. Implementation of this research and development module may therefore be best facilitated through the use of competitive proposal processes (e.g., Requests for Proposals, with merit reviews of submissions), or through use of monitoring funds as a match against larger academic and/or agency external research proposals. Given the likely size and complexity of research teams necessary to address these research questions, collaborations to share and use existing information, together with partnerships that leverage existing or planned research programs, will be essential. While research and development is fundamental to an adaptive and advancing monitoring program, full implementation of this component of a monitoring program and generation of results that can inform the monitoring program is likely to take many years. (See also the broader discussion in Chapter 7 of developing monitoring partnerships.)

5. Evaluating MPA Design & Management Decisions

- Structuring MPA design & management evaluations
- Short-term design & management evaluations
- Long-term design & management evaluations

As explained in Chapter 2, monitoring to meet MLPA requirements necessitates implementation of two complementary monitoring elements: assessing ecosystem condition and trends, which is described in Chapter 4; and evaluation of specific MPA and network design and management decisions (this chapter).

The establishment and on-going management of MPAs involve a number of decisions, ranging from fundamental design decisions made during the MPA planning process, such as MPA size and spacing, to day-to-day management decisions made to address ongoing and emerging issues, such as those related to managing visitors to MPAs. This chapter describes the approach to evaluating the effects of these design and management decisions on ecosystems and their components. The results of these evaluations, together with results of assessing ecosystem condition and trends, are then used to inform future management decisions, thus facilitating adaptive MPA management as required under MLPA.

STRUCTURING MPA DESIGN & MANAGEMENT EVALUATIONS

APPLYING MANAGEMENT EFFECTIVENESS MONITORING TO THE MLPA CONTEXT

Evaluation of specific design or management decisions is often referred to as 'management effectiveness monitoring'. The term can be misleading, because assessment of management effectiveness generally requires both focused investigation of the impacts of specific decisions as well as assessment of the condition and trends of ecosystems and/or ecosystem components. For example, an MPA boundary may be designed to enclose a rocky reef, in order to protect an entire habitat and maximize the protection provided to reef-associated species. Evaluation of the 'management effectiveness' of this decision may use fish tagging studies to determine how many reef-associated fish move across the boundary and thus are available to the fishery. However, interpreting this information to determine whether, for example, rockfish are being protected as intended by the MPA is strengthened by information about the condition and trend of the rockfish population of interest. If the population is increasing, then 'leakage' of individual fish across the MPA boundary may not be a concern, and indeed may be considered beneficial to help support nearby fisheries. In contrast, if the population is declining, then adjustment to the MPA boundary, for example by moving the boundary away from the reef to encompass a sandy buffer area that rockfish are less likely to cross, may be considered to reduce leakage.

This example illustrates the complexities involved in this type of monitoring, both in designing useful evaluation of the design or management decision of interest (e.g., which species of fish should be tagged?) and in interpreting results. In the context of the MLPA, this component of monitoring also applies to a very broad range of design and management decisions.

During the MPA planning process, guidelines were developed for the design of the North Central Coast regional MPA network, relating to MPA size and spacing, representation of habitat types, levels of protection (reflecting the types of activities allowed in the MPAs), and other characteristics. In addition, the planning process incorporated many other decisions, such as locating an MPA near an educational institution in order to promote research and education at that site. All of these design decisions, as well as additional decisions that will be made by managers after the MPAs take effect (relating, for example, to education and outreach or visitor management) can be evaluated to determine their impacts on the ecosystems of the North Central Coast region and their contributions to meeting MLPA goals. However, not all decisions

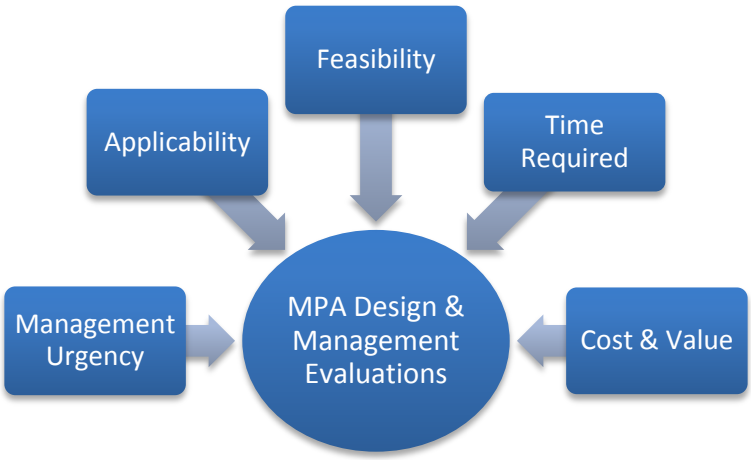
are equally amenable to evaluation, or as useful to management if evaluated. In designing monitoring to evaluate specific MPA design and management decisions, Ecosystem Features provide the overarching organizational framework. The challenge is to choose wisely from the large pool of decisions that could be evaluated, and ensure the chosen decisions are evaluated well to ensure results are useful for informing future MPA management decisions. To meet these needs, this plan includes guidance for structuring potential evaluations of design and management decisions, and selection criteria to inform the choice of potential evaluations to prioritize for implementation. Implementation options for this component of monitoring are also discussed.

FRAMING EVALUATIONS OF MPA DESIGN & MANAGEMENT DECISIONS

Evaluations of MPA design and management decisions seek to assess the impacts of a given decision on the ecology or socioeconomics of the North Central Coast region, to inform possible future management decisions. Thus potential evaluations are best framed as questions that explicitly link the decision to be evaluated and the ecosystem response to be assessed. For the evaluation to be as useful as possible, both the decision and the response must be stated specifically. Thus a question formulated as "What is the effect of MPA design on conserving biodiversity?" is much less likely to generate useful information than "What is the effect of placing an MPA boundary across a rocky reef on protecting rockfish within the MPA?".

Once the evaluation question has been formulated as specifically as possible, specific hypotheses or mechanisms are identified that link the decision and the response. In the example given above, it might be hypothesized that rockfish resident in an MPA with a boundary crossing a rocky reef leave the MPA more frequently than do rockfish resident in an MPA with a boundary encircling a rocky reef. Then initial decisions about likely evaluation methods are made, such as the species and numbers of rockfish to be monitored, and the type of tagging or other method to use to detect boundary crossings. After questions, hypotheses, and methods have been identified for MPA design or management questions that are candidates for evaluation, the candidates are assessed and prioritized based on the selection criteria discussed below.

CRITERIA TO SELECT DESIGN & MANAGEMENT DECISIONS FOR EVALUATION



The criteria illustrated above have been developed to guide selection and prioritization among the wide range of MPA design and management decisions that could be evaluated. Many of the criteria will be easiest to apply by comparing potential evaluations against one another to generate relative rankings and prioritizations. This, of course, requires some structure or process for identifying, then prioritizing, potential evaluations, which is discussed later in this chapter under

Implementation Options. Following are descriptions of the criteria, with brief discussions of their application to selecting and prioritizing potential MPA design and management evaluations.

MANAGEMENT URGENCY

Some MPA management decisions, or potential decisions, require urgent evaluation, for example when a resource may be at risk or user conflicts are occurring. In these cases, one or more management responses may be under consideration, or implemented, to address the urgent issue. Evaluation of the considered or implemented management responses can predict or assess their effectiveness in resolving the issue. To take a simple example, an MPA may experience increased numbers of visitors observing nesting birds, raising the concern that the disturbance may disrupt the nesting season. Possible management responses would include increasing the distance between visitors and birds, reducing the numbers of visitors, and educating visitors about how to minimize disturbance. Evaluations could be designed to help choose among these possible management measures and evaluate any that are implemented. These types of evaluations often involve multiple steps. In this case, if a mechanism to increase the distance between visitors and birds was implemented but found to be ineffective in reducing disturbance, a follow-up evaluation may assess whether the increased distance is still inadequate to prevent disturbance or the mechanism is ineffective. For obvious reasons, evaluations to address urgent management needs should be accorded high priority under this criterion.

MANAGEMENT APPLICABILITY

Evaluations of design or management decisions should produce results that are directly applicable to the decision or decisions being evaluated. For example, an evaluation of the effects of MPA size should not merely characterize MPAs of different sizes, but provide information on the relationship of MPA size to key elements of the ecology or socioeconomics of the North Central Coast region, and ideally generate predictions of the effects of different MPA sizes or size ranges. Thus, future management decisions that may adjust MPA sizes are directly informed by the results of the evaluation. While this may sound obvious, some decisions are much more amenable to informative evaluation than others, and it is important during the structuring of a potential evaluation to identify explicitly which management decision or decisions will be informed by the evaluation, and how the resulting information will be applicable to future decisions.

Breadth of applicability to management should also be considered. For example, an evaluation that will generate information applicable to the entire North Central Coast regional MPA network may be prioritized over one that is applicable only to a single MPA. Similarly, an evaluation that applies to an entire Ecosystem Feature, or a broad spectrum of human uses, may be more valuable than one narrowly focused on a single species or human activity.

Evaluations that will have the most direct and useful application to future management should be prioritized over those that may generate interesting information but would require additional research or interpretation to be directly relevant to management decisions. This also implies that priority should be given to evaluations applicable to future MPA management decisions that are most likely to be considered.

FEASIBILITY

Given the limited understanding and highly dynamic nature of North Central Coast marine ecosystems, some otherwise desirable evaluations may be beyond the reach of current science or methods. Priority should be accorded to evaluations that are considered feasible. This includes the feasibility of collecting the data or other information needed to support the evaluation, as well as the feasibility of generating conclusive results that are sufficiently robust or reliable to inform management. Speculative findings, or theoretical results that cannot be verified empirically, may be interesting and

generate fruitful avenues for research, but inappropriate as a basis for making management decisions unless or until they can be adequately confirmed.

Evaluations considered likely to generate conclusive information, and likely to generate findings that will be viewed with a high level of confidence despite a complex and dynamic environment, should be given higher priority than those for which such an outcome is less likely or uncertain.

TIME REQUIRED FOR ROBUST EVALUATION

Some design and management decisions can be evaluated relatively quickly. Others are likely to take much longer to generate results that are sufficiently robust that they can with confidence be used to inform management. As discussed in Chapter 3, potential MPA effects will occur in the context of a highly dynamic and variable environment that is affected by a variety of anthropogenic and natural influences, and a wide range of management measures. For example, MPA design decisions relating to larval connectivity among individual MPAs are likely to take many years to evaluate, reflecting the influence of oceanographic cycles and the naturally high variability in the larval production and recruitment patterns of many species. Some of these long-term evaluations are extremely important for facilitating adaptive MPA management, so evaluations requiring long time periods for robust evaluation should not be discounted. Indeed, as is discussed further under Implementation Options below, both short-term and long-term evaluations are important. But clear understanding of the time required to produce the desired information from different potential evaluations should be part of the analysis and prioritization of potential evaluations.

COST & VALUE OF INFORMATION TO BE PRODUCED

Potential evaluations are likely to vary widely in cost, and this will obviously be an important consideration in selecting and prioritizing candidates. Some types of evaluations, such as those involving assessments of wildlife disturbance, may be well-suited to collaborations with citizen-science or community-based monitoring partners, possibly leading to significant cost-sharing. Other evaluations may be expensive, but with costs shared among a variety of partners, such as through collaborations with multi-disciplinary research teams. The cost of a potential evaluation should be weighed against its value, which includes not only its performance against the criteria described above, but also the likely impact of the evaluation's results.

While it is obvious that low-cost, high-value evaluations should be given high priority, in practice many potential evaluations are likely to occupy some middle ground of cost and value. For such evaluations, other considerations may be useful to apply, such as the degree of public interest in specific potential evaluations.

IMPLEMENTATION OPTIONS

To further guide the implementation of this monitoring element, two modules have been developed based on the expected time needed to generate robust information that can confidently be used to inform management: short-term evaluations; and long-term evaluations. These two modules are both important to help meet MLPA monitoring requirements, and both can be scaled according to management priorities and available resources.

An inventory of potential evaluation questions will assist with identifying, assessing, and prioritizing potential evaluations, and managing those selected for implementation. The inventory should separately track short-term and long-term modules, to facilitate their management, and could be further classified and prioritized as desired (e.g., by subject area or by geographic scope). Ideally the inventory would be publicly accessible, and reviewed and updated regularly (e.g., annually or biennially). An initial inventory is included in this plan. These questions have arisen through the North Central Coast MPA

planning process or during stakeholder consultations conducted in the development of this monitoring plan (see Workshop 1 Report, Appendix C-3). During implementation of this monitoring element, the questions below may be augmented or replaced with others, depending on management priorities.

SHORT-TERM MPA DESIGN & MANAGEMENT EVALUATIONS

Short-term evaluations are those expected to generate conclusive information in four years or less, and are thus answerable within the five-year review cycle of the MPAs recommended by the MLPA Master Plan. These questions tend to be focused on very specific design or management decisions, and the responses of select ecological or socioeconomic components of Ecosystem Features to those decisions.

During the MPA planning process for the North Central Coast, stakeholders were asked to develop specific proposals for the regional MPA network, implementing guidelines relating to individual MPA and network design aspects, and considering the interests of different stakeholders. In preparing their proposals, stakeholders made many decisions about the siting, size, and boundary placement of individual MPAs, as well as the human activities allowed in each MPA, based on the guidelines and seeking to balance competing interests and priorities to the extent possible. Many potential short-term evaluation questions arose through this process. Some of these questions may be addressed comparatively inexpensively, and some may be feasibly approached through collaborations with community members.

IDENTIFIED SHORT-TERM EVALUATION QUESTIONS

Following are short-term evaluation monitoring questions repeatedly identified by stakeholders during the monitoring planning process to date. These questions form an initial inventory for further evaluation and prioritization prior to implementation.

- In recommending which human activities to allow in particular MPAs, stakeholders considered the potential impacts of salmon trolling on benthic communities, and drew a distinction based on water depth. The Science Advisory Team recommended allowing this activity in water depths of 50m or greater in select MPAs, in an effort to allow this activity in some sites but minimize or prevent bycatch of juvenile rockfish. What are the rates of rockfish bycatch with salmon trolling, and do rates vary with water depth?
- Under the MLPA, one goal of the regional MPA network is to "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".[21] Given this, are there impacts (e.g., trampling, moving flora and fauna) of increased visitation on rocky intertidal ecosystems in MPAs? Are there impacts (e.g., increased disturbance, improved data on reproductive rates) of increased visitation on hauled-out seals and nesting seabirds on estuaries and beaches?
- The stakeholders recommended specific "special closures" designed to limit human access in order to reduce disturbance of wildlife. Are there impacts (e.g., decreased disturbance rates) on hauled-out seals and nesting seabirds in special closures?
- Stakeholders proposed allowing fishing for crabs to occur in some MPAs. What are the effects of crab fishing on benthic habitats?
- In the Central Coast region, proposed State Marine Reserve ("no-take" MPA) boundaries were drawn to completely encompass patches of rocky reef habitat, prohibiting fishing throughout the entire reef, whereas in the North Central Coast the boundaries were in some cases drawn to prohibit fishing in a portion of a rocky

[21] California Marine Life Protection Act, Statutes 1999, Chapter 1015, Fish and Game Code section 2853(b)(3).

reef and allow fishing in the remaining portion. How frequent are boundary-crossings by rockfish species in these MPAs and do frequencies differ between these two MPA designs? What changes have occurred in the fisheries conducted on the portions of reefs left open to fishing?

- Given that the MPAs are closing some existing abalone beds to harvest, how has abalone harvest (e.g., distribution and intensity) changed following MPA implementation?

LONG-TERM MPA DESIGN & MANAGEMENT EVALUATIONS

Long-term evaluations are those expected to take more than four years to answer, and thus will span one or more of the recommended five-year review cycles of the MPAs. These questions tend to be focused on design or management decisions in which the effects of the decision on an Ecosystem Feature or feature components are likely to be difficult to detect or interpret due to the dynamic environment of the North Central Coast region. These questions may require considerable cost-sharing to be feasibly addressed, and are well-suited to long-term partnerships with research institutions. Given the long time-frame required to generate useful findings from these evaluations, and the importance of such information for possible future management decisions, work should begin on the top priority long-term evaluations as soon as possible.

Long-term evaluations encompass many different aspects of MPA network design and functioning. To support the North Central Coast MPA planning process, the North Central Coast Science Advisory Team (NCCSAT) applied and refined prior recommendations of the MLPA Science Advisory Team (MLPASAT). The resulting science guidelines included recommended minimum MPA size, maximum distance between adjacent MPAs, specific habitat types to be represented within replicated MPAs, and levels of protection (reflecting the types of activities allowed in the MPAs). These guidelines were used to evaluate and refine MPA proposals and strongly influenced the design of the network adopted by the Fish and Game Commission. Thus evaluation of the design decisions will be particularly valuable in informing future management decisions.

Future management decisions may involve adjustments to any of these design aspects of individual MPAs and the regional MPA network. Monitoring should thus seek to test the design guidance and provide useful input to future decisions to maintain or adjust network design. However, given the temporal and spatial dynamics in nearshore marine environments, many of these questions present conceptual and practical challenges. For example, investigation of larval dispersal patterns to inform MPA connectivity questions must accommodate considerable uncertainty in results, which are likely to vary dramatically between years. In this case, considerable research effort will be required to generate information that is sufficiently robust to be used to inform potential changes to the MPA network. This complexity also applies to many other potential evaluations of MPA network function.

To identify approaches that can inform management decisions and guide the development of research partnerships, 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 MLPASAT[22], the science guidance developed during the North Central Coast MPA planning process, and consultations with stakeholders during the development of this monitoring plan (see Workshop Report 1, Appendix C-3). All of the categories below may include evaluations focusing on ecological and/or socioeconomic responses. Differences in MPA placement for example, are likely to be reflected in different effects on species as well as different effects on human use patterns in the region. The categories are each presented separately, but evaluations may also combine categories (e.g., MPA size and spacing). The questions listed in each category should be considered as starting points for discussion only, as considerable focusing and refinement would be essential to design effective evaluations to answer them. Where possible, selected evaluations should encompass

[22] California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008, pp. 34-41.

Ecosystem Feature attributes, indicators, or vital signs, to benefit from the information being gathered on those metrics, and potentially inform the use of those metrics in long-term ecosystem tracking.

SIZE & SHAPE

The science guidance in the MLPA Master Plan for MPAs states that available scientific information on movement patterns of various species suggests that MPAs should span a minimum of 3-6 miles in extent along coastlines, and that "larger MPAs, spanning 6-12.5 miles of coastline, are probably a better choice given current data on adult fish movement patterns".[23] In applying this guidance to the North Central Coast region, the NCCSAT recommended that each individual MPA cover an alongshore span of at least 3-6 miles, with a total minimum size of 9 square miles.[24]

Science guidance was also developed for the shape of MPAs. Because several species move between shallow and deeper habitat, the science guidance in the MLPA Master Plan notes that MPAs that extend offshore (from the coastline to the three-nautical-mile offshore boundary of state waters) will accommodate such movement and protect individuals over their lifetimes. The NCCSAT adopted this recommendation.

Evaluations of the size and shape guidelines, as implemented, will be particularly useful if they reveal thresholds or discontinuities in the responses of Ecosystem Features, or feature components. Because the MPAs were designed to follow the science guidelines, based on the best readily available science, the individual MPAs do not vary dramatically in size. Evaluations of the effects of size are thus likely to rely on a combination of modeling and empirical assessment, and may be facilitated by including MPAs from several MLPA regions.

Potential evaluation questions:

- Are there differences in ecosystem responses (e.g., types and rates of changes observed) among MPAs of different sizes?
- What is the relationship between MPA size and protection afforded to organisms with different home range sizes and movement patterns?
- Is "spillover" of fishery species affected by MPA size and what are the implications for designing MPAs to achieve ecosystem protection and potential benefits to fisheries?
- If fishing occurs along the boundaries of MPAs, what are the effects on species and communities inside MPAs of different sizes?

SPACING

The science guidance on MPA spacing, meaning the recommended distance between adjacent MPAs, is based on analysis of scientific information about the larval dispersal distances of various marine organisms. The MLPASAT recommended spacing MPAs approximately 31-62 miles apart to be within the larval dispersal ranges of most commercial or recreational groundfish or invertebrate species. The NCCSAT adopted this guideline and considered the distance between MPAs that contain each of the key habitats, assessing spacing separately for each key habitat.[25]

[23] Ibid. p. 37.
[24] The total size criterion could also be met through clustering adjacent MPAs together, as long as each MPA is at least of moderate-high protection and intended by stakeholders to contribute toward population and network goals (North Central Coast regional goals 2 and 6).
[25] Methods Used to Evaluate MPA Proposals in the North Central Coast Study Region. May 30, 2008, revised draft. California Marine Life Protection Act Initiative. p. vii Protection levels were also considered in the NCCSAT's analysis, see ref.

Given that larval connectivity can be strongly influenced by large-scale oceanographic processes and cycles, evaluations of larval connectivity among MPAs may be best approached over larger spatial scales than the North Central Coast region, and even at a statewide scale. Larval connectivity assessments are likely to rely in part on modeling. Empirical testing or 'ground-truthing' of modeling results will be important prior to using such information as a basis for making future management decisions. Although the MPA spacing guidelines focus on larval dispersal distances, the distances between MPAs can also interact with the movements of adult organisms, for example during along-shore migrations.

Potential evaluation questions:

- Do the different distances between MPAs affect patterns of larval supply and recruitment in MPAs?
- Are there thresholds for MPA spacing, distances greater or less than which larval recruitment patterns differ significantly?
- How are the MPAs used by species such as marine mammals and some fishes that make along-shore migrations, and what are the implications for the effects of different inter-MPA distances in coastal MPAs?

HABITAT REPRESENTATION

In addition to recommendations concerning MPA size and spacing, the science guidelines also recommended habitat representation and replication. Under the MLPA Master Plan, all key habitat types must be protected in MPAs, with each key habitat protected in 3-5 MPAs (replicates) per biogeographic region. In the North Central Coast region, the NCCSAT confirmed key habitat types (see Chapter 3), and recommended that each habitat type be protected with 3-5 replicate MPAs with at least one in each of the three identified bioregions (North, South, and Farallones) where feasible.

Habitat representation is widely used in MPA planning as a proxy for representing different biological communities, based on the knowledge that different species and biological communities are associated with different habitats and that many species are dependent on different habitat types at different stages of their life cycles. Evaluations of design decisions relating to habitat representation can thus range from assessment of the extent to which MPAs do include the identified habitat types (e.g., through detailed mapping) to evaluation of habitat/species relationships to assess the extent to which the identified habitat types are associated with different species, life stages, or biological communities. In the context of the North Central Coast region, the three bioregions can also be evaluated to determine the extent to which habitat representation in the different regions corresponds to protection of different species and communities for each habitat type.

Potential evaluation questions:

- Are the identified key habitats represented and replicated in the implemented array of MPAs?
- Are there unique habitats which contribute significantly to the biodiversity of the region and which are not represented in the MPAs or identified key habitats?
- Do MPAs enclosing multiple habitat types harbor higher species abundances or more diverse communities through the effects of increased habitat structural complexity?
- How are the MPAs used by species which inhabit shallow nearshore habitats when young and move to deeper habitats as adults, and what are the implications for the design of clustered nearshore and offshore MPAs?

PLACEMENT & SITING

The design of the North Central Coast regional MPA network involved many decisions about where to place the individual MPAs. For example, stakeholders considered whether siting MPAs close to existing terrestrial parks would better promote educational opportunities.

Potential evaluation questions:

- What are the population effects of siting MPAs in larval source or sink locations, and what are the implications for MPA network design?
- What are the socioeconomic effects of MPA placement, specifically distance from ports and location relative to fishing grounds, and what are the implications for siting MPAs to minimize socioeconomic impacts and to prevent serial depletion?
- What are the effects on visitation and associated recreational opportunity of siting MPAs adjacent to public versus private land?
- Does locating an MPA close to a boat ramp or other access point affect the level of enforcement and/or compliance with MPA regulations?

LEVELS OF PROTECTION

The North Central Coast regional MPA network includes MPAs of different types and allowed activities, ranging from State Marine Reserves (SMRs), which prohibit all take of living marine resources, to State Marine Conservation Areas (SMCAs) and State Marine Parks (SMPs), which allow different fisheries, depending on the site. To guide the MPA planning process, the NCCSAT defined 'Levels of Protection', reflecting scientific judgments of the relative effects of allowing specific fishing activities within MPAs. Each MPA was assigned to one of six protection levels, depending on the activities to be allowed within that site. Thus, a no-take SMR was categorized as "Very High" protection, and MPAs allowing trawling, mechanical harvest of giant kelp, bull kelp and mussel extraction, and mariculture were categorized as "Low" protection (see Appendix C-8). During the planning process, stakeholders arranged MPAs of different levels of protection to meet MLPA requirements and design guidelines, while, to the extent possible, balancing competing or conflicting interests.

For the MPAs that allow fishing, different fishing activities are therefore allowed in different sites, even within the same level of protection. However, the 11 SMRs adopted for the North Central Coast region provide the simplest and most straightforward entry point for initial evaluations of levels of protection. This may include assessment of the comparative effects of SMRs of different configurations, and broad comparisons of SMRs with SMCAs. Over time, and perhaps through evaluation of MPAs in several regions, fine-scale evaluations of the effects of allowing specific fisheries, or of the comparative effects of SMCAs of adjacent levels of protection, will become more feasible.

Potential evaluation questions:

- What are the ecosystem responses (types of changes and rates of change) within SMRs and how do these differ from such responses within SMCAs?
- Do SMR/SMCA clusters provide greater protection than stand-alone SMRs, for example through a "buffer" effect?
- Do large SMRs provide higher or equivalent protection to ecosystems than areas of equivalent size that are comprised of an SMR and contiguous SMCA (referred to as an SMR/SMCA cluster)?
- What are the effects, if any, on ecosystem functioning of the removal of biomass from SMCAs which occurs during extractive uses, for example, while trolling for salmon within an MPA?

6. Reporting Monitoring Results

- Designing effective monitoring reporting
- Example monitoring report pages
- Communicating monitoring findings
- Managing monitoring information

Under the MLPA, one of the purposes of monitoring is to facilitate adaptive MPA management. As noted in the MLPA Master Plan and discussed in Chapter 2, to meet this requirement, "the results of monitoring and evaluation must be communicated to decision makers and the public in terms that they can understand and act upon".[26] To be useful, communication of monitoring results must also be timely. In the context of MLPA, this means that monitoring results should be available to inform the five-year reviews of the MPAs recommended in the Master Plan. The monitoring framework and approaches have been designed to facilitate reporting of useful, understandable results in advance of the anticipated five-year reviews of the North Central Coast regional MPA network. This chapter discusses features of and approaches to reporting monitoring results designed to effectively support MPA management, including five-year reviews.

DESIGNING EFFECTIVE MONITORING REPORTING

ESSENTIAL FEATURES OF MONITORING REPORTING

To be useful to non-scientists, monitoring reports must include highly synthesized and interpretable results, presented as key conclusions or findings that clearly meet MLPA requirements, including assessing the regional MPA network's effectiveness in meeting MLPA goals and facilitating adaptive MPA management. For example, given that one goal of the regional MPA network under MLPA is to help protect ecosystems, findings should include assessment of the condition of ecosystems and how condition is changing over time, inside and outside MPAs. Findings should also include assessment of progress towards individual (site-level) MPA objectives, for monitored MPAs. These findings must be presented using intuitive reporting tools, in a way that is appropriate given the underlying data, and be understandable and meaningful for evaluating MPA effectiveness and facilitating adaptive MPA management. Findings must also be transparent, meaning that it is clear how they were generated, and available for independent review, along with the data used to generate the findings.

[26] California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008, p. 75.

USE OF INTUITIVE REPORTING TOOLS FOR KEY FINDINGS

For some types of monitoring, especially where precisely defined characteristics can be measured accurately, findings can be reported quantitatively, for example as numeric scores. For example, monitoring the average height or weight of a human population, or the mean size or number of fish caught, appropriately allows reporting of a number (the mean or average), usually accompanied by a statistical estimation of the number's accuracy (e.g., standard error or 95% confidence interval). However, neither the MLPA goals nor the North Central Coast ecosystems are that straightforward. While monitoring metrics are designed to generate quantitative data (e.g., areal extent of kelp, numbers of blue rockfish), the scientific understanding of ecosystems is too limited to justify quantitative scoring of ecosystem condition. Thus it is most appropriate for some summary results to be reported qualitatively.

Implementation of the monitoring framework will generate a mixture of quantitative and qualitative results. Reporting tools need to be suitable for both kinds of results, and to present the results in a way that facilitates understanding. One reporting tool that meets these requirements is shown below.[27]

In this color bar, the relative position of the dot indicates the status or condition of the item being reported and the arrow indicates the change in condition over the reporting period or since the previous report. If no change is observed, then the arrow can be omitted. In this illustration, the ends of the color bar are red, indicating a less desirable condition, and green, indicating a more desirable condition. The monitoring metrics for tracking the condition of Ecosystem Features have been chosen to be interpretable in this way, allowing assessment of whether vital signs, indicators, attributes, and Ecosystem Features are improving or declining. Making such judgments will incorporate quantitative data generated through monitoring, as well as qualitative findings and expert assessments. Assumptions and criteria for making judgments, as well as underlying qualitative and quantitative data, should be published along with the findings, for transparency and in order to allow independent evaluation (see discussions of expert judgment and transparency below).

The color bar reporting tool could also be further refined to illustrate changes due to MPA implementation or other factors. The color bar could also be modified, or a different reporting tool used, for changes in condition that are neutral, neither improvements nor declines. Possible applications of this reporting tool to the different types of findings that will be generated through monitoring of the North Central Coast regional MPA network are shown later in this chapter.

USE OF EXPERT JUDGMENT

While quantitative analyses are an essential component of monitoring results reporting, the use of expert judgment is necessary to generate the highly interpreted and synthesized findings that link monitoring results to assessment of MPA effectiveness and informing MPA management decisions. These include, for example, judgments of the condition and trends of ecosystems.

Increasing research effort is being directed towards improved frameworks for high-level ecosystem assessment. Analysis and interpretation of MPA monitoring results should take advantage of the best knowledge available when monitoring analyses occur. Approaches that engender and combine expert opinion have already been successfully employed in other

[27] This tool is adapted from one employed by the Puget Sound Action Team in the State of the Sound reports. See www.psp.wa.gov/downloads/SOS07/2007_stateofthesound_fulldoc.pdf.

programs (including, for example, in the production of the National Marine Sanctuary Condition Reports[28]). Typically these involve convening a technical panel selected to encompass appropriate areas of expertise and charged with developing recommended syntheses and interpretations of detailed monitoring results and analyses.

The theoretical underpinning for many of these approaches is a social science technique called Delphic analysis. Delphic analysis is a method for the systematic solicitation and aggregation of informed opinions from a group of experts on specific questions or issues, and which is designed to reach a collective judgment or assessment. Typically, questions are asked individually of experts and then responses are discussed and modified in an iterative fashion towards a consensus opinion. This method offers an approach that can garner input from the breadth of scientific disciplines needed to provide a scientifically robust interpretation of MPA monitoring results and produce synthesized key messages useful for managers and decision-makers. Standard approaches are also available to record deliberations and decisions by panel members so that these can be presented with the synthesized results.

Vital to the success and credibility of Delphic analyses, and the use of expert assessment in general, is appropriate selection and use of experts. In California and elsewhere, many models exist for selecting expert panels. These differ in some details, but share many common features, including:

- Public call for nominations to the panel, clearly identifying the purpose and scope of the panel's role and the qualifications for nominees
- Clear and transparent criteria for selecting panelists
- Public announcement of selected panelists and, as appropriate, alternates
- Publicly available reports or findings, with underlying data, assumptions, and criteria used to generate findings

In preparation for conducting the high-level syntheses and interpretations of MPA monitoring data, it will be critically important to identify the needed areas of technical expertise and diversity of perspectives essential to generating unbiased, credible, and scientifically valid results.

TIMELY RELEASE OF MONITORING FINDINGS

For monitoring findings to be useful, and used in MPA management processes and decisions, they must be released in a timely fashion. The MLPA Master Plan recommends reviews of MPAs at five-year intervals following their establishment. Monitoring findings and reports should be released close enough to the timing of the reviews to be as current as possible, but sufficiently in advance of the reviews to allow consideration of the findings and their potential implications, and, for those who desire to conduct them, independent evaluations.

TRANSPARENCY OF ANALYSIS & REPORTING

Analytical methods, underlying assumptions, and criteria used in developing monitoring findings should be recorded during the analytic process and made available. This will not only facilitate understanding of the way in which findings were developed, but also allow independent evaluation of analytic approaches and attempted replication of results or use of alternative approaches, as desired.

[28] 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. Further information is available at http://sanctuaries.noaa.gov/science/condition.

AVAILABILITY OF DATA

Monitoring data used to generate monitoring results and findings should be made available, consistent with a transparent approach to monitoring reporting and analysis. This is also essential to allow independent evaluation of findings and independent analyses, as desired. Moreover, it will facilitate research to improve understanding of marine systems and MPA monitoring methods and approaches.

EXAMPLE MONITORING REPORT PAGES

Monitoring reports should be designed to most effectively communicate the full range of monitoring results and conclusions, consistent with the features and characteristics described above. To illustrate the types of reports that are envisioned, example or "mock-up" pages of a possible approach to a future monitoring report have been developed.

The mock-up pages have been developed to illustrate how a subset of monitoring results and findings may be presented in a way that is consistent with the design aspects above, and also meaningful for evaluating MPA effectiveness and facilitating adaptive MPA management. The mock-up pages depict an approach to reporting on ecosystem condition and trends, overall and for the specific example of the Kelp and Shallow Rock Ecosystem Feature.

As described in Chapter 4, ecosystem condition and trends are assessed through monitoring of the nine Ecosystem Features, which are in turn evaluated though Ecosystem Feature Checkups and/or Ecosystem Feature Assessments. For example, for the ecological Ecosystem Features, including Kelp and Shallow Rock, the Ecosystem Feature Assessment approach employs selected focal species and indicators to assess key ecosystem attributes, which in turn are used to assess the feature.

Reporting on the condition and trends of these ecological Ecosystem Features, including reporting attribute and indicator results, may employ intuitive reporting tools such as the color bar example shown above. This is illustrated in the mocked-up report pages in Figure 6-1. In these example pages, the color bar is used to convey an overall assessment of each Ecosystem Feature and is also used to present more detailed results for the Kelp and Shallow Rock Ecosystem Feature.

These example report pages, illustrating one approach to intuitive reporting of Ecosystem Feature Assessment results, should be accompanied by more detailed and transparent reporting of analyses and links to raw data, where appropriate (see Figure 6-2). A similar approach may be used to report findings based on vital signs, and to report findings for the human uses Ecosystem Features.

Assessing the condition and trends of the Ecosystem Features also enables assessment of the individual MPAs that are monitored, and these results may be combined to allow assessment of the regional MPA network. The same or an equivalent reporting tool can also be used to convey understandable, synthesized results from monitored MPAs. For illustrative purposes, Figure 6-3 shows example report pages that employ the same color bar reporting tool to present summary results and key findings from monitored MPAs.

Monitoring reports should also encompass reporting of MPA design and management evaluations, results from research and development programs, and integrated analyses incorporating information on broader ecosystem influences and drivers (such as water quality and oceanographic information). The approach described here, which integrates the essential features of monitoring reports described above, is adaptable to include these additional report elements.

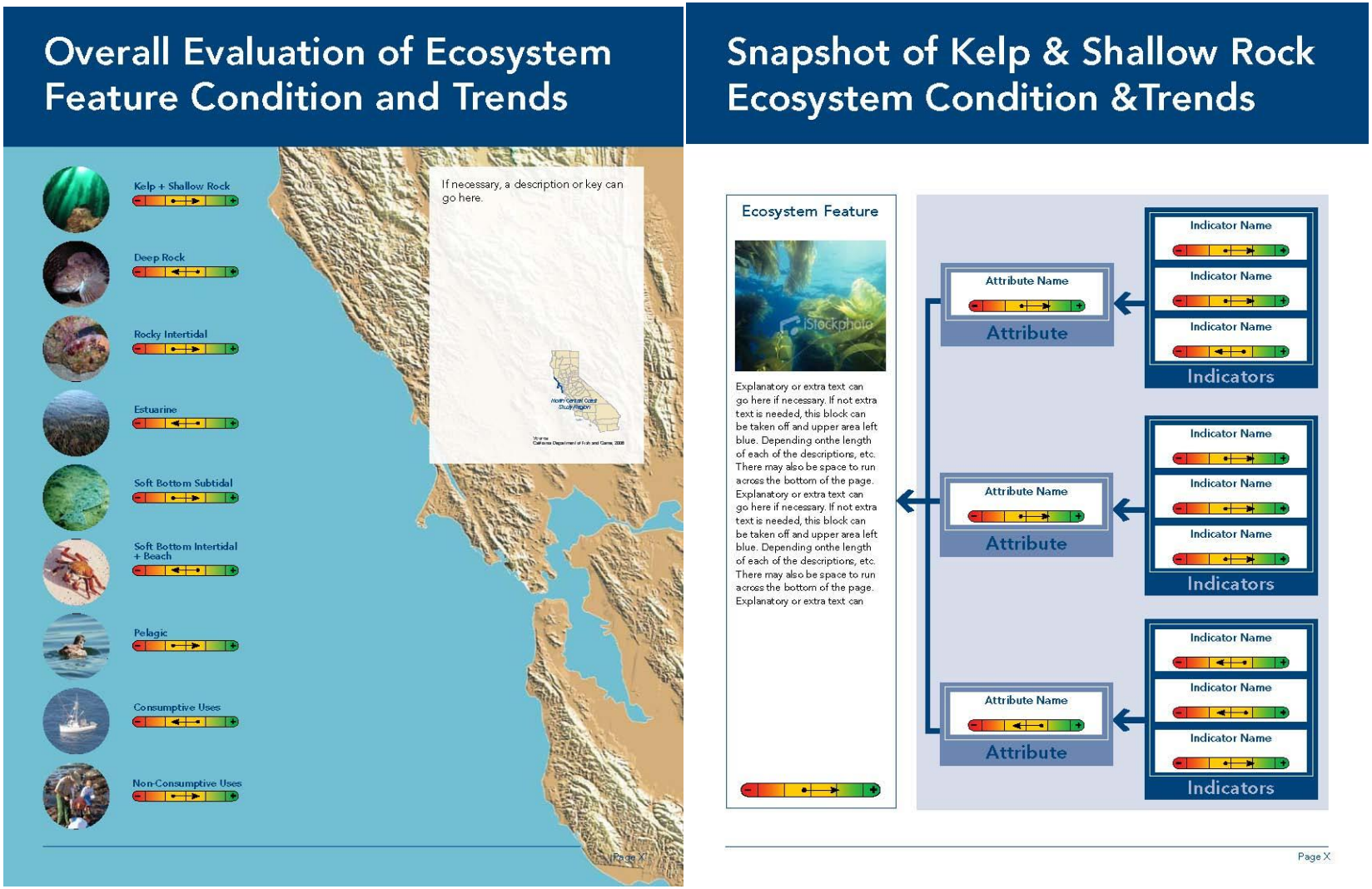


Figure 6-1. *Mocked-up pages from a possible approach to monitoring reports, illustrating the use of a color-bar reporting tool to communicate monitoring results. These example pages illustrate possible formats to depict the overall assessment of the Ecosystem Features and how the assessment may be developed for the Kelp & Shallow Rock Ecosystem Feature. These summary pages would be accompanied by in-depth technical reporting of data, analyses, and interpretations.*

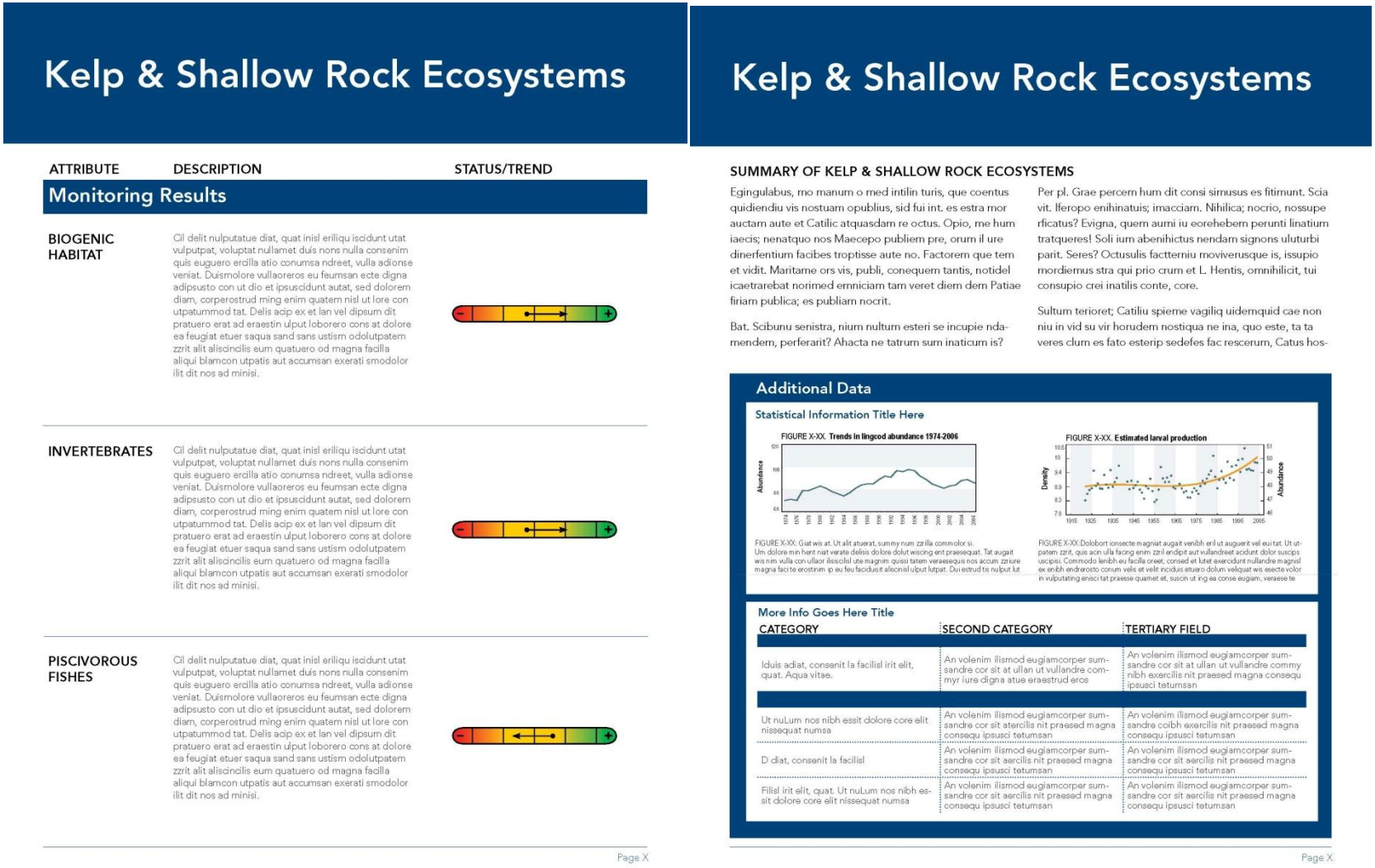


Figure 6-2. *Mocked-up pages from future monitoring reports illustrating pages that may be included to convey more detailed analyses and interpretation. In these example report pages, attribute results are accompanied by an explanation and rationale, as well as a possible approach to more detailed reporting of results and analyses. Technical reporting of data and analyses should also accompany these report sections.*

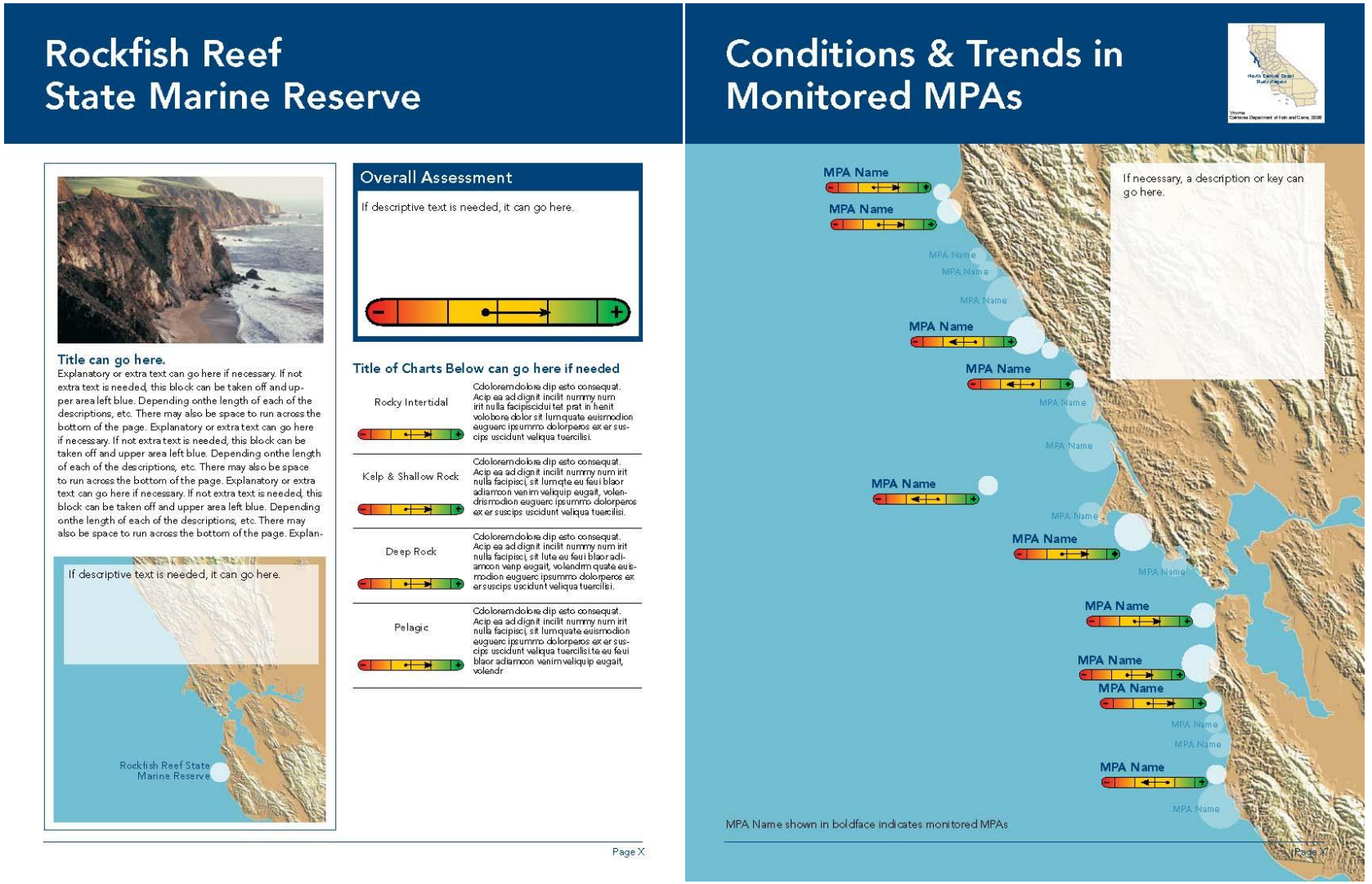


Figure 6-3. *Mocked-up pages from future monitoring reports. These example report pages illustrate potential formats employing the color bar reporting tool as a possible approach to reporting on the condition and changes within individual monitored MPAs, allowing comparison across the regional MPA network. These summary pages would be accompanied by in-depth technical reporting of data, analyses, and interpretations.*

COMMUNICATING MONITORING FINDINGS

Results and findings from monitoring the North Central Coast regional MPA network should be made available electronically to facilitate broad distribution and minimize costs, although it will also be important to have limited numbers of paper reports. As discussed above, reports should be made available in advance of the five-year reviews recommended in the MLPA Master Plan. The North Central Coast MPAs were adopted by the Fish and Game Commission in August, 2009, and took effect on May 1, 2010. A five-year review would thus be expected to occur in mid- to late 2015. The first North Central Coast MPA monitoring report should thus be made available in late 2014 or early 2015, depending on the expected date of the review. A public meeting, such as was held in February 2008 to present the findings of the first five years of monitoring the Channel Islands MPAs[29], might be helpful to facilitate dissemination and discussion of monitoring results.

MANAGING MONITORING INFORMATION

Maintaining and making available MPA monitoring information, including data, reports, and other associated information will require the use of an MPA Monitoring Information Management System (IMS). The IMS should accommodate different types of users, including technically advanced users seeking to download data in order to conduct their own analyses, as well as users interested only in highly synthesized information products. The MPA Monitoring Enterprise is currently completing a user needs analysis to characterize different likely user profiles. The analysis will be used to determine how best to meet user needs, consistent with meeting MLPA requirements and priorities.

[29] For more information on the Channel Islands meeting, a Special Session held at the 2008 California Islands Symposium, see http://www.dfg.ca.gov/marine/channel_islands/specialsession.asp

7. Developing Monitoring Partnerships

- Building a partnerships approach
- Partnerships for conducting monitoring
- Partnerships for interpreting monitoring results
- Partnerships for sharing monitoring information

This monitoring plan has been designed to facilitate development of partnerships to conduct and support monitoring of the North Central Coast regional MPA network. Potential partners are many, and include state and federal agencies, 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. To be effective, however, partnerships must be carefully developed and managed. Coordination and oversight are required to ensure that partnerships are tuned to best contribute to implementing this monitoring plan. In this chapter, considerations for developing a partnerships approach are provided. Particular attention is given to establishing partnerships to collect monitoring data, as these may be expected to be the initial top priorities for implementation.

BUILDING A PARTNERSHIPS APPROACH

In the context of monitoring the North Central Coast regional MPA network, there are many potential partnerships that may assist with various aspects of monitoring, including data collection, interpretation of results, and dissemination of information. The monitoring framework has been designed to facilitate such partnerships. For example, two implementation options are provided for long-term tracking of ecosystem condition (Chapter 4). Ecosystem Feature Checkups are designed for community participation in MPA monitoring. Ecosystem Feature Assessments are designed to facilitate partnerships among government agencies and with research institutions. In addition, the structure for evaluation of specific MPA design and management decisions (Chapter 5) is tailored to facilitate implementation through research partnerships.

Establishing these partnerships will be important to maximize the capacity and efficiency of North Central Coast MPA monitoring, but will take time and attention to ensure partnerships 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.

PARTNERSHIP AGREEMENTS

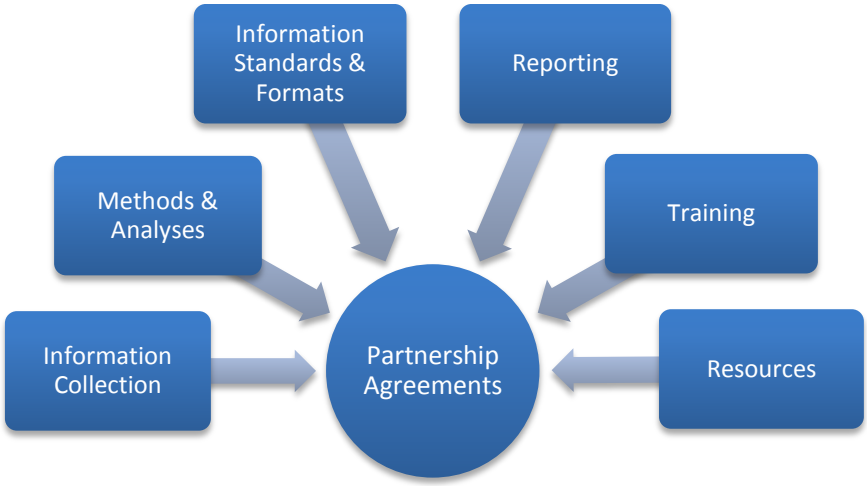
For a partnership to be successful, partners should understand and agree to each partner's roles and responsibilities, including what each partner is providing to, and expecting from, the partnership. Partnership agreements may be formal or informal and range from brief Memoranda of Understanding to detailed contracts. In each case they are an important tool for clarifying and recording vital operational aspects of partnerships. Because each partnership is unique, each agreement should be tailored to the specific requirements of the partnership. For instance, partnerships to assist with conducting monitoring of the North Central Coast MPAs will involve collection or sharing of data; consequently, it is critically important that these partnership agreements cover such topics as data ownership and use. Partnership agreements should also include terms and conditions under which a partnership may be ended. Regular review of agreements is important to reflect any changes in roles, resources, or other aspects of partnerships. Management of partnership agreements should include reconsidering and adjusting partnership terms and details as needed.

PARTNERSHIPS FOR CONDUCTING MONITORING

There are many potential partners to assist with collecting MPA monitoring data in the North Central Coast region. However, not all monitoring data are equally useful in meeting MLPA requirements. Priority for developing partnerships to conduct MPA monitoring in the North Central Coast region should be placed on those which fit best with the approaches identified in this monitoring plan.

Existing MPA monitoring programs in the North Central Coast region, such as those conducted by the National Marine Sanctuaries Program and the National Park Service, are obvious candidates for monitoring partnerships. The mandates and monitoring requirements of each program are slightly different, and differ from those imposed by 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 wildlife monitoring programs, community-based and citizen-science programs, that may also be valuable monitoring partners, depending on their priorities and approaches.

In addition to the considerations discussed above, partnership agreements covering the collection of MPA monitoring data should also 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. These items are discussed further below to provide a brief overview of key considerations.



INFORMATION COLLECTION

Partnership agreements should clearly detail the specific information to be collected and provided by the monitoring partner in support of North Central Coast MPA monitoring, including the specific vital signs, attributes and indicators/focal species, or other information to be provided. Information should conform to that identified in this monitoring plan, unless otherwise agreed.

MONITORING METHODS & ANALYSES

The specific methods to be used by the monitoring partner to collect the agreed information are of critical importance in analyzing and interpreting the information. It is important, therefore, that data collection methods, and, where appropriate, analytical approaches, are detailed and agreed by partners.

INFORMATION STANDARDS & FORMATS

All monitoring information collected by partners should be provided in agreed form and format, with appropriate curatorship of raw data by the designated partner. The specific standards and formats for data and metadata and other types of monitoring information to be collected by partners will depend on what is being collected, and should be described in the partnership agreement. Data quality control/quality assurance (QA/QC) standards and procedures also should be agreed upon.

REPORTING

A schedule for reporting of monitoring data or results from partnerships is essential to ensure that information is provided at useful time points for integration with other information sources and to inform reviews of the regional MPA network. Agreements should also specify reporting requirements, including the presentation of synthesized results and key messages together with more detailed analyses and raw data.

TRAINING

Regular training and testing of those collecting monitoring data are essential to ensure data quality and comparability. No two people collect data in exactly the same way; even highly trained observers will vary in their estimates of, for example, the length of a fish seen while conducting an underwater survey. Thus, regular training is necessary to minimize differences in how data are collected, and regular evaluation (testing) of data collectors is essential to measure inter-observer error and allow development of any necessary correction factors. Partnership agreements should include details of observer training and evaluation.

RESOURCES

As noted above, partnership agreements should include information about the resources to be provided by each partner. This includes funding, but also equipment, personnel, and infrastructure (e.g., office space, classrooms). It also includes information (e.g., data), materials (e.g., training materials), and services (e.g., training, testing, data entry, data curatorship, analysis).

PARTNERSHIPS FOR INTERPRETING MONITORING RESULTS

Interpretation of MPA monitoring data will involve consideration of information from many other sources and programs. This will include, for example, information about oceanographic conditions and trends, water quality, economic trends and indices, and other contextual information that will be important to understand the larger ecological and economic environment within which the MPAs are operating.

In addition, information from other (non-MPA) monitoring programs will be useful. The monitoring approaches described in this plan necessarily focus on obtaining the most useful and important information to meet MLPA requirements. The monitoring indicators and other metrics have been chosen to emphasize MPAs while providing some insight into or overlap with other important issues that bear on assessment of potential MPA effects. For example, the inclusion of select fished species as focal species for ecosystem checkups and assessments, and the monitoring of Consumptive Uses, will provide information consistent with fisheries monitoring, specifically in the context of potential MPA effects. Other focal species have been chosen in part for their sensitivity as “sentinels” for water quality or climate change effects. For example, Cassin’s auklets have been selected as indicators of food web changes in nearshore pelagic ecosystems but also serve as

indicators of climate change (for further information see the Guide to the Vital Signs of Ecosystem Feature Checkups, Appendix B-1). However, monitoring focused in support of other programs, such as fisheries management, water quality, invasive species, climate change impacts, and threatened species conservation, will generate much more detailed and comprehensive coverage of these issues and thus can provide valuable supplemental information for interpreting MPA monitoring results (see Figure 7-1).

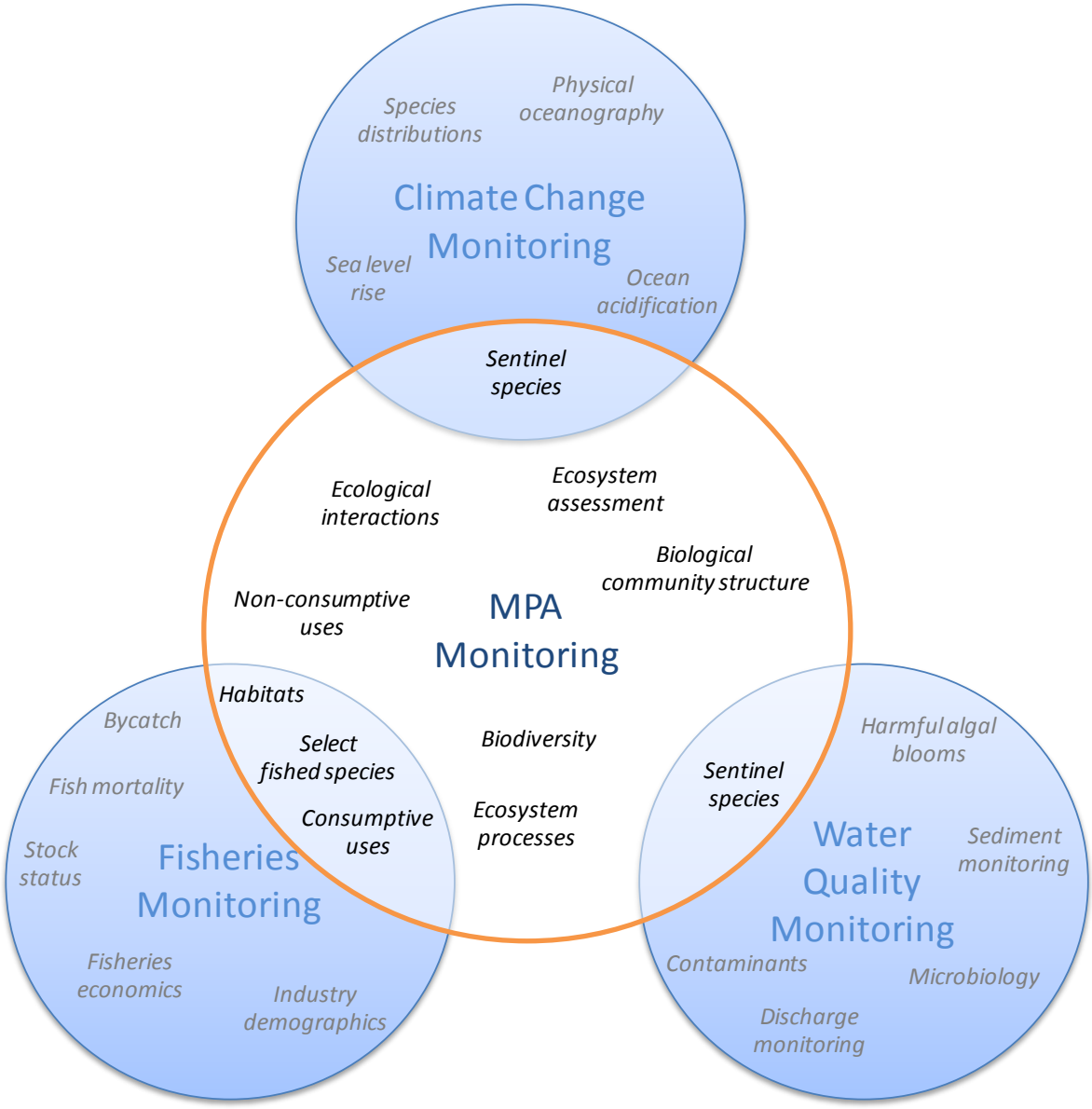


Figure 7-1. *MPA monitoring prioritizes collection of information that is most important and useful for meeting MLPA requirements. This necessarily involves some overlap with information typically collected by other (non-MPA) monitoring programs, such those focused on monitoring fisheries management, water quality, or climate change. However, the more detailed and comprehensive coverage of those issues provided through those programs can provide valuable supplemental information for interpreting MPA monitoring results. Partnerships and linkages with relevant programs will be developed to gather this supplemental information. (Note: Monitoring elements shown are for illustration purposes only and are not meant to fully represent or describe any of the programs indicated.)*

Obvious candidates for partnerships to gather this contextual and supplemental information to support interpretation of MPA monitoring results for the North Central Coast region include the Central and Northern California Ocean Observing System (CeNCOOS), the State Water Resources Control Board and the North Coast and San Francisco Bay Regional Water Quality Control Boards, and the National Marine Fisheries Service (NMFS). There are also a variety of other programs and entities involved in aspects of fisheries or water quality monitoring, as well as research institutions engaged in socioeconomic assessments and oceanographic monitoring and research, to cite but a few examples.

PARTNERSHIPS FOR SHARING MONITORING INFORMATION

One of the purposes of monitoring, under the MLPA, is to facilitate adaptive MPA management. Thus, those involved in future MPA decisions, including decision-makers (particularly the Fish and Game Commission) and stakeholders in MPA decision processes, are among the primary intended recipients of monitoring information and results. Approaches for meeting this purpose are discussed further in Chapter 6.

Monitoring of the North Central Coast regional MPA network will provide information not only about the MPAs, but also about the condition and trends of the region's marine and coastal ecosystems, including consumptive and non-consumptive human activities. Thus the monitoring results and data are likely to be of use to those generally interested in marine ecosystems, both in the North Central Coast region and elsewhere.

A variety of potential partners is available to assist with the sharing and dissemination of monitoring results and information. These range from public libraries to media outlets to formal and informal education programs and institutions at all levels. Technology partners may also emerge to facilitate use of the rapidly evolving ways that people gather and track information in which they are interested. These partnerships will be developed as opportunities and resources allow, consistent with meeting MLPA requirements and priorities.

8. Estimating Costs of MPA Monitoring Components

- Bases for costing individual monitoring components
- Developing assumptions to enable cost estimation
- Estimating costs to assess Ecosystem Feature condition

To facilitate preparations for monitoring implementation, it is useful to estimate the potential financial costs of monitoring the North Central Coast regional MPA network. Estimating costs is, however, complicated by the deliberately flexible nature of this monitoring plan. Flexibility is essential to ensure that monitoring can be tailored to reflect management priorities and available resources at the time of monitoring implementation, but means that monitoring costs are similarly flexible, depending on which monitoring components are implemented and at what scale.

In this chapter, estimates are provided of the annual financial costs of implementing many of the monitoring components. These estimates include costs to collect, analyze, and report monitoring results for potential individual monitoring components, based on costs of existing activities and programs. Collectively the cost ranges provide a set of options, or menu, for implementing monitoring components. Considerations for selecting monitoring components to form a coherent and effective monitoring program for the North Central Coast MPAs are described in Chapter 9.

BASES FOR COSTING INDIVIDUAL MONITORING COMPONENTS

There are several possible bases for developing cost estimates for individual monitoring components. One approach would be to issue a preparatory Call for Pre-Proposals, leaving it to respondents to develop indicative budgets for work they propose to conduct. The submitted budgets could then be used to estimate costs. It may also be possible to estimate some costs using the projects implemented as part of the North Central Coast MPA Baseline Program (Appendix C-2). However, given that this plan should guide the design of Baseline Program projects, and will thus influence their costs, perhaps the most sensible approach is to learn as much as possible from existing monitoring programs.

As described in Appendix L of the MLPA Master Plan, the total costs for implementing the MLPA were estimated in 2006, based on an analysis of the costs of similar programs.[30] These cost estimates included all aspects of MPA implementation, including monitoring. The estimated costs for monitoring the statewide MPA network, once complete, ranged from a minimum of $206,000 to a maximum of $7,495,000 annually.[31] Estimated monitoring costs included monitoring of both biotic and socioeconomic conditions, using methods such as “benthic or trawl surveys, water sampling, socioeconomic surveys and contracted services if needed”.[32] However, no further details of cost breakdown were provided, thus it is difficult to use these figures to estimate costs for the monitoring components described in this monitoring plan.

Since that 2006 analysis, considerably more experience with MPA monitoring has been gathered in California, not only through completion of the first five years of monitoring the Channel Islands MPAs, but also through two years of baseline monitoring of the Central Coast region MPAs. Many of the MPA monitoring activities conducted in the Channel Islands and Central Coast MPAs are similar to some that are included in this monitoring plan. Other MPA and non-MPA programs in California also conduct relevant activities. Those programs thus provide useful starting points for estimating some monitoring costs.

[30] Estimated Long-Term Costs to Implement the California MLPA. April 20, 2006 Draft. California Marine Life Protection Act Master Plan for Marine Protected Areas, Revised Draft, Jan. 2008. Appendix L. pp. L-1 – L-17.
[31] Ibid. p. L-11.
[32] Ibid. p. L-3.

This basis for estimating monitoring costs is most appropriate for the monitoring components designed for assessing ecosystem condition and trends. This element of monitoring is highly structured and cost estimates derived from existing monitoring programs and activities can readily be applied to the various levels of the monitoring hierarchy. In contrast, the monitoring components for evaluating MPA design and management decisions are necessarily much less structured, reflecting the broad spectrum of potential evaluation questions. Possible costs of short- and long-term evaluations range from as little as a few thousand dollars, for example for straightforward evaluations conducted largely by volunteers, to hundreds of thousands dollars for complex, collaborative evaluations conducted in partnership with multi-disciplinary research teams. Given this huge potential cost range, the most appropriate approach to allocating funds for this monitoring component is to simply assign it a percentage of the overall monitoring budget. This is discussed further in Chapter 9.

DEVELOPING ASSUMPTIONS TO ENABLE COST ESTIMATION

Estimating costs of individual monitoring components designed to assess the condition and trends of Ecosystem Features requires development of certain assumptions. These include assumptions about likely monitoring methods and the spatial and temporal distribution of monitoring. These are discussed further below.

IDENTIFYING MONITORING METHODS

Likely monitoring methods have been identified for assessing the condition and trends of Ecosystem Features, based primarily on methods commonly employed today in programs in California and elsewhere. At the time of monitoring implementation, different or additional methods may be employed. However, for the purposes of generating cost estimates, commonly employed methods have been assumed to the extent possible.

Likely monitoring methods have been identified for each of the two implementation options for assessing ecosystem condition and trends: Ecosystem Feature Checkups and Ecosystem Feature Assessments (see Chapter 4 for explanation of these options). For Ecosystem Feature Checkups, the identified monitoring methods are appropriate for implementation through community partners and citizen scientists. For Ecosystem Feature Assessments, the identified monitoring methods are suitable for implementing via research partnerships, and in many cases allow collection of more detailed information.

DEVELOPING TEMPORAL SAMPLING ASSUMPTIONS

The cost of monitoring is obviously affected by the frequency with which it is carried out. However, for the purposes of generating annual cost estimates for monitoring components, it is sufficient to assume sampling occurs annually. In applying cost estimates from existing programs and budgets, we also assume that those costs include sufficient temporal sampling to detect ecosystem change and MPA effects.

During development of monitoring programs, individual monitoring components may use annual, biennial, or other frequency of sampling, depending on management priorities and available resources. At that time, sampling strategies intended to provide data with specified degrees of certainty and resolution will also be developed. Initial recommendations and further information on temporal aspects of sampling are provided in Chapter 9.

DEVELOPING SPATIAL SAMPLING ASSUMPTIONS

Developing a full spatial sampling design for monitoring, identifying which specific sites or locations will be monitored in the North Central Coast region, is beyond the scope of this monitoring plan, because the spatial sampling design must reflect the management priorities and available resources at the time of monitoring implementation. For example, the appropriate

spatial design of monitoring will depend in part on which monitoring modules are selected for implementation and the associated selected implementation options and monitoring methods. However, to generate cost estimates, it is necessary to make assumptions about the general spatial distribution of monitoring activities in the region and the number of locations to be monitored.

Assumptions about the spatial distribution of monitoring data collection are based on general spatial sampling guidelines, which have been developed to reflect current scientific knowledge of the spatial variation in the marine ecosystems and socioeconomic elements of the North Central Coast region, and take into account the intended geographic scope and spatial resolution of monitoring data analysis and interpretation.

The following spatial sampling guidelines have been developed and used to generate annual cost estimates for monitoring components to monitor ecosystem condition and trends:

- MPA monitoring is being designed to facilitate evaluation of individual MPAs as well as the regional network. To provide robust regional assessments, sampling should be distributed throughout the North Central Coast region.
- For the MPA design process, the North Central Coast Science Advisory Team (NCCSAT) guidance recognized three bioregions within the region: north of the Point Reyes headland, south of the Point Reyes headland, and the Farallon Islands[33]. To adequately represent the region in monitoring data collection, sampling should be replicated within each of these bioregions, as Ecosystem Feature presence and feasibility permit.
- For the ecological Features, excluding estuaries, detection of MPA effects is facilitated by inside-outside comparisons. To facilitate these analyses, an equal number of inside MPA and outside reference locations should be sampled.
- Estuarine & Wetland ecosystems vary significantly within the region, and adopted MPAs in the region encompass whole estuarine ecosystems. This precludes sampling based on inside-outside comparisons for these ecosystems and these MPAs. Instead, sampling should be structured to allow comparison of ecosystem trends and trajectories of change between protected and unprotected estuaries.
- Five counties border the North Central Coast region: Mendocino, Sonoma, Marin, San Francisco, and San Mateo. In addition, the region includes four main ports: Point Arena, Bodega Harbor, San Francisco, and Half Moon Bay/Pillar Point Harbor. To adequately track trends in consumptive and non-consumptive uses, sampling should be structured to allow region-wide and port or county assessments, as appropriate for the activity being considered.
- Sampling should include multiple MPA designations (including both State Marine Reserves and State Marine Conservation Areas), and where appropriate additional designations including Special Closures.

These guidelines were used to develop spatial sampling assumptions for each Ecosystem Feature sufficient to generate valid cost estimates. For the purposes of cost estimation, it is sufficient to assume a minimum number of sites or locations within which monitoring data will be collected.

For the ecological Features, excluding estuaries, a reasonable minimum sampling distribution would focus on two MPAs and two reference sites in each of the three bioregions identified by the NCCSAT, for a total of six MPAs and six reference sites to be sampled for each Ecosystem Feature in the region. This would provide adequate information to assess the condition and trends within each Ecosystem Feature at scales ranging from individual MPAs to the whole region. As not all Ecosystem Features are found in all MPAs, this would include sampling of approximately 12-15 MPAs. Monitoring more sites would generate more data, but the incremental increase in understanding (and statistical power) that resulted would be small, because of the natural variation within each Ecosystem Feature across the North Central Coast region, the variation in influence of broader drivers such as oceanographic currents and water quality variables, and the variation in the allowed

[33] Methods Used to Evaluate MPA Proposals in the North Central Coast Study Region. May 30, 2008, revised draft. California Marine Life Protection Act Initiative. p. 28.

activities within the MPAs. For estuaries, a reasonable sampling distribution would include four estuaries, including two estuaries designated as MPAs. This distribution would allow comparisons of trends through time between estuaries.

For the Consumptive Uses Ecosystem Feature, the sampling assumption reflects the units around which many of the component human activities tend to focus or be managed. In the North Central Coast region, the assumption is that all four major port/harbor complexes will be sampled, focusing on identified key fisheries (see Chapter 4 for the specific recommended monitoring metrics for Consumptive Uses). As an exception to this, monitoring of abalone harvest is assumed to encompass key access locations within each of the five counties bordering the coast in the region. Non-consumptive Uses are also typically monitored through survey efforts that target locations based on the activities being monitored. These locations differ depending on the activity and the frequency of locations is challenging to identify prior to project design. A minimum sampling distribution would focus on robust sampling within the five counties bordering the coast in the region to allow region-wide assessments.

ESTIMATING COSTS TO ASSESS ECOSYSTEM FEATURE CONDITION

ESTIMATING COSTS OF MONITORING METHODS

Initial cost estimates, in the form of annual cost ranges, have been estimated for each likely monitoring method using the sampling assumptions above. These estimates include the costs to collect, analyze and report monitoring results for the identified methods.

These cost estimates were developed by building on existing information and ongoing MPA monitoring, and through consultation with existing organizations and groups in the region that are currently conducting monitoring activities. Costs information from the following organizations and groups was received and incorporated into the monitoring cost estimates:

- California Department of Fish & Game
- Beach Watch, Gulf of the Farallones National Marine Sanctuary
- LiMPETS (Long-term Monitoring Program and Experimental Training for Students)
- MARINe (Multi-Agency Rocky Intertidal Network)
- National Park Service, Resource Inventory & Monitoring Program
- PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans)
- PRBO Conservation Science
- Reef Check California

Further, known costs of existing MPA monitoring in California were also incorporated, including the programs contributing to the Channel Islands MPA monitoring program and the Central Coast MPA Baseline Data Collection Project.

In all cases, costs information required adjustments to generate appropriate cost estimates for the North Central Coast region, or to tailor costs to the specific array of adopted MPAs. A number of additional assumptions were necessary to appropriately estimate MPA monitoring costs for these components in this region. These have been included here to facilitate interpretation of the cost estimates and also inform estimation of costs of new methods:

- All costs are annual implementation costs. All monitoring data collection is assumed to occur in the same year. During implementation of monitoring, the frequency of sampling may vary to reflect management priorities or available resources, for example by sampling high priority Ecosystem Features annually and lower priority Features biennially or triennially (see, for example, the example spending plans described in Chapter 9). However, assuming

that all data collection occurs in the same annual period facilitates comparisons of cost estimates among individual monitoring components that may be used for ecosystem condition monitoring.

- Costs information from other monitoring programs included the number of sites sampled by each program. Total cost was divided by the number of sites to generate a per-site cost, and then this cost was multiplied by the intended number of sampling sites. For example, per-site costs of sampling mid-depth rock ecosystems were multiplied by 12 (6 MPA and 6 non-MPA locations) to give an estimated cost range for sampling the Mid-depth Rock Ecosystem Feature.
- To account for sources of error, and to incorporate start-up costs that would be necessary to implement many of the monitoring methods in the North Central Coast region, an additional 10% was added to the cost estimates.
- In many cases, multiple sources of information and multiple cost estimates were available for each monitoring method. Monitoring cost ranges were therefore generated by encompassing these cost estimates in a cost range, rounded to the nearest $5,000.
- Monitoring metrics identified as optional add-ons to Ecosystem Feature Assesments are not incorporated into cost estimates. These metrics represent optional additions to the monitoring plan that may be implemented as methods, capacity, and resources permit.
- Cost estimates include standard components of funded projects such as overhead costs but do not include leveraged or matched funds. Leveraging resources and taking advantage of existing expertise and capacity in the region will be important in implementing monitoring cost-effectively. The cost estimates assume that leveraged funds will be available to provide additional support for monitoring activities, using existing programs and cost-sharing arrangements as a model.

ESTIMATING COSTS OF ECOSYSTEM FEATURE CHECKUPS & ASSESSMENTS

Each Ecosystem Feature Checkup or Assessment may require use of multiple monitoring methods in order to collect data on all required monitoring metrics. Estimating the cost of each Checkup or Assessment thus required selecting the appropriate method or methods to be used to collect all the necessary data.

For each Checkup or Assessment, if two or more monitoring methods collect the same data, one was generally selected for use in generating the Checkup or Assessment implementation cost, based on considerations of the costs and advantages and disadvantages of each method. Costs are separately estimated for each monitoring method and for each Ecosystem Feature. During data collection, there may be significant opportunities for cost savings by combining methods within data collection programs (for example combining fishing surveys with ship-based bird censuses) or by combining data collection for multiple Ecosystem Features using the same method and program (e.g., ROV surveys of deep rock and soft-bottom subtidal ecosystems). Initial suggestions are included in the example spending plans in Chapter 9. Additionally, many of the estimated costs of monitoring methods reflect implementation of baseline data collection. For many methods, this may overestimate long-term monitoring costs, as baseline data collection often involves one-time start-up costs (e.g., for program initiation and equipment purchase). Costs of long-term monitoring may thus be comparatively high for initial data collection but may decrease through time.

TABLES OF ESTIMATED COSTS FOR EACH ECOSYSTEM FEATURE

For each Ecosystem Feature, potential monitoring methods, data collected, and associated cost estimates are included for each implementation option: Ecosystem Feature Checkup or Assessment. Both options are not required to track ecosystem condition although both may be implemented where resources and capacity permit. Specific assumptions regarding spatial sampling used to generate cost estimates are reiterated to assist interpretation. Individual methods selected to estimate the overarching cost estimates for each implementation option are enclosed by a black box.

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: KELP & SHALLOW ROCK ECOSYSTEMS (0-30M)

Spatial sampling assumption for estimating costs of each monitoring method: 6 MPAs and 6 reference locations.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods		
	Visual surveys (scuba diving)	**Video surveys (scuba diving)**	**Hook & line fishing surveys (collaborative fisheries approach)**
Data collected – Vital signs	All vital signs	Red & purple sea urchin, rockfish, lingcod	Rockfish, lingcod
Potential benefits of monitoring method	Consistent with existing monitoring efforts	Permanent record created Species ID skills not required	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Size estimation requires training	Many cryptic and mobile species often missed Logistically difficult in kelp	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$50,000 - $75,000	$100,000 - $150,000	$150,000 - $200,000
Estimated cost to implement Ecosystem Feature Checkup = $50,000 - $150,000[1]			

[1]Video surveys may be used as an alternative to visual surveys, and require less technical training to conduct. However, this method has a higher implementation cost and does not accurately record red abalone abundance.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods			
	Remote sensing/multispectral imaging	**Aerial photography**	**Visual surveys (scuba diving)**	**Hook & line fishing surveys (collaborative fisheries approach)**
Data collected – Attributes & indicators	Macroalgal assemblage: Areal extent of surface kelp canopy	Macroalgal assemblage: Areal extent of surface kelp canopy	Kelp stipe density, Invertebrates, piscivorous fish	Piscivorous fish
Potential benefits of monitoring method	Permanent record created	Consistent with existing monitoring efforts	Consistent with existing monitoring efforts	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Significant technical expertise required	Significant data processing capacity required	Size estimation requires significant training	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$25,000 - $50,000	$50,000 - $75,000	$175,000 - $225,000	$150,000 - $200,000
Estimated cost to implement Ecosystem Feature Assessment = $200,000 - $275,000				

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: MID-DEPTH ROCK ECOSYSTEMS (30-100M)

Spatial sampling assumption for estimating costs of each potential monitoring method: 6 MPAs and 6 reference locations.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods	
	Trap fishing surveys	**Hook & line fishing surveys**
Data collected – Vital signs	Rock crabs	Rockfish, lingcod
Potential benefits of monitoring method	Wide geographic coverage feasible	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Potential biases may be introduced by gear selectivity	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$150,000 - $200,000	$150,000 - $200,000
Estimated cost to implement Ecosystem Feature Checkup = $300,000 - $400,000		

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods			
	ROV (Remotely Operated Vehicle) Surveys	**Submersible Surveys**	**Trap fishing surveys**	**Hook & line fishing surveys**
Data collected – Attributes & indicators	All attributes and indicators	All attributes and indicators	Mobile invertebrates	Piscivorous fish
Potential benefits of monitoring method	Associated habitat data can be used to interpret trends in fish populations	Associated habitat data can be used to interpret trends in population abundances	Wide geographic coverage feasible	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Requires high technical expertise Requires high data processing capacity	Requires high technical expertise Requires high data processing capacity	Potential biases may be introduced by gear selectivity	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$300,000 - $450,000	$500,000 - $600,000	$150,000 - $200,000	$150,000 - $200,000
Estimated cost to implement Ecosystem Feature Assessment = $300,000 - $600,000[1]				

[1]Submersibles may be employed as an alternative method to collect data on all attributes and indicators. However, this method has a higher implementation cost.

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: ROCKY INTERTIDAL ECOSYSTEMS

Spatial sampling assumption for estimating costs of each potential monitoring method: 6 MPAs and 6 reference locations.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods		
	Visual Surveys – fixed area	**Photographic surveys – quadrats**	**Visual surveys**
Data collected – Vital signs	Mussels, sea urchins, limpets, abalone, sea stars	Mussels, sea urchins, limpets, black abalone, sea stars	Harbor seal abundance, black oystercatchers
Potential benefits of monitoring method	Consistent with existing monitoring efforts	Minimal field time required Permanent record created	Fixed location and fixed-period surveys are simple & repeatable
Potential disadvantages of monitoring method	Requires some species identification skills	Requires significant data processing capacity	
Estimated cost range for each potential method	$50,000 - $75,000	$50,000 - $75,000	$40,000 - $50,000
Estimated cost to implement Ecosystem Feature Checkup = $90,000 - $125,000[1]			

[1]Photographic surveys could also be employed as an alternative to visual surveys, if desired.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods	
	Visual surveys – transects/quadrats	**Photographic surveys**
Data collected – Attributes & indicators	All attributes & indicators	All attributes & indicators
Potential benefits of monitoring method	Consistent with existing monitoring efforts	Minimal field time required Permanent record created
Potential disadvantages of monitoring method	Requires some species identification skills	Requires significant data processing capacity
Estimated cost range for each potential method	$75,000 - $125,000	$75,000 - $125,000
Estimated cost to implement Ecosystem Feature Assessment = $75,000 - $125,000		

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: SOFT-BOTTOM SUBTIDAL ECOSYSTEMS

Spatial sampling assumption for estimating costs of each potential monitoring method: 6 MPAs and 6 reference locations.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods	
	Trap fishing surveys	**Hook & line fishing surveys**
Data collected – Vital signs	Dungeness crab	Starry flounder, halibut, other flatfish
Potential benefits of monitoring method	Wide geographic coverage feasible	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Potential biases may be introduced by gear selectivity	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$150,000 - $200,000	$150,000 - $200,000
Estimated cost to implement Ecosystem Feature Checkup = $300,000 - $400,000		

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods			
	ROV (Remotely Operated Vehicle) Surveys	**Submersible Surveys**	**Trap fishing surveys**	**Hook & line fishing surveys**
Data collected – Attributes & indicators	All attributes and indicators	All attributes and indicators	Benthic invertebrates	Demersal fish predators
Potential benefits of monitoring method	Associated habitat data can be used to interpret trends in fish populations	Associated habitat data can be used to interpret trends in population abundances	Wide geographic coverage feasible	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Requires high technical expertise Requires high data processing capacity	Requires high technical expertise Requires high data processing capacity	Potential biases may be introduced by gear selectivity	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$300,000 - $450,000	$500,000 - $600,000	$150,000 - $200,000	$150,000 - $200,000
Estimated cost to implement Ecosystem Feature Assessment = $300,000 - $600,000[1]				

[1]Submersibles may be employed as an alternative method to collect data on all attributes and indicators. However, this method has a higher implementation cost.

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: ESTUARINE & WETLAND ECOSYSTEMS

Spatial sampling assumption to estimate costs for each potential monitoring method: 4 estuaries, including estuaries with and without MPAs.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods			
	Visual surveys & benthic sampling	**Hook & line fishing surveys**	**Visual surveys (bird surveys)**	**Visual surveys (mammal surveys)**
Data collected – Vital signs	Areal extent of eel grass, ghost & mud shrimp, clams	Starry flounder	Piscivorous/shore birds	Harbor seals
Potential benefits of monitoring method	Low equipment requirements	Wide geographic coverage feasible	Fixed location surveys are simple and repeatable	Consistent with existing monitoring
Potential disadvantages of monitoring method	Invasive sampling may cause localized damage GPS mapping appropriate only for shallow eelgrass beds	Potential biases may be introduced by gear selectivity	Shore-based surveys may be most effective in shallow water	
Estimated cost range for each potential method	$50,000 - $75,000	$50,000 - $100,000	$40,000 - $60,000	$40,000 - $50,000
Estimated cost to implement Ecosystem Feature Checkup = $180,000 - $285,000				

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods			
	Remote sensing/multispectral imaging	**Aerial photography**	**Visual surveys & benthic sampling**	**Fishing surveys**
Data collected – Attributes & indicators	Areal extent of eelgrass	Areal extent of eelgrass	Ghost & mud shrimp, clams	Surfperches
Potential benefits of monitoring method	Permanent record created	Consistent with existing monitoring efforts	Low equipment requirements	Wide geographic coverage feasible
Potential disadvantages of monitoring method	Significant technical expertise required Significant data processing capacity required	Significant data processing capacity required	Invasive sampling may cause localized damage	Potential biases may be introduced by gear selectivity
Estimated cost range for each potential method	$25,000-$50,000	$50,000 - $75,000	$75,000 - $100,000	$50,000 - $75,000

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT (CONTINUED)

	Potential Monitoring Methods		
	Fishing surveys (e.g. seines)	**Visual surveys (bird surveys)**	**Visual surveys (mammal surveys)**
Data collected – Attributes & indicators	Leopard sharks, bat rays	Piscivorous/shore birds	Harbor seals
Potential benefits of monitoring method	Wide geographic coverage feasible	Fixed location surveys are simple and repeatable	Consistent with existing monitoring
Potential disadvantages of monitoring method	Potential biases may be introduced by gear selectivity Seines may cause habitat damage	Shore-based surveys may be most effective in shallow water	
Estimated cost range for each potential method	$50,000 - $75,000	$40,000 - $60,000	$40,000 - $50,000
Estimated cost to implement Ecosystem Feature Assessment = $280,000- $410,000			

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: SOFT-BOTTOM INTERTIDAL & BEACH ECOSYSTEMS

Spatial sampling assumption to estimate costs for each potential monitoring method: 6 MPAs and 6 reference locations.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods	
	Visual surveys – fixed-area benthos surveys	**Visual surveys**
Data collected – Vital signs	Sand crabs	Harbor seals, marine birds
Potential benefits of monitoring method	Consistent with existing monitoring efforts	Fixed location fixed-period surveys are simple and repeatable
Potential disadvantages of monitoring method		
Estimated cost range for each potential method	$50,000 - $75,000	$40,000 - $60,000
Estimated cost to implement Ecosystem Feature Checkup = $90,000 - $135,000		

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods		
	Visual surveys - transects/ quadrats/benthic sampling	**Fishing surveys (Hook & line/nets)**	**Visual surveys**
Data collected – Attributes & indicators	Invertebrates	Surf perch, surf smelt	Marine birds, harbor seals
Potential benefits of monitoring method	Consistent with existing monitoring efforts	Wide geographic coverage feasible	Fixed location & fixed-period surveys are simple & repeatable
Potential disadvantages of monitoring method	Requires some species identification skills	Potential biases may be introduced by gear selectivity	
Estimated cost range for each potential method	$75,000 - $100,000	$150,000 - $200,000	$40,000 - $60,000
Estimated cost to implement Ecosystem Feature Assessment = $265,000 - $360,000			

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: NEARSHORE PELAGIC ECOSYSTEMS

Spatial sampling assumption to estimate costs for each potential monitoring method: 6 MPAs and 6 reference locations.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods	
	Hook & line fishing surveys	**Visual surveys – colony abundance/on water abundance**
Data collected – Vital signs	Pelagic/semi-pelagic rockfish	Marine birds
Potential benefits of monitoring method	Wide geographic coverage feasible	Fixed location and fixed-period surveys are simple and repeatable
Potential disadvantages of monitoring method	Potential biases may be introduced by gear selectivity	On-water surveys require significant vessel support
Estimated cost range for each potential method	$150,000 - $200,000	$40,000 - $60,000
Estimated cost to implement Ecosystem Feature Checkup = $190,000 - $260,000		

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods		
	Hook & line fishing surveys	**Remotely operated baited video cameras**	**Visual surveys – colony abundance/on water abundance**
Data collected – Attributes & indicators	Pelagic/semi-pelagic rockfish	Pelagic/semi-pelagic rockfish	Marine birds
Potential benefits of monitoring method	Wide geographic coverage feasible	Successfully employed in other monitoring programs Non-intrusive (fish capture not required)	Fixed location and fixed-period surveys are simple and repeatable
Potential disadvantages of monitoring method	Potential biases may be induced by gear selectivity	Stereo video equipment required for accurate size estimation	On-water surveys require significant vessel support
Estimated cost range for each potential method	$150,000 - $200,000	?[1]	$100,000 - $200,000
Estimated cost to implement Ecosystem Feature Assessment = $250,000 - $400,000			

[1]Information was not available to estimate the cost of implementing this method.

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: CONSUMPTIVE USES

Spatial sampling assumption to estimate costs of each potential monitoring method: Focus on 4 main port/harbor complexes and identified key fisheries.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

	Potential Monitoring Methods		
	Analysis of commercial landings data (including licenses)	**Analysis of CRFS (California Recreational Fisheries Survey) data**	**Analysis of DFG abalone punch card data**
Data collected – Vital signs	Landings(weight & value)	Landings (number & weight), CPUE	Landings (number)
Potential benefits of monitoring method	Established data collection and archiving mechanisms Historical trends available from 1969	Data collection began in 2004 providing baseline information Consistent state-wide program	Data collection began in 2004 providing baseline information Consistent state-wide program
Potential disadvantages of monitoring method	Poor spatial resolution in collected data for detection of MPA effects	CRFS regions do not correspond with the North Central Coast region	Poor spatial resolution in collected data for detection of MPA effects
Estimated cost range for each potential method	$50,000 - $150,000	$75,000 - $125,000	$10,000 - $15,000
Estimated cost to implement Ecosystem Feature Checkup = $135,000 - $290,000			

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods			
	Analysis of commercial landings data (including licenses)	**Survey program – commercial fishery information with high spatial resolution**	**Survey program – Costs and earnings for commercial fishers**	**Analysis of CRFS (California Recreational Fisheries Survey) data**
Data collected – Attributes & indicators	Number of participants Level of activity Economic value/quality of activity	Number of participants Level of activity Economic value/quality of activity	Economic value/quality of activity – ex vessel, net revenue	Number of participants Level of activity Quality of activity
Potential benefits of monitoring method	Established data collection and archiving mechanisms Historical trends available from 1969	Diverse survey techniques (e.g., telephone, online) offer opportunity to scale costs	Allows collection of a broad array of information	Data collection began in 2004 providing baseline information Consistent state-wide program
Potential disadvantages of monitoring method	Poor spatial resolution in collected data	Requires trust and effort to reduce potential/perceived bias	Requires trust and effort to reduce potential/perceived bias	Current CRFS regions do not correspond with the North Central Coast region
Estimated cost range for each potential method	$100,000 - $150,000	$250,000 - $500,000	$300,000 - $400,000	$75,000 - $125,000

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT (CONTINUED)

	Potential Monitoring Methods			
	Survey program – Supplement to CRFS data with high spatial resolution and additional key fisheries (e.g., abalone)	**Survey program – Costs for consumptive recreational users**	**Survey program – Knowledge, Attitudes, Perceptions (KAP) of Users**	**Aerial surveys/remote sensing**
Data collected – Attributes & indicators	Number of participants Level of activity Quality of activity	Quality of activity – net expenditures/costs	KAP	Number of participants Level of activity
Potential benefits of monitoring method	Expanded survey effort allows increased analysis of MPA-specific effects	Allows collection of a broad array of information	Allows collection of a broad array of information	Provides fine spatial scale data on fishing locations
Potential disadvantages of monitoring method		Requires trust and effort to reduce potential/perceived bias	Requires trust and effort to reduce potential/perceived bias	Low temporal resolution
Estimated cost range for each potential method	$250,000 - $350,000	$100,000 - $200,000	$250,000 - $300,000	$50,000 - $75,000
Estimated cost to implement Ecosystem Feature Assessment (All indicator categories) = $1,325,000 - $2,025,000[1]				

[1]The indicators for monitoring of Non-consumptive Users are scalable to support partial implementation of this monitoring component as resources permit. Initial recommendations for partial implementation are included in Chapter 9.

ESTIMATED COSTS OF ECOSYSTEM FEATURE CHECKUP OR ASSESSMENT: NON-CONSUMPTIVE USES

Spatial sampling assumption to estimate costs for each potential monitoring method: Focus on 5 coastal counties and region-wide assessments.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE CHECKUP

There are no suitable programs at this time to estimate costs of monitoring non-consumptive uses via the Checkup option.

IMPLEMENTATION OPTION: ECOSYSTEM FEATURE ASSESSMENT

	Potential Monitoring Methods		
	Survey Program – scuba divers	**Survey program – expanded to other activities**	**Survey program – expanded to include KAP (Knowledge, Attitudes and Perceptions)**
Data collected – Attributes & indicators	Level of activity Motivation	Level of activity Motivation	KAP (Knowledge, Attitudes and Perceptions)
Potential benefits of monitoring method	Survey methods can be scaled to reflect available resources	Survey methods can be scaled to reflect available resources	Survey methods can be scaled to reflect available resources
Potential disadvantages of monitoring method	High start-up costs to design survey instruments Significant data processing capacity required	High start-up costs to design survey instruments Significant data processing capacity required	High start-up costs to design survey instruments Significant data processing capacity required
Estimated cost range for each potential method	$350,000 - $450,000	$150,000 - $250,000	$100,000 - $150,000
Estimated cost to implement Ecosystem Feature Assessment (All indicator categories) = $600,000 - $900,000[1]			

[1] The indicators for monitoring of Non-consumptive Users are scalable to support partial implementation of this monitoring component as resources permit. Initial recommendations for partial implementation are included in Chapter 9.

9. Building an Effective MPA Monitoring Program

- Configuring a coherent & effective monitoring program
- Choosing a monitoring &reporting cycle
- An Illustration: Developing two example monitoring spending plans

The preceding chapters of this plan have detailed the MPA monitoring elements developed to meet the requirements of the MLPA: assessment of ecosystem condition and trends (Chapter 4); and evaluation of MPA design and management decisions (Chapter 5). Options for implementing each monitoring element have been described, and cost estimates have been generated for assessing ecosystem condition and trends (Chapter 8). Implementing monitoring will require selecting the appropriate monitoring modules to build a coherent and effective monitoring program for the North Central Coast regional MPA network. This chapter provides guidance for doing this and for choosing an appropriate monitoring and reporting cycle. The chapter then illustrates the application of that guidance via elaboration of two example monitoring spending plans, reflecting two hypothetical budget scenarios.

CONFIGURING A COHERENT & EFFECTIVE MONITORING PROGRAM

This monitoring plan has been designed to be comprehensive, providing full coverage of MLPA goals and North Central Coast ecosystems. However, it has also been designed to be flexible, to allow tailoring to management priorities and available resources at the time of monitoring implementation. The modular structure of the plan, and the implementation options, enable a variety of monitoring configurations. This allows a monitoring program to be built to the specifications applicable at the time of implementation and revised as needed. However, to maintain the overall coherence and effectiveness of monitoring, comply with MLPA requirements, and ensure efficient use of monitoring resources, care must be taken in selecting and implementing monitoring components.

SELECTING MONITORING ELEMENTS

The two principal monitoring elements developed for monitoring the North Central Coast regional MPA network are assessment of ecosystem condition and trends and evaluation of MPA design and management decisions. Ultimately, both elements are required to best facilitate adaptive management. Assessment of ecosystem condition and trends is required to assess the MPA network's effectiveness in conserving species, habitats, and ecosystems. Evaluation of MPA design and management decisions allows direct assessment of the effects of MPA size, spacing, and other characteristics to inform possible future site or network design adjustments. Many of the design decisions are likely to require long-term evaluations, and work on this element should commence as soon as possible.

In an extremely austere financial environment, it is viable to delay implementation of evaluation of MPA design and management decisions, particularly in the first one or two of the recommended five-year MPA review cycles (e.g., in the first five to ten years following MPA implementation), and focus the limited available resources on assessing ecosystem condition and trends. Assessment of ecosystem condition and trends provides the most basic evaluation of potential MPA effects, and focuses on many of the North Central Coast aspects that are of great public interest, such as the status of kelp ecosystems and selected fish and invertebrate species, or the trajectories of key consumptive and non-consumptive human uses. However, delaying onset of evaluation of MPA design and management decisions should be viewed as a measure of last resort, as it will cause a corresponding delay in the availability of specific evaluations of MPA size and other design characteristics that are important to inform future management decisions.

SELECTING MONITORING MODULES

Each of the two principal monitoring elements, assessment of ecosystem condition and trends and evaluation of MPA design and management decisions, is implemented through selection of modules, which have been developed to be stand-alone monitoring components as needed. Guidance for prioritizing among the modules is provided for each element below.

PRIORITIZING AMONG ECOSYSTEM CONDITION ASSESSMENT MODULES

Ecosystem condition assessment is conducted through monitoring the nine Ecosystem Features. The Ecosystem Features have been developed to collectively represent and encompass the North Central Coast region for the purposes of MPA monitoring. A monitoring module has been developed for each Ecosystem Feature to enable assessment of condition and trends. Ultimately, to allow comprehensive evaluation of the extent to which the regional MPA network is meeting MLPA goals, all Ecosystem Features should be monitored at some scale. For each Ecosystem Feature, the implementation options for the module (i.e., Ecosystem Feature Check-up and/or Ecosystem Feature Assessment) provide a mechanism to scale implementation.

Resource limitations may require prioritizing among ecosystem condition assessment modules, particularly in the initial years of monitoring. Monitoring will generally be more effective and informative, and will better meet MLPA requirements, by selecting fewer features and implementing them as designed, compared to selecting more features and implementing them incompletely. If it is not possible to monitor all Ecosystem Features, priority should be accorded to those considered likely to be most responsive to potential MPA effects, and also to those that are of greatest public interest, for example because they are associated with important fisheries. The Kelp and Shallow Rock and Consumptive Uses Ecosystem Features, for example, include metrics that may respond comparatively quickly and directly to MPA implementation. In contrast, estuaries, for example, are likely to be very strongly influenced by factors additional to MPAs, and many species in the Nearshore Pelagic Ecosystem Feature are highly mobile species that may be slow to show MPA effects (see Chapter 3 for additional details).

These criteria lead to three groupings of the Ecosystem Features, corresponding to first, second, and third priorities for implementation. Equal priority is accorded to Ecosystem Features within each group.

First priority:

- Kelp & Shallow Rock Ecosystems
- Consumptive Uses

Second priority:

- Mid-depth Rock Ecosystems
- Rocky Intertidal Ecosystems
- Non-consumptive Uses

Third priority:

- Soft Bottom Subtidal Ecosystems
- Soft Bottom Intertidal & Beach Ecosystems
- Estuarine & Wetland Ecosystems
- Pelagic Ecosystems

Each selected Ecosystem Feature module should be implemented through use of an Ecosystem Feature Checkup or Ecosystem Feature Assessment approach. Where capacity and resources permit, both implementation options may be

employed. However, partial implementation of a module, for example through choosing only some of the vital signs or indicators for the Checkup or Assessment of that module, will not generate an adequate condition assessment of the Feature and should usually be avoided. The exception to this recommendation is monitoring of Consumptive and Non-consumptive Uses via the Ecosystem Assessment option. These two monitoring modules are explicitly based on a scalable set of indictors that allow partial implementation.

PRIORITIZING AMONG MPA DESIGN & MANAGEMENT DECISION EVALUATION MODULES

The decision evaluation element of MPA monitoring is conducted through implementing short-term and long-term evaluations, prioritizing potential evaluations within each module, and structuring the evaluations to ensure generation of conclusive, robust information suitable for informing future MPA management decisions. Ultimately, both modules are needed, and an optimal implementation approach would include both modules, even if only one or a few evaluations in each module are conducted. If that is not feasible, the inventories of short-term and long-term candidate evaluations should be combined, and the overall highest priority evaluation(s) that can be feasibly conducted with available resources selected for implementation.

CHOOSING A MONITORING & REPORTING CYCLE

One of the most important considerations in building an effective monitoring program, in addition to selecting the monitoring modules to be implemented and the scale at which each should be implemented, is the timing of the monitoring and reporting cycle. In the context of the MLPA, the monitoring program should be built to most effectively and efficiently gather information and report results in advance of the five-year MPA reviews recommended in the MLPA Master Plan.

A five-year monitoring cycle, for example, would allow monitoring data collection and initial analyses to be staged over four years, and the fifth (review) year allocated to preparation and dissemination of results and findings. It is not, of course, necessary for the same monitoring data to be collected every year within the monitoring cycle. Indeed, resources may be most efficiently used by staggering data collection among selected monitoring components, and scheduling components that are strongly related to one another, or which may efficiently be monitored together, to occur in the same year, and scheduling other components to occur in other years of the cycle. The advantages of this approach are explored in detail later in this chapter.

AN ILLUSTRATION: DEVELOPING TWO EXAMPLE MONITORING SPENDING PLANS

The implemented form of the monitoring program for the North Central Coast regional MPA network will of course depend in part on available resources. Those resources will include those within the Department of Fish and Game, and also those available through potential monitoring partners. MLPA implementation to date, including both the MPA planning process and the monitoring that has occurred, has relied heavily on partnerships, including funding from private and public sources.

Implementing the North Central Coast MPA monitoring program as efficiently and effectively as possible, and ensuring the best use of resources, regardless of the source, will be facilitated by agreement on monitoring priorities. Resources, whether private or public, cash or in-kind, can then be focused on implementing the agreed priorities, thereby minimizing waste and duplication and maximizing utility.

To illustrate application of the guidelines discussed above, and to facilitate setting of clear monitoring priorities for the North Central Coast regional MPA network, two example ‘spending plans’ have been developed. The spending plans provide recommendations for spending a specified monitoring budget, and have been developed for two hypothetical

budget scenarios: annual North Coast regional MPA monitoring budgets of $1,000,000 (Spending Plan A) and $2,000,000 (Spending Plan B).

The spending plans reflect all guidance provided in this monitoring plan, and also reflect priorities identified during consultations with stakeholders in the region. The spending plans assume implementation of MPA monitoring using the partnerships approach described in Chapter 7 and elsewhere, and reflect the cost estimates developed in Chapter 8. These cost estimates do not include potential sources of leveraged funds. Thus, in most cases, the allocated funding levels assume that opportunities for partnerships and collaborations, building on existing capacity to leverage additional resources, will be sought during implementation. For example, the spending plans include allocated funding levels to implement Ecosystem Feature Checkups for some Ecosystem Features. This implementation option is tailored for community participation in monitoring, and the allocated funding levels assume leveraged support from community groups and partners that are identified to collect this monitoring information. This cost-sharing model is based on existing monitoring programs in California, as is explained in Chapter 8.

For both spending plans, the available budget is allocated to conducting monitoring, including collecting, analyzing and reporting monitoring results. The spending plans depict the choices and trade-offs involved in selecting particular monitoring components for implementation, and explanations for these choices are provided alongside the plans. This approach allows the methodology used to develop the plans to be applied to additional or alternative budget scenarios, using the principles and guidelines described.

The spending plans do not include all possible costs of implementing MPA monitoring in the North Central Coast region. For example, costs of coordination and oversight of monitoring are not included, as the degree of coordination and oversight required will depend on a variety of factors, including the monitoring modules to be implemented, the scale at which each will be implemented, and the monitoring partnerships involved. Other implementation costs, such as Department of Fish and Game staff costs, may also be identified. These additional costs will need to be considered at the time of monitoring implementation. Nonetheless, the spending plans include the majority of anticipated new costs of MPA monitoring in the North Central Coast region, tailored to make best use of a hypothetical annual budget for these costs of $1,000,000 or $2,000,000. The following sections describe the decisions underlying the spending plans, and are followed by the two spending plans.

ALLOCATING BUDGET AMONG MONITORING ELEMENTS

First, monitoring implementation must appropriately allocate funding and resources among the two principal monitoring elements: assessing condition and trends of Ecosystem Features; and evaluating MPA design and management decisions. In general, the majority of the available budget should be allocated to ecosystem condition assessment, especially for the first two to three of the recommended five-year review cycles. Assessment of ecosystem condition and trends is foundational for interpreting all other monitoring information. Additionally, given the highly dynamic and heterogeneous nature of North Central Coast ecosystems, considerable time and effort will be required to confidently detect trends.

ALLOCATING BUDGET AMONG MONITORING MODULES

Second, budget must be allocated within the two principal monitoring elements, appropriately selecting among the monitoring modules developed for each.

ALLOCATING BUDGET AMONG THE ECOSYSTEM CONDITION MONITORING MODULES

The Ecosystem Features modules are selected for implementation in accordance with the priorities described earlier in this chapter, and in reflection of the available budget. In addition, an implementation schedule for the Ecosystem Features has been developed, considering the links among Ecosystem Features. For example, implementation of Non-consumptive Uses data collection may be most usefully synchronized with implementation of the nearshore and intertidal ecosystems, such as Estuarine & Wetland and Rocky Intertidal Ecosystem Features, where non-consumptive human uses are most prevalent. This facilitates integrated analyses across linked Ecosystem Features.

Both spending plans include assessment of the condition of some but not all of the Ecosystem Features. For those selected for funding in the spending plans, the estimated cost range for full implementation is provided, which corresponds to the estimated cost ranges provided in Chapter 8. Estimated cost ranges and allocated funding levels are also provided for the selected monitoring metrics or methods recommended for implementation. In most cases, funding levels adopt the recommendation, above, to avoid partial implementation of Ecosystem Feature Assessments or Checkups because it will result in significant loss of information. In many cases full implementation is achieved through the selection of specific methods capable of collecting all identified vital signs or indicators within budget. Where partial implementation of an Ecosystem Feature Assessment or Checkup is considered viable, this is identified and explained.

Both Ecosystem Feature Checkups and Ecosystem Feature Assessments are included in the spending plans, sometimes for the same Feature but conducted in different years. The choice between the two balances the available budget (Checkups are often, but not always, less expensive) with the degree of information resolution necessary to best assess the condition of the Ecosystem Feature. Checkups have been designed to provide adequate assessments of feature condition, but the additional detail provided through Ecosystem Feature Assessments can be useful, especially for high-priority features or immediately preceding a possible five-year review.

As discussed in Chapter 4, ecosystem condition assessments may over time be improved through targeted research and development, which is likely to be best advanced through partnerships with research entities. These partnerships may be encouraged through clear articulation and prioritization of management needs, which may assist potential partners in securing funds. If resources permit, a small percentage of the monitoring budget may be allocated to such research and development partnerships, in order to provide “seed” funding.

ALLOCATING BUDGET AMONG THE MPA DESIGN & MANAGEMENT DECISION EVALUATION MODULES

As discussed in Chapter 8, it is possible to generate cost estimates for many of the monitoring components associated with assessing ecosystem condition, because this monitoring element is highly structured and there is considerable relevant experience with this type of monitoring, broadly speaking, in California.

In contrast, the tremendous variety of possible decision evaluations, which may cost a few thousand or a few hundred thousand dollars to implement, render cost estimations for this monitoring element less useful. Thus budget is allocated within this element on a percentage basis, ensuring funding of both short-term and long-term evaluation modules.

IMPLEMENTING A FIVE-YEAR MONITORING & REPORTING CYCLE

The example spending plans have been designed to operate on a five-year funding cycle, explicitly allocating funding within each of the four data collection years so that each year comprises a cohesive set of monitoring elements, and so that the four data collection years collectively provide the most useful information to inform the five-year reviews recommended in the MLPA Master Plan.

In the fifth (review) year, funding has not been directly allocated for monitoring data collection, analysis, and reporting. However, in this year, as discussed earlier, resources may be most appropriately allocated for synthesis and communication of monitoring results, and preparation for the review process.

Implementing a five-year monitoring cycle also allows advantage to be taken of the repetition of the cycle. Thus the spending plans should be interpreted as schedules of implementation and not as prescriptions for spending within a single funding cycle only. Each spending plan assumes repetitive five-year cycles of implementation, and this has guided the choices and trade-offs within the plans. For example, surveys designed to reveal broad perceptions and opinions of the MPA network among consumptive and non-consumptive users (technically described as knowledge, attitudes and perceptions or KAP studies) are an important component of MPA monitoring but, given the slow rate of change in these indicators and the high costs of the surveys, are typically conducted relatively infrequently. Thus, this monitoring element is included within year four of the $2 million annual budget scenario. This does not mean that this survey will only be conducted once. Rather it has been scheduled to occur every five years, in the fourth year of the funding cycle in order to provide results that will inform the five-year reviews.

MPA MONITORING BUDGET SCENARIOS & EXAMPLE SPENDING PLANS

GUIDE TO THE SPENDING PLAN TABLES

The example spending plan tables below describe monitoring programs implementing two hypothetical regional MPA monitoring budget scenarios of $1 million and $2 million annually. Both scenarios assume a five-year funding cycle, including four years of data collection activities. Each page describes funded monitoring elements for implementation within one of the four years of the five-year cycle for a particular spending plan. Also included are descriptions and explanations for the selections within each year and for individual monitoring elements.

Key to the spending plan tables:

Monitoring elements funded for implementation. Each monitoring element is also ranked as high, medium or low priority. These rankings refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup option.
Monitoring element is implemented via the Ecosystem Feature Assessment option.
Empty cells indicate that the monitoring element is not funded for implementation.

EXAMPLE SPENDING PLAN A: $1M ANNUAL BUDGET; 5-YEAR FUNDING CYCLE

Example Spending Plan A, assuming a $1 million annual budget allocated to each of the four data collection years of the five-year monitoring and reporting cycle, is presented in four tables below, one for each data collection year. The specific choices and trade-offs inherent within this spending plan include the following, in addition to the general considerations described above:

- *Priorities across years*
  Taking into account the temporal dynamics within the ecosystem, sampling of Kelp & Shallow Rock ecosystems is funded annually in this spending plan. Funds are allocated to conduct Ecosystem Feature Checkups in Years 1 to 3, with the more comprehensive Ecosystem Feature Assessment funded in Year 4, just prior to the presumed five-year review. This approach has been supplemented by the addition of aerial surveys of kelp canopy extent, for which funding has been allocated in Years 2 and 4 of the funding cycle. (Kelp areal extent is not currently included

as a vital sign and therefore not included within the Checkup, although there may be community partners able to collect this information, and this may be included as a vital sign in the future).

- *Assessing ecosystem condition and trends - monitoring focus in Year 1*
  In the first year of the funding cycle, the selected monitoring elements focus on priority Ecosystem Features identified in the general recommendations above. These are the rocky ecosystems (Kelp & Shallow Rock, Mid-depth Rock, and Rocky Intertidal) and the Consumptive Uses Ecosystem Feature. The plan funds full implementation of the three rocky ecosystems modules, through Ecosystem Feature Assessment or Ecosystem Feature Checkup, depending on the Feature. Funds are allocated to partially implement an Ecosystem Feature Assessment of the Consumptive Uses Feature. These funds are sufficient to conduct new survey programs to collect information corresponding to the top two levels of the indicator categories for Consumptive Uses (number of participants and level of activity). These surveys will provide useful information to assess overarching trends in these activities, justifying an exception to the general guideline against partial implementation of a module.
- *Assessing ecosystem condition and trends – monitoring focus in Year 2*
  The selected Ecosystem Features in the second year of the funding cycle provide a cohesive set of information from subtidal ecosystems by seeking efficiencies in data collection in ecosystems that are typically expensive to sample. In this budget scenario, Ecosystem Feature Checkups are preferable, and efficiencies in data collection are obtained through combining fishing surveys of mid-depth rock and pelagic rockfish. Funding is also allocated for analysis of consumptive uses data, reflecting the high priority of this Ecosystem Feature, and recognizing that information on the spatial patterns and intensity of fishing are necessary for accurate interpretation of ecological vital signs data from these subtidal habitats.
- *Assessing ecosystem condition and trends – monitoring focus in Year 3*
  In Year 3 of the funding cycle, the funded Ecosystem Features are selected to link assessment of Non-Consumptive uses with ecological information from intertidal and nearshore ecosystems by collecting data on those Features within the same year. This reflects the stronger associations between non-consumptive uses such as wildlife viewing, scuba-diving and tidepooling and intertidal/nearshore habitats. Again, given the available budget, the Ecosystem Feature Checkup implementation option is preferable and will allow integrated analyses with results from surveys of non-consumptive uses.
- *Assessing ecosystem condition and trends – monitoring focus in Year 4*
  Funding decisions in Year 4 highlight particularly useful information to collect immediately preceding the expected review year (Year 5 of each cycle, reflecting the recommendation of the MLPA Master Plan). Thus, the focus is placed on the highest priority Ecosystem Features, as recommended earlier in this chapter and including the Kelp & Shallow Rock and Consumptive Uses Ecosystem Features. In this year, sufficient funding is allocated to enable more comprehensive monitoring of these Ecosystem Features via Ecosystem Feature Assessments, robustly complementing the data conducted in previous years.
- *MPA management & design evaluations – monitoring focus in Years 2 and 4*
  Addressing priority short-term MPA design and management decisions and collecting data to contribute toward long-term design and management evaluations are both core components of monitoring, as described above and in previous chapters. The available budget enables funding of these components in Years 2 and 4, with the intent to leverage partnerships.
- *Advancing ecosystem monitoring (research & development) – included but unfunded*
  In the current budget scenario, funding research and development is not a priority. Research and development partnerships will be encouraged and incentivized through public dissemination of specific priorities to test and refine MPA monitoring approaches and meet other top MPA management needs.

EXAMPLE MPA MONITORING SPENDING PLAN: $1M ANNUAL BUDGET; 5-YEAR FUNDING CYCLE

$1M ANNUAL BUDGET – YEAR 1

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$50,000 - $150,000	All vital signs; Scuba surveys	$50,000 - $75,000	$75,000
Mid-depth Rock	Medium	$300,000 - $600,000	All attributes & indicators; ROV surveys	$300,000 - $450,000	$300,000
Rocky Intertidal	Medium	$75,000 - $125,000	All attributes & indicators; Visual surveys	$75,000 - $125,000	$75,000
Soft-bottom Subtidal					
Soft-bottom Intertidal					
Estuarine & Wetland					
Nearshore Pelagic					
Consumptive Uses	High	$1,325,000 - $2,025,000	Number of participants & level of activity; Survey program – commercial fisheries Survey program – recreational fisheries	 $250,000 - $500,000 $250,000 - $350,000	$500,000
Non-consumptive Uses					
Subtotal				***$925,000 - $1,500,000***	***$950,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocated funding level
Short-term MPA management					
Long-term MPA design and management					
Subtotal					
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring					
Total Expenditure					***$950,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup option Monitoring element is implemented via the Ecosystem Feature Assessment option

$1M ANNUAL BUDGET – YEAR 2

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$50,000 - $150,000	All vital signs; Scuba surveys	$50,000 - $75,000	$75,000
Kelp & Shallow Rock (additional)	High	$200,000 - $275,000	Kelp areal extent; Aerial imaging	$25,000 - $50,000	$25,000
Mid-depth Rock	Medium	$300,000 - $400,000	Rockfish, lingcod; Hook & line surveys	$150,000 - $200,000	$150,000
Rocky Intertidal					
Soft-bottom Subtidal	Low	$300,000 - $400,000	Flatfish; Hook & line surveys	$150,000 - $200,000	$150,000
Soft-bottom Intertidal					
Estuarine & Wetland					
Nearshore Pelagic	Low	$190,000 - $260,000	Rockfish; Hook & line surveys Marine birds; Colony surveys	$150,000 - $200,000 $40,000 - $60,000	$65,000[34]
Consumptive Uses	High	$135,000 - $290,000	All vital signs; Existing data analysis	$135,000 - $290,000	$290,000
Non-consumptive Uses					
Subtotal				***$700,000 - $1,075,000***	***$755,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocated funding level
Short-term MPA management		15%			$150,000
Long-term MPA design and management		10%			$100,000
Subtotal		***25%***			***$250,000***
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring					
Total Expenditure					***$1,005,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup implementation option Monitoring element is implemented via the Ecosystem Feature Assessment implementation option

[34] Allocated funding level includes $40,000 for marine bird colony surveys and $25,000 for hook & line fish surveys. This assumes that hook & line rockfish surveys are combined with hook & line surveys conducted in the Deep Rock Ecosystem Feature to increase data collection efficiency and leverage funds.

$1M ANNUAL BUDGET – YEAR 3

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$50,000 - $150,000	All vital signs; Scuba surveys	$50,000 - $75,000	$75,000
Mid-depth Rock					
Rocky Intertidal	Medium	$75,000 - $125,000	All attributes & indicators; Visual surveys	$75,000 - $125,000	$75,000
Soft-bottom Subtidal					
Soft-bottom Intertidal	Low	$90,000 - $135,000	All vital signs; Visual surveys	$90,000 - $135,000	$90,000
Estuarine & Wetland	Low	$180,000 - $285,000	All vital signs; Multiple methods	$180,000 - $285,000	$180,000
Nearshore Pelagic					
Consumptive Uses					
Non-consumptive Uses	Medium	$600,000 - $900,000	All attributes & indicators; Survey program	$600,000 - $900,000	$600,000
Subtotal				***$995,000 - $1,520,000***	***$1,020,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocated funding level
Short-term MPA management					
Long-term MPA design and management					
Subtotal					
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring					
Total Expenditure					***$1,020,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup implementation option Monitoring element is implemented via the Ecosystem Feature Assessment implementation option

$1M ANNUAL BUDGET – YEAR 4

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$200,000 - $275,000	All attributes & indicators; Multiple methods	$200,000 - $275,000	$275,000
Mid-depth Rock					
Rocky Intertidal					
Soft-bottom Subtidal					
Soft-bottom Intertidal					
Estuarine & Wetland					
Nearshore Pelagic					
Consumptive Uses	High	$1,325,000 - $2,025,000	Number of participants & level of activity; Survey program – commercial fisheries Survey program – recreational fisheries	 $250,000 - $500,000 $250,000 - $350,000	$500,000
Non-consumptive Uses					
Subtotal				***$800,000 - $1,275,000***	***$775,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocated funding level
Short-term MPA management		15%			$150,000
Long-term MPA design and management		10%			$100,000
Subtotal		***25%***			***$250,000***
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring					
Total Expenditure					***$1,025,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup implementation option Monitoring element is implemented via the Ecosystem Feature Assessment implementation option

EXAMPLE SPENDING PLAN B: $2M ANNUAL BUDGET; 5-YEAR FUNDING CYCLE

Example Spending Plan B, assuming a $2 million annual budget allocated to each of the four data collection years of the five-year monitoring and reporting cycle, is presented in four tables below, one for each data collection year.

Key differences between this spending plan and the previous plan implementing a $1 million annual budget are:

- Monitoring to assess Ecosystem Feature condition more frequently uses Ecosystem Feature Assessments rather than Ecosystem Feature Checkups in order to collect more detailed data. Funding allocations to conduct both Ecosystem Feature Assessments and Checkups are also higher in some cases, to strengthen data collection through increased sampling and/or implementation of additional monitoring methods.
- MPA design and management decision evaluations are funded every year, rather than just in Years 2 and 4.
- Advancing ecosystem monitoring (research & development) is funded every year, rather than being unfunded.

The full rationale for the choices and trade-offs that are inherent within this spending plan is as follows:

- *Priorities across years*
  Taking into account the temporal dynamics within the ecosystem, annual assessments of Kelp & Shallow Rock ecosystems are funded, as in Spending Plan A. Given the interaction with other management priorities (such as fisheries management) together with keen public interest in MPA effects, the Consumptive Uses Ecosystem Feature is also funded annually in this scenario, unlike in Spending Plan A. However, allocated funding levels vary among years for this Ecosystem Feature to accommodate the high cost of full implementation of Ecosystem Feature Assessments. The Ecosystem Features previously ranked as low priority are each implemented using Ecosystem Feature Checkups once within the four-year funding cycle.
- *Assessing ecosystem condition and trends - monitoring focus in Year 1*
  In the first year of the funding cycle, Ecosystem Feature priorities are unchanged from Spending Plan A. The funded monitoring elements again focus on priority Ecosystem Features identified in the general recommendations above, namely the rocky ecosystems (Kelp & Shallow Rock, Mid-depth Rock, and Rocky Intertidal) and Consumptive Uses. However, under this budget scenario, Ecosystem Feature Assessments are fully funded for the rocky ecosystems to obtain more detailed information about these priority ecosystems. As in Spending Plan A, the Consumptive Uses Ecosystem Feature is monitored through partial implementation of Ecosystem Feature Assessment. As noted previously, the allocated funds are sufficient to conduct new survey programs to collect information corresponding to the top two levels of the indicator categories for Consumptive Uses (number of participants and level of activity).
- *Assessing ecosystem condition and trends – monitoring focus in Year 2*
  As in Spending Plan A, the selected Ecosystem Features in the second year of the funding cycle provide a cohesive set of information from subtidal ecosystems. Under this budget scenario, priority ecological Ecosystem Features (Kelp & Shallow Rock and Mid-depth Rock) are monitored via Ecosystem Feature Assessments to allow more detailed information to be collected for these ecosystems. Ecosystem Feature Checkups are preferable for the remaining subtidal Ecosystem Features. In this scenario, partial implementation of Soft-bottom Subtidal Ecosystem Feature Checkup will include monitoring of all but one of the vital signs (Dungeness crab), which cannot be included without exceeding the budget. There may be opportunities to implement cost-sharing arrangements to allow monitoring of Dungeness crab to occur. In addition, opportunities to extend ROV data collection in mid-depth rock ecosystems to cover some soft-bottom subtidal habitats and increase the information available to assess this Ecosystem Feature are likely. As in Spending Plan A, funding is also allocated for analysis of consumptive uses data, reflecting the high priority of this Ecosystem Feature, and recognizing that information on the spatial

patterns and intensity of fishing at high levels of spatial resolution are necessary for accurate interpretation of ecological indicator and vital signs data from these subtidal habitats.

- *Assessing ecosystem condition and trends – monitoring focus in Year 3*
  In Year 3 of the funding cycle, the funded Ecosystem Features are selected to focus on Non-consumptive Uses and link assessment of this Ecosystem Feature with ecological information from intertidal and nearshore ecosystems, as was the emphasis of Year 3 in Spending Plan A. Again, this reflects the stronger associations between non-consumptive uses such as wildlife viewing, scuba-diving and tidepooling and these ecosystems. Non-consumptive Uses Ecosystem Feature Assessment is partially funded, excluding knowledge attitudes and perceptions (KAP) surveys that are funded in Year 4. The Kelp & Shallow Rock Feature is funded for Ecosystem Feature Assessment, but the Soft-Bottom Intertidal and Estuarine & Wetland Features will be monitored via Ecosystem Feature Checkups. These Checkups are less expensive than Assessments for these Features, and this allocation allows funding of monitoring of more Ecosystem Features. For Rocky Intertidal Ecosystems, a Checkup is funded because the vital signs include monitoring harbor seals and black oystercatchers, which are important aspects of the ecosystem to link to non-consumptive wildlife-viewing. Under this budget scenario, and unlike Spending Plan A, Consumptive Uses data collection is included but, given that monitoring activity occurs for this Feature in every year, the focus in Year 3 is on analysis of existing data rather than collection of new data.
- *Assessing ecosystem condition and trends – monitoring focus in Year 4*
  As in Spending Plan A, the strategy in Year 4 is to focus on the most useful information to collect immediately preceding the scheduled review year (Year 5 of each cycle). This again includes Kelp & Shallow Rock, funded at the same level as Year 4 in Spending Plan A, and again includes Consumptive Uses, which is funded at a considerably higher level under this budget scenario. In addition, monitoring of Rocky Intertidal and Non-Consumptive Uses is funded, although the latter only partially. The funded metric for the Non-Consumptive Uses Feature is a survey program designed to reveal knowledge, attitudes and perceptions of users and visitors to MPAs. Such survey programs are a valuable aspect of monitoring broad perceptions of the MPAs, but are required only periodically. Here, funding is allocated to conduct these surveys every five years.
- *MPA management & design evaluations – funded every year*
  Under this budget scenario, and unlike in Spending Plan A, funding is allocated for MPA design and management evaluations in each year of the funding cycle. The funding levels are designed to provide multiple opportunities to implement data collection and analysis, including directly supporting research projects to address priority evaluations, and also leveraging the funds with larger project proposals. Portions of the funding may be used to support multi-year projects, and these funds may be also combined to support larger projects addressing priority questions.
- *Advancing ecosystem monitoring (research & development) – funded every year*
  Research and development to advance ecosystem-based monitoring are also considered a key aspect of the monitoring plan and, in this budget scenario, annual funding is provided. Variations between years in the allocated funding levels illustrate balancing the total budget while adequately funding monitoring of selected Ecosystem Features.

EXAMPLE MPA MONITORING SPENDING PLAN: $2M ANNUAL BUDGET, 5-YEAR FUNDING CYCLE

$2M ANNUAL BUDGET – YEAR 1

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$200,000 - $275,000	All attributes & indicators; Multiple methods	$200,000 - $275,000	$275,000
Mid-depth Rock	Medium	$300,000 - $600,000	All attributes & indicators; ROV surveys Hook & line surveys	 $300,000 - $450,000 $150,000 - $200,000	$450,000
Rocky Intertidal	Medium	$75,000 - $125,000	All attributes & indicators; Visual surveys	$75,000 - $125,000	$75,000
Soft-bottom Subtidal					
Soft-bottom Intertidal					
Estuarine & Wetland					
Nearshore Pelagic					
Consumptive Uses	High	$1,325,000 - $2,025,000	Number of participants & level of activity; Survey program – commercial fisheries Survey program – recreational fisheries	 $250,000 - $500,000 $250,000 - $350,000	$500,000
Non-consumptive Uses					
Subtotal				***$1,400,000 - $2,050,000***	***$1,300,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocating funding level
Short-term MPA management		10%			$200,000
Long-term MPA design and management		10%			$200,000
Subtotal		***20%***			***$400,000***
Research & Development		Budget allocation (%)			Allocating funding level
Advancing ecosystem monitoring		**5%**			**$100,000**
Total Expenditure					***$1,800,000***

$2M ANNUAL BUDGET – YEAR 2

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$200,000 - $275,000	All attributes & indicators; Multiple methods	$200,000 - $275,000	$275,000
Mid-depth Rock	Medium	$300,000 - $600,000	All attributes & indicators; ROV surveys	$300,000 - $450,000	$450,000
Rocky Intertidal					
Soft-bottom Subtidal	Low	$300,000 - $400,000	Flatfish; Hook & line surveys	$150,000 - $200,000	$200,000
Soft-bottom Intertidal					
Estuarine & Wetland					
Nearshore Pelagic	Low	$190,000 - $260,000	All vital signs; Multiple methods	$190,000 - $260,000	$190,000
Consumptive Uses	High	$135,000 - $290,000	All vital signs; Existing data analysis	$175,000 - $290,000	$290,000
Non-consumptive Uses					
Subtotal				***$1, 115,000 - $1,610,000***	***$1,405,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocated funding level
Short-term MPA management		10%			$200,000
Long-term MPA design and management		10%			$200,000
Subtotal		***20%***			***$400,000***
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring		10%			$200,000
Total Expenditure					***$2,005,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup implementation option Monitoring element is implemented via the Ecosystem Feature Assessment implementation option

$2M ANNUAL BUDGET – YEAR 3

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$200,000 - $275,000	All attributes & indicators; Multiple methods	$200,000 - $275,000	$275,000
Mid-depth Rock					
Rocky Intertidal	Medium	$90,000 - $125,000	All vital signs; Visual surveys	$90,000 - $125,000	$90,000
Soft-bottom Subtidal					
Soft-bottom Intertidal	Low	$90,000 - $135,000	All vital signs; Visual surveys	$90,000 - $135,000	$90,000
Estuarine & Wetland	Low	$180,000 - $285,000	All vital signs; Multiple methods	$180,000 - $285,000	$180,000
Nearshore Pelagic					
Consumptive Uses	High	$135,000 - $290,000	All vital signs; Existing data analysis	$135,000 - $290,000	$290,000
Non-consumptive Uses	Medium	$600,000 - $900,000	Level of activity; Survey program	$500,000 - $700,000	$500,000
Subtotal				***$1,335,000 - $1,945,000***	***$1,425,000***
Evaluating MPA Design & Management Questions		Budget allocation (%)			Allocated funding level
Short-term MPA management		10%			$200,000
Long-term MPA design and management		10%			$200,000
Subtotal		***20%***			***$400,000***
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring		5%			$100,000
Total Expenditure					***$1,925,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup implementation option Monitoring element is implemented via the Ecosystem Feature Assessment implementation option

$2M ANNUAL BUDGET – YEAR 4

Assessing Ecosystem Condition & Trends	Priorities	Estimated cost range for full implementation	Selected monitoring metrics; Selected method(s)	Estimated cost range of selected element(s)	Allocated funding level
Kelp & Shallow Rock	High	$200,000 - $275,000	All attributes and indicators; Multiple methods	$200,000 - $275,000	$275,000
Mid-depth Rock					
Rocky Intertidal	Medium	$75,000 - $125,000	All attributes & indicators; Visual surveys	$75,000 - $125,000	$75,000
Soft-bottom Subtidal					
Soft-bottom Intertidal					
Estuarine & Wetland					
Nearshore Pelagic					
Consumptive Uses	High	$1,325,000 - $2,025,000	Number of participants & level of activity; Survey program – commercial fisheries Survey program – recreational fisheries Survey program – costs and earnings	 $250,000 - $500,000 $250,000 - $350,000 $400,000 - $600,000	$900,000
Non-consumptive Uses	Medium	$600,000 - $900,000	Knowledge, Attitudes & Perceptions; Survey program	$100,000 - $150,000	$150,000
Subtotal				***$1,375,000 - $2,150,000***	***$1,400,000***
Evaluating MPA Design & Management questions		Budget allocation (%)			Allocated funding level
Short-term MPA management		10%			$200,000
Long-term MPA design and management		10%			$200,000
Subtotal		***20%***			***$400,000***
Research & Development		Budget allocation (%)			Allocated funding level
Advancing ecosystem monitoring		10%			$200,000
Total Expenditure					***$2,000,000***

Priority of monitoring elements funded for implementation. Priorities refer to prioritization within the full five-year funding cycle and not for each individual year.
Monitoring element is implemented via the Ecosystem Feature Checkup implementation option Monitoring element is implemented via the Ecosystem Feature Assessment implementation option

APPENDICES

APPENDIX A. POSSIBLE SUPPLEMENTAL MONITORING MODULES

Appendix A-1. Possible supplemental fisheries monitoring module

APPENDIX B. GUIDES TO MONITORING ECOSYSTEM FEATURE CONDITION AND TRENDS

Appendix B-1. Guide to the metrics (vital signs) of Ecosystem Feature Checkups

Appendix B-2. Guide to the metrics (attributes & indicators) of Ecosystem Feature Assessments

APPENDIX C. BACKGROUND AND REFERENCE MATERIALS

Appendix C-1. North Central Coast region map including the MPAs adopted by the California Fish & Game Commission

Appendix C-2. North Central Coast MPA Baseline Program Request for Proposals (RFP)

Appendix C-3. Summary Report from the North Central Coast MPA Monitoring Planning Workshop 1, October 22-23, 2008

Appendix C-4. Summary Report from the North Central Coast MPA Monitoring Planning Workshop 2, March 11-12, 2009

Appendix C-5. Summary of MPA Monitoring Framework additional technical comments

Appendix C-6. North Central Coast Regional Goals and Objectives and Site-level Objectives

Appendix C-7. List of Species Likely to Benefit from Marine Protected Areas in the North Central Coast Region

Appendix C-8. Levels of protection assigned to individual MPAs and the activities associated with each level of protection in the North Central Coast Region (H&L refers to hook & line fishing)

APPENDIX A. POSSIBLE SUPPLEMENTAL MONITORING MODULES

Monitoring of the North Central Coast regional MPA network must reflect many different ecological and socioeconomic aspects in order to meet the broad requirements of the MLPA. The monitoring framework and approaches thus adopt an ecosystem-based approach to provide a sufficiently broad umbrella to encompass habitats, marine life populations, socioeconomic trends, and recreational uses. This broad coverage is achieved through use of limited sets of strategically selected monitoring indicators and other metrics designed to track the condition and trends of ecosystems through time, and evaluate MPA design and management decisions. However, the approach also allows possible addition of supplemental monitoring of specific ecosystem elements, human activities, or pressures on the system, if necessary to respond to public interest or management priorities.

Such additional monitoring may be included in the monitoring framework as supplemental monitoring modules. These supplemental modules, if implemented under the umbrella of MPA monitoring, should be designed to complement and augment the main monitoring modules developed to track ecosystem condition and evaluate MPA design and management decisions. Most critically, any supplemental monitoring module should retain the focus on assessing MPA effectiveness in achieving MLPA goals and facilitating adaptive MPA management. This means that any supplemental modules should link, ultimately, to the Ecosystem Features, be designed to be directly applicable to MPA management needs and decisions and generate conclusive and robust findings suitable for informing management, and take advantage of appropriate partnerships. For ease and efficiency of implementation, supplemental monitoring modules should be designed to be scalable and should provide detailed information on the chosen topics, focusing on their relationship to MPAs.

Many different topics may be appropriate for supplemental monitoring modules, and this format offers opportunity to link MPA monitoring to other management mandates including water quality monitoring, invasive species monitoring, or particular resource management plans such as for abalone. We describe below one possible supplemental monitoring module - supplemental MPA-related fisheries monitoring - designed to reflect current priority issues and overlap with MLPA goals. The general format and approach can be applied to any other area or issue of interest.

The possible supplemental fisheries monitoring module focuses on presenting an approach, together with key considerations and assumptions, for developing a fully implementable supplemental monitoring module. The goal is to present a logical approach, or series of steps, to identify priority information needs, should implementation of this or other supplemental modules be desired.

APPENDIX A-1. POSSIBLE SUPPLEMENTAL FISHERIES MONITORING MODULE

INFORMING FISHERIES MANAGEMENT THROUGH MPA MONITORING

Although MPA monitoring and fisheries monitoring clearly overlap, there are fundamental differences reflecting the scope of monitoring and the ultimate information needs of the respective programs. As described above and elsewhere, the MPA monitoring framework focuses on ecosystem-based monitoring of individual MPAs, the regional MPA network, and the region itself. MPA monitoring seeks to determine the condition of, and trends, in overall ecosystem components as part of evaluating MPA effectiveness towards achieving MLPA goals.

In contrast, fisheries monitoring has traditionally focused on individual stocks of fished species and their status, or the status of fisheries targeting them. Thus, while MPA monitoring often takes a multi-species, place-based approach, focusing on individual MPAs and then scaling up to regional network effects, fisheries monitoring generally focuses on one or a few local target species populations and then scales up to broad regional populations or stocks. Both MPA monitoring and

fisheries monitoring may include information on changes in fishing locations and impacts to fishermen, although differences of scale between the two monitoring types typically remain.

Even so, the two types of monitoring are not mutually exclusive and should be designed to be mutually reinforcing. From the perspective of ecosystem-based MPA monitoring, fisheries data are critical for interpreting changes within MPAs over time as well as for allowing comparisons between MPAs and areas that continue to be fished. This is considered more fully in Chapter 3. Similarly, MPA monitoring will generate new, detailed data on the abundance and biology of many species targeted by fisheries. Information on relative abundances and size distributions of fishery species generated through MPA monitoring may be useful as inputs for population modeling by fishery scientists. Also, fisheries managers are now examining how population status of species within MPAs can be used to help estimate unfished abundance (B_0), recruitment rates, and other key fisheries information. For example, fishery scientists have begun exploring new ways to inform fishery managers of the status of fished populations, based upon differences in species density inside and outside MPAs. Further, MPAs provide a unique reference point for how ecosystems function in the absence of fishing as well as how recovery occurs within previously fished areas.

Many fisheries policies reference "ecosystem-based fishery management" (EBFM). Some of the underlying data needed to support EBFM may also be obtained through MPA monitoring, such as assessments of ecosystem condition. For example, the Marine Life Management Act (MLMA) requires conservation of the health and diversity of marine ecosystems and marine living resources.[1]

When considered together, MPA and fisheries monitoring programs can be developed to maximize the utility of data collected. The supplemental fisheries monitoring module presents an approach to developing and implementing additional fisheries monitoring that builds on, and takes maximum advantage of, the MPAs for informing fisheries management.

DEVELOPING POSSIBLE SUPPLEMENTAL FISHERIES MONITORING

To develop a supplemental fisheries monitoring module, we propose a three-tiered approach. This tiered approach is designed to create scalable implementation options, allowing the module to be tailored to available resources and capacity. The three implementation options range from basic implementation, most closely aligned with proposed MPA monitoring, to new programs and questions explicitly targeted toward priority fisheries questions, although still focused on the relationship between fisheries and MPAs:

- Tier 1. Existing fisheries indicators within the MPA monitoring framework
- Tier 2. Additional fisheries indicators that may be added to the existing MPA monitoring framework
- Tier 3. New framework elements and programs to address priority fisheries questions in relation to MPAs

ESTABLISHING PRIORITIES FOR POSSIBLE SUPPLEMENTAL FISHERIES MONITORING

In each of the three potential tiers of supplemental fisheries monitoring, a clear method for selecting among potential indicators and questions is required, taking into account many different considerations and criteria in developing priorities. The following criteria are provided to inform this decision-making process:

- Focus on MPA-relevant questions - Programs should be directed towards issues or questions that are reasonably tied to the establishment of MPAs. General fisheries questions that would not be expected to change with MPA implementation should not be considered consistent with this framework.

[1] California Marine Life Management Act, Statutes 1998, Chapter 1052, Fish and Game Code section 7050(b)(1).

- 'Fit' with existing framework - Certain species, species groups and habitats are already a focus of the MPA monitoring approaches, for example as focal species or indicators. Fisheries monitoring that focuses on these same indicators or species can be more readily linked to MPA monitoring data and analyses.
- Resource management priorities - Fisheries that are either at risk or currently high priorities for management change should be considered first. While any number of fisheries might be available for monitoring, the goal of this framework is to provide information that is most directly relevant to current fisheries management needs.
- Informative for existing regulatory frameworks - Certain fisheries information and questions are critical to other management, including the development of fisheries management plans pursuant to the MLMA[2]. Activities that are tied to the generation of essential fishery information necessary for high priority species within the MLMA Master Plan should receive high priority.[3]
- Policy relevance - The ability to inform decision makers, as with MPA monitoring, is a key consideration. Fisheries questions that can be answered in a timeframe useful to the adaptive management process should receive the highest priority. These questions should focus on areas of concern to management agencies and decision makers.
- Scientific merit and feasibility - As with the rest of this framework, monitoring should focus on questions that are both scientifically sound and feasible to implement within current budgetary and technical constraints.
- Leverage of existing programs through collaboration and partnerships - In the case of fisheries monitoring, a large number of programs exist that may be linked to this framework. Collaboration and partnership as well as capitalizing on existing efforts will help increase the cost/benefit ratio.
- Cost-efficiency - The most cost-effective methods available to generate results on useful timescales should be employed.

IMPLEMENTING POSSIBLE SUPPLEMENTAL FISHERIES MONITORING

Consistent with implementation of MPA monitoring, significant opportunity exists within California to link this module with other ongoing monitoring activities. There may be opportunities to involve stakeholders in supplemental fisheries monitoring, particularly where this fits with and extends methods developed for MPA monitoring, thus leveraging further available resources.

Most existing fisheries information comes from direct monitoring of commercial and recreational fisheries by the Department of Fish & Game and the National Marine Fisheries Service. Existing data can provide broad geographic information on fisheries catch, profitability, general locations, numbers of fishermen, and other details. Basic implementation of supplemental fisheries monitoring may be best achieved through augmenting methods developed for MPA monitoring. Additional data collection may also be feasible through collaborations and partnerships with other groups and individuals, particularly fisheries participants. For example, programs may be developed that increase the resolution of spatial data recording fishing locations. With appropriate training, fishermen can also provide detailed ecological information on catch, bycatch, and other indicators. In the case of recreational fisheries, fishing groups or individuals may provide location-specific fishing information. The most intensive implementation option presented for the supplemental fisheries monitoring module will require partnerships and collaborations with additional agencies and research institutions to implement new monitoring programs and/or new research projects.

[2] Additional information on the Marine Life Management Act is available at http://www.dfg.ca.gov/marine/mlma.
[3] The Master Plan: A Guide for the Development of Fishery Management Plans, as directed by the Marine Life Management Act of 1998. December 2001. See discussion of essential fishery information in Chapter 4 of that reference.

CANDIDATE SUPPLEMENTAL FISHERIES MONITORING PRIORITIES

The following fisheries monitoring recommendations present initial ideas that may form components of a program designed to answer priority fisheries management questions, focusing on relationships with MPAs and MPA monitoring. These candidate fisheries monitoring focuses have been developed using the three-tiered approach outlined above, and considering the criteria identified for establishing priorities. The information developed will also be useful for other fisheries management processes and will be available for analysis in a variety of contexts. Where new questions or management issues arise, these may be evaluated using this same approach, to further refine and maximize the utility of implemented fisheries monitoring.

For each section, potential focal topics or questions are identified through application of the proposed list of considerations and criteria, and examples of appropriate indicators or approaches are identified. The intent here is to describe the application of the approach and facilitate further development of this supplemental monitoring module, should implementation be desired

As with an ecosystem-based approach to MPA monitoring, understanding of ecosystem structure and function to support implementation of ecosystem-based fisheries monitoring (EBFM) is incomplete. The three implementation options focus on monitoring metrics and questions for which data can be feasibly collected and interpreted. However, it is also possible to identify information needs that may warrant further research and development to support EBFM. Research in support of supplemental fisheries monitoring could be designed to increase our understanding of concepts such as maximum food chain length, connectance, species richness and redundancy, and how these metrics may be applied to inform EBFM. Increased understanding of these concepts may be used in the future to refine the development and implementation of this supplemental monitoring module.

EXISTING FISHERIES INDICATORS WITHIN THE MPA MONITORING FRAMEWORK

Although the MPA monitoring framework adopts an ecosystems approach and includes indicators that contribute to ecosystem assessment and evaluation of MPA effectiveness, species and indicators are included that may also be informative for fisheries management. Indeed, monitoring metrics have been chosen that will benefit fisheries management as much as possible without compromising the ability to meet MLPA monitoring requirements. These include species or fisheries that are either high volume or high value in the North Central Coast region; that are recreationally or culturally important to the region; species that are of a key management focus; or those that are representative of the region's ecosystems. Such fisheries-informative elements of the existing monitoring plan occur within these monitoring plan components:

- Ecological indicators of ecosystem condition and trends - Many of the recommended ecological indicators are species and species groups that are targeted by commercial and recreational fisheries outside MPAs. Examples include lingcod, cabezon, red abalone, and red urchin, among others.
- Socioeconomic indicators of trends in consumptive use - In terms of fisheries activities, several of the metrics for assessing the Consumptive Uses Ecosystem Feature are directly tied to fisheries monitoring. These include the level of effort, catch, and economic return of several important commercial and recreational fisheries.
- MPA design and management questions – Several of the questions related to evaluation of MPA design and management decisions will be directly applicable to fisheries management decisions as well, if implemented. For instance, a potential short-term MPA management question includes examining the effects of crab fishing on benthic habitats and ecosystems within MPAs.

CANDIDATE FISHERIES INDICATORS TO ADD TO THE MPA MONITORING FRAMEWORK

Identification and prioritization of fisheries indicators to supplement, but fit within, the existing MPA monitoring framework, may usefully place an initial focus on local density, age and size differences inside and outside MPAs for key species. Key species, reflecting those of management and policy relevance, may include those listed within the Nearshore Fishery Management Plan[4] but not currently included in the MPA monitoring plan. Candidate species for inclusion based on these criteria include:

- Calico rockfish - *Sebastes dallii*
- Grass rockfish - *Sebastes rastrelliger*
- Olive rockfish - *Sebastes serranoides*
- Quillback rockfish - *Sebastes maliger*
- Treefish – *Sebastes serriceps*
- Rock greenling - *Hexagrammos lagocephalus*

CANDIDATE NEW FRAMEWORK ELEMENTS FOR FISHERIES MONITORING IN MPAS

The most intensive implementation option proposed for this supplemental fisheries monitoring module focuses on additional questions that may require new research or development of new methods. The following areas have been identified as candidate topics using the criteria above, and considering gaps in current knowledge regarding the interaction between MPAs and other fishery management tools. For each element, brief information is provided on what might be required to implement new supplemental monitoring.

FOCUS AREA 1 –MPA EFFECTS ON LOCAL FISHERIES

Information Need: Spatial patterns of fishing and catch, and consequences for effectiveness of fishery regulations.

- Question 1. Do MPAs concentrate fishery effort in particular areas and what effect does that have on the fish populations?
  Potential approach: Spatially explicit monitoring of fisheries activities through either logbooks, observers, vessel monitoring systems (VMS) or aerial monitoring programs.
- Question 2. Do MPAs cause serial depletion of species or geographic zones?
  Potential approach: Long-term monitoring of species abundances for individual fished species within specified zones.
- Question 3. Are there “edge effects”? (concentrated fishery activities along MPA boundaries)
  Potential approach: Spatially explicit monitoring of fisheries activities, including catch and CPUE, through logbooks or other fishery observation programs.

FOCUS AREA 2 – STOCK CONSEQUENCES OF PROTECTED SUB-POPULATION

Information Need: Adult and larval production within MPAs, and contribution to the local fishery through movement of adults and larvae from MPAs to fished areas outside MPAs.

- Question 1. Does spillover occur?
  Potential approach: Mark/recapture and sonic tagging combined with model approach/empirical data to link movement patterns to protected fish population.

[4] See http://www.dfg.ca.gov/marine/nfmp/index.asp.

- Question 2. Does spillover contribute to local fisheries?
  Potential approach: Mark/recapture and sonic tagging combined with model approach/empirical data to estimate mortality rates of fish from MPAs and contribution to total catch.
- Question 3. How does larval transport impact fisheries and fish stocks outside MPAs?
  Potential approach: This element would require the ability to track larval source and sink populations and identify the source of larvae found outside MPAs. New genetic, chemical, and other larval markers as well as oceanographic information would be needed.

Information Need: Contribution of nursery habitat protection within estuarine and shallow nearshore MPAs for key species stocks.

- Question 1. Do shallow nearshore and estuarine areas within MPAs produce greater numbers of new recruits in fished species?
  Potential approach: New methods to measure abundance of fished species in shallow nearshore habitats and estuaries and track the movements of those species to deeper areas.

Information Need: Contribution of protected adult population to stocks through increased production of young.

- Question 1. Are life-history traits (age structure, size at maturity, fecundity) different within MPAs?
  Potential approach: Long-term tracking of changes in life history traits over time inside and outside MPAs.
- Question 2. What is the spawning contribution of individuals within MPAs to areas outside?
  Potential approach: Answering this question requires the development of genetic or other markers to determine fine-scale spawning contributions to areas outside MPAs. This element may also be approached through a modeling framework.

FOCUS AREA 3 – EMERGING CONCEPTS TO SUPPORT ECOSYSTEM-BASED FISHERIES MANAGEMENT

Information Need: Research into ecosystem structure and function and the interaction with fisheries management measures to support application and use of ecosystem-based fisheries metrics.

- Question 1. What metrics can be used to characterize food webs and ecosystem structure, and how can these metrics be applied to support ecosystem-based fisheries management?
  Potential approach: Investigation of concepts including maximum food chain length, connectance, species richness, and species redundancy.
- Question 2. What metrics can be used to characterize ecosystem functioning, including species interactions, and how can these metrics be applied to support ecosystem-based fisheries management?
  Potential approach: Investigation of species behaviors, diet and stable isotopes to develop management-applicable metrics informative of ecological processes.

APPENDIX B. GUIDES TO MONITORING ECOSYSTEM FEATURE CONDITION AND TRENDS

B-1. GUIDE TO THE METRICS (VITAL SIGNS) OF ECOSYSTEM FEATURE CHECKUPS

As described in Chapter 4, Ecosystem Feature Checkup is an implementation option for tracking the condition and trends of Ecosystem Features, and is designed to facilitate community participation in monitoring. Vital signs are the monitoring metrics comprising an Ecosystem Feature Checkup. The following guide to the vital signs is provided to supplement the summary information listed in Chapter 4 for each Ecosystem Feature.

The vital signs have been separated into ecological and socioeconomic vital signs, and are listed in alphabetical order within each section. Each vital sign description includes a list of the Ecosystem Features to which it applies, a rationale for the selection of the vital sign, including the proposed contribution of the vital sign to a coarse assessment of ecosystem condition, and brief consideration of other factors that will influence the interpretation of vital signs information.

DESCRIPTIONS OF ECOLOGICAL VITAL SIGNS

VITAL SIGN: BLACK ABALONE ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Rocky Intertidal Ecosystems

Black abalone (*Haliotis cracherodii*) are rare within the North Central Coast region but previously played an important grazing role within rocky intertidal habitats. This species is typically observed under rocks and in crevices, from the high intertidal to 6 meters depth – higher in the intertidal than any other California abalone species. A recent ruling (January 13, 2009) by the National Marine Fisheries Service determined that black abalone should be listed as endangered under the Endangered Species Act.

Increases in the abundance of this species, together with the presence of juveniles and increased average size, are a reflection of improved ecosystem condition. However, interactions with other species, particularly otters, may affect observable population changes. Population trends are likely to reflect changing sea temperatures, and the increasing frequency of warm temperatures along the North Central Coast may also be leading to increased incidence and spread of withering foot disease in this species. Monitoring results will be interpreted considering oceanographic information and disease incidence reports to elucidate MPA-related changes in abundance and population size structure.

VITAL SIGN: BLACK OYSTERCATCHER ABUNDANCE

Ecosystem Feature: Rocky Intertidal Ecosystems

Rocky intertidal ecosystems provide an important foraging habitat for a range of resident and migratory predatory bird species. Among these, black oystercatchers (*Haematopus bachmani*) are permanent residents of rocky shores along almost the entire California coast and on adjacent islands, and are one of the most characteristic predatory bird species in this habitat. Populations of this species are highly dependent on nearshore resources including invertebrate prey (primarily mussels and limpets) in rocky intertidal zones and undisturbed, rocky open ocean shores for breeding. Oystercatcher abundance is therefore indicative of undisturbed sites with available prey.

Given current low population sizes in the North Central Coast region, ecosystem protection afforded through MPA designation may be predicted to increase the abundance of this species via forage base increases. However, responses to

MPA implementation are likely to be dependent on human access to, and disturbance of, rocky intertidal habitats. Monitoring will link analysis of non-consumptive uses and visitation with abundance information to separate the influence of humans from the potential effects of MPAs.

VITAL SIGN: BRANDT'S CORMORANT ABUNDANCE

Ecosystem Feature: Nearshore Pelagic Ecosystems

Brandt's Cormorants (*Phalacrocorax penicillatus*) are common marine birds that forage in bays and close to shore along the coast, particularly where kelp beds occur. The dominant component of their diet is small fish, particularly rockfish in California, and they breed on small, offshore islands and rocky slopes. Although generally wide ranging, colonies may benefit from local protection reducing disturbance during the breeding season and potentially increasing fledging rates. Longer-term increases in abundance may also reflect a stable and potentially increasing forage base. Annual fluctuations in both predator and prey populations will be interpreted in the context of broader oceanographic trends and fluctuations and will be used in region-wide assessments of Ecosystem Feature condition.

VITAL SIGN: CASSIN'S AUKLET BREEDING SUCCESS

Ecosystem Feature: Nearshore Pelagic Ecosystems

Populations and annual breeding success of many seabirds fluctuate annually in response to prey availability and prey quality. Hence, seabirds are frequently used as indicators of food web changes in marine ecosystems. Cassin's auklet (*Ptychoramphus aleuticus*) is a small diving seabird that feeds primarily on krill, mysids, and some larval fish. In the North Central Coast region, a significant breeding colony of this species occurs on Southeast Farallon Island. The Farallon auklet population has declined by ~6% per year over the last three decades and breeding success of this population has become increasingly variable. Indeed, the last decade has seen both the highest and lowest recorded breeding rates on record, including a year with complete breeding failure (2005).

This species has recently been chosen as a key biological indicator of climate change within California (http://www.oehha.org/multimedia/epic/climateindicators.html). The existing historical record establishes a robust baseline for this vital sign, and average number of offspring per year from each breeding pair is a reliable indicator of prey availability within the ecosystem during the summer breeding season. Given the large geographic scale over which forage fish and krill populations range, interpretation of this vital sign will focus on regional-scale trends in the Nearshore Pelagic Ecosystem Feature condition.

VITAL SIGN: CLAM ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Estuarine & Wetland Ecosystems

Within estuarine habitats, clams together with other shellfish form an important habitat for multiple species and play a particularly important role in the uptake and recycling of energy and nutrients. These filtering and recycling processes are critical in regulating ecosystem condition; uptake of organic matter can control phytoplankton levels, improve water clarity and allow greater light penetration for the growth of seagrasses.

In the North Central Coast region, recreational clamming is popular, especially in Bodega and Tomales Bays. Large catches have historically been recorded although changes in accessibility have recently limited take. Clamming includes common littleneck clams (*Protothaca staminea*), gaper clams (*Tresus nuttalli*) and occasionally geoduck clams (*Panopea abrupta*) at

very low negative tides. Reduced take following MPA implementation may lead to population increases in some areas. Monitoring clam abundances will provide insight into their role in maintaining ecosystem condition, and also offers the opportunity to track the interactions between recreational fishing (clamming) take and population sizes. Data interpretation will incorporate information on the spatial distribution of fishing mortality and fishery regulations.

VITAL SIGN: DUNGENESS CRAB ABUNDANCE

Ecosystem Features: Soft-bottom Subtidal Ecosystems

Dungeness crabs (*Cancer magister*) have a preference for sandy to sandy-mud benthic habitats but may be found on almost any benthic habitat type. This species is an important benthic predator, feeding on diverse prey species including clams, fish, isopods and amphipods. Dungeness crabs also serve as prey for octopus and many species of fish.

Declines in Dungeness crab catches in the central California fishery (including the North Central Coast region) during the late 1950s focused considerable research attention on this resource during the 1970s and 1980s and indicated strong correlations between population abundance and oceanographic conditions, especially water temperature. Monitoring crab numbers will provide useful insight into their role as predators within MPAs and also links to broader resource management. Data interpretation will consider information on the spatial distribution of fishing mortality and fishery regulations.

VITAL SIGN: DWARF ROCKFISH ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Mid-depth Rock Ecosystems

In rockfish communities, fishing disproportionately affects larger, slow growing and late maturing species. By comparison, the so-called dwarf rockfish (generally comprised in the North Central Coast region of halfbanded (*S.semicinctus*), pygmy (*S. wilsoni*), squarespot (*S. hopkinsi*), and stripetail (*S. saxicola*) rockfish are relatively unfished. These dwarf rockfish are important prey for the larger rockfish species and may also compete with juveniles of the larger, competitively dominant species for habitat and prey resources. Historically, competition and predation are likely to have constrained population densities of the dwarf species, except in sub-optimal habitats. Overfishing of the larger species has substantially reduced population densities and consequently reduced the predation and competition pressures on dwarf rockfish, which now dominate the rockfish community in some locations.

Trends in the relative abundance of dwarf rockfish at sites inside and outside of MPAs are indicative of shifting community structure in response to protection. This vital sign will thus provide useful insight into effects of MPAs that extend beyond single species responses.

VITAL SIGN: EELGRASS AREAL EXTENT

Ecosystem Feature: Estuarine & Wetland Ecosystems

In temperate marine ecosystems, loss of biogenic habitat (i.e., habitat formed by the growth and architecture of particular species) has contributed to declines in fish and invertebrate populations and loss of species diversity. In estuarine ecosystems in the North Central Coast region, habitat provisioning by eelgrass (*Zostera marina*) is critical to maintaining the ecological roles played by these estuaries as nursery and foraging habitats.

Although habitat quality may vary within eelgrass beds, the total area of eelgrass is a fundamental measure of habitat provisioning. Broad environmental changes including physical disturbance, poor water quality and high turbidity can result in loss of eelgrass habitat. In protected locations, increases in the areal extent of eelgrass have occurred where protection reduces physical habitat damage (for example, via a reduction in bottom contact fishing gear or propeller disturbance). In locations without existing physical damage, trends in eelgrass areal extent may be predicted to stay stable or increase only slowly as an indirect response to ecosystem protection.

VITAL SIGN: FLATFISH TOTAL ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Soft-bottom Subtidal Ecosystems

Halibut (described below) and starry flounder are both included as vital signs of soft-bottom subtidal ecosystems, reflecting their role as important predators as well as their contribution to commercial and recreational fisheries. The vital sign, total flatfish abundance, includes additional species such as Dover sole (*Microstomus pacificus*) and sanddab (*Citharichthys sordidus*), and provides a broader assessment of ecosystem productivity. Generally, increases in fish size, abundance and biomass are predicted following MPA implementation, however the timing and magnitude of responses are unknown. Data interpretation will consider information on the spatial distribution of fishing mortality, and will be primarily used in region-wide evaluations of Ecosystem Feature condition.

VITAL SIGN: HALIBUT ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Soft-bottom Subtidal Ecosystems

Many of the same ecological principles that structure rocky habitats may also apply within soft-sediment habitats. In rocky habitats, community structure is largely driven by a combination of bottom-up and top-down regulation by production and predation respectively. In soft-bottom subtidal ecosystems within the North Central Coast region, halibut (*Paralichthys californicus*) are an abundant benthic predator. Adults feed largely on Pacific sardine, northern anchovy, squid and other nearshore nektonic fishes. Shallow subtidal waters are also an important juvenile habitat. Halibut also represent a significant proportion of the commercial and recreational fishery in the region. As with many other fish species, average fish size and population abundance may be expected to increase in response to MPA implementation, however the magnitude and timing of responses are unknown. As with the vital sign above, data interpretation will consider information on the spatial distribution of fishing mortality, and will be primarily used in region-wide evaluations of Ecosystem Feature condition.

VITAL SIGN: HARBOR SEAL ABUNDANCE (COLONY SIZE)

Ecosystem Features: Rocky Intertidal Ecosystems, Estuarine & Wetland Ecosystems, Soft-bottom Intertidal & Beach Ecosystems

Harbor seals are important apex predators feeding on a diverse range of fish and invertebrates in nearshore waters, including herring, anchovies, sardines, hake, flounder, sole, octopus, squid and crabs. Abundances of this species declined early in the century but have since stabilized. However, harbor seals spend approximately half of the time on land at haulout sites, rendering them vulnerable to human disturbance. In the North Central Coast region, harbor seal haulout sites are widely distributed along the mainland and on offshore islands in estuarine habitats, intertidal sand bars, rocky shores and beaches. Individuals haulout on land for rest, thermal regulation, social interaction and to give birth. Haulout sites thus

offer an opportunity to conduct local sub-population assessments. Interpretation of data on this vital sign will consider additional information including evidence of disturbance as well as oceanographic data.

VITAL SIGN: LINGCOD ABUNDANCE & SIZE FREQUENCY

Ecosystem Features: Kelp & Shallow Rock Ecosystems, Mid-depth Rock Ecosystems

Loss of predators is a frequent indicator of declining ecosystem condition. In rocky habitats, piscivorous fish play a key role in regulating populations of species lower in the food chain and consequently are key drivers of community structure. Lingcod (*Ophiodon elongatus)*, which occupy shallow and deep rocky reefs in the North Central Coast region, are important predators, feeding on demersal fishes, squid, octopi and crabs. Declining lingcod catches since the 1970s suggest population declines in this region although recent fishery designations list populations as recovered.

Several life history characteristics of lingcod render the species a valuable choice for a vital sign of increasing predator abundance within shallow and mid-depth rock habitats. Increased fish size and abundance in response to MPA implementation are most frequently observed in fished species, and particularly in relatively sedentary species. Lingcod are an important recreational and commercial catch within the region. They also occupy relatively small home ranges (~1500 to 2500 m^2) and actively guard egg nests spawned on shallow rocky reefs. Existing evidence suggests that lingcod populations may respond rapidly to protection (within 5-10 years), although this may reflect movement of individuals into MPAs as well as decreased mortality of adult fish. Data interpretation will consider information on the spatial distribution of fishing catch.

VITAL SIGN: MARINE BIRDS DIVERSITY & ABUNDANCE

Ecosystem Feature: Estuarine & Wetland Ecosystems, Soft-bottom Intertidal & Beach Ecosystems

Coastal bays, estuaries and beaches in the North Central Coast region are an important part of the Pacific Flyway and host thousands of migrating shorebirds annually. In addition, several of the estuaries in the region are important foraging and nesting areas for resident bird populations. Marine seabirds are also an important component of the pelagic ecosystem. Piscivorous birds and shorebirds across all these habitats forage on a wide range of fish and invertebrate prey. Increased total abundance and diversity of these bird species can therefore be indicative of an abundant and diverse prey population.

Monitoring may be focused on colony abundances as well as on-water foraging abundances. Implementation of this vital sign will require additional specificity regarding appropriate species to include within the diversity and abundance measures. Additional data from the region may also support using particular species as a vital sign of ecosystem condition across or within different habitats. Information from the North Central Coast MPA Baseline Program projects will be used to refine this indicator for implementation.

VITAL SIGN: MUD & GHOST SHRIMP ABUNDANCE

Ecosystem Feature: Estuarine & Wetland Ecosystems

Mud shrimp and ghost shrimp play an important ecological role in estuarine environments, filtering large volumes of water as they forage for planktonic food. These species themselves are also important prey for many different birds and fish.

Although relatively simple methods exist to monitor local abundances, interpretation of this information is more challenging and likely to reflect a broad array of environmental factors. Although mud shrimp were historically the dominant species in estuaries in the region, populations have recently been decimated by an invasive parasitic isopod.

Additionally ghost shrimp are harvested in the region as bait, and continuance of this activity is permitted within some of the adopted State Marine Conservation Areas. To interpret trends in abundance, information on these broader influences will be considered in analyses of monitoring results.

VITAL SIGN: MUSSEL BED COVER

Ecosystem Feature: Rocky Intertidal Ecosystems

A suite of different species plays a key role in rocky intertidal ecosystems as biogenic habitat, offering refuge from predators and exposure while increasing rugosity and space. Intertidal biogenic habitats are thus critical in regulating community structure and food web dynamics. Among these species, mussels (*Mytilus* spp.) are common in the mid- to lower intertidal, where they often dominate the substrate in wave exposed areas. Mussels provide habitat for many invertebrate species and are prey for seastars, birds and mammals.

Unlike many subtidal ecosystems, biogenic habitats in the rocky intertidal, including mussels, may directly respond to MPA designation if implementation results in increased or decreased human disturbance such as trampling or harvesting. However, these potential MPA effects will also occur in the context of natural variations in population sizes and complex patch dynamics. Analyses of monitoring results will include assessment of effects at a range of spatial scales to separate potential MPA effects from broader temporal dynamics.

VITAL SIGN: OCHRE SEA STAR ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Rocky Intertidal Ecosystems

Ochre sea stars (*Pisaster ochraceus*) are common in intertidal habitats, occurring in the mid- to low-intertidal throughout California, especially in exposed locations with high mussel (*Mytilus* spp.) growth. In a now classic experiment, ecologist Robert Paine demonstrated that the ochre sea star plays an important role in maintaining species diversity within mussel-dominated intertidal habitats. Although subsequent experiments have demonstrated that the strength of this keystone predator effect varies according to the hydrographic regime influencing mussel recruitment and abundance, sea stars remain an appropriate vital sign of a functioning ecological community within this habitat.

VITAL SIGN: OWL LIMPET ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Rocky Intertidal Ecosystems

Owl limpets (*Lottia gigantea*) are distributed throughout California, occurring in the mid- to high-intertidal zones, on cliff faces and rocks of wave-exposed shores. Females maintain territories on rocks by grazing or bulldozing other competitors such as mussels and barnacles for rock space. This species thus plays an important ecological role, clearing space and promoting algal growth, and is a valuable vital sign of ecosystem function.

Owl limpets can live as long as 50 years and have a short pelagic larval duration (< 1 week). MPA implementation may therefore be predicted to lead to localized increases in abundance. Such strong local effects of protection have previously been demonstrated within longstanding protected areas in southern California. However this species is also sensitive to trampling disturbance, which may also affect observed abundances. Owl limpets are sequential hermaphrodites, beginning life as males and then switching to females as they become older and larger. Collection of this species frequently targets the largest individuals within the populations, mostly females. As a result, populations may become dominated by smaller males, skewing the gender ratio and decreasing reproductive capacity. Interpretation of monitoring results will include

information on trampling and collection, in part, through links to the Non-consumptive and Consumptive Uses monitoring results.

VITAL SIGN: PELAGIC CORMORANT ABUNDANCE

Ecosystem Feature: Nearshore Pelagic Ecosystems

Exclusively marine, pelagic cormorants (*Phalacrocorax pelagicus*) are common resident birds that forage in bays and estuaries and close to shore along the coast. The dominant component of their diet is small fish together with crustaceans and other marine animals, and they breed on small, offshore islands and rocky cliffs with deep water at the base. Although generally wide ranging, colonies may benefit from local protection reducing disturbance during the breeding season and potentially increasing fledging rates. Longer-term increases in abundance may also reflect a stable and potentially increasing forage base, although annual fluctuations in both predator and prey populations will be interpreted in the context of broader oceanographic trends and fluctuations. Trends in abundance of this species will primarily be used in region-wide evaluations of Ecosystem Feature condition.

VITAL SIGN: PIGEON GUILLEMOT ABUNDANCE

Ecosystem Feature: Nearshore Pelagic Ecosystems

Pigeon guillemots (*Cepphus columba*) are found along rocky shores and in inshore waters along the Pacific coast from Alaska to California. In the water, they are usually close to rocky shorelines where the water is 30-90 feet deep, and they dive for sculpins, sand lance, and smelt. They also feed in kelp beds and in waters near spits and jetties. During the breeding season, they can be found on rocky islands and mainland cliffs that are protected from predators, as well as on a variety of man-made structures. Breeding individuals return to their natal breeding groups and are typically dispersed across cliffs. While nesting, pigeon guillemots are sensitive to local disturbance. Local protection may feasibly reduce or increase disturbance via human visitation to nearshore environments and this may be revealed in fluctuating fledging rates. Monitoring will be structured to facilitate integrated analyses of population abundance and data from monitoring of the Non-Consumptive Uses Ecosystem Feature, including visitation rates.

VITAL SIGN: PURPLE SEA URCHIN ABUNDANCE & SIZE FREQUENCY

Ecosystem Features: Kelp & Shallow Rock Ecosystems, Rocky Intertidal Ecosystems

Purple sea urchins (*Strongylocentrotus purpuratus*) are the most abundant sea urchin in rocky intertidal habitats along the California coast, although they also occur in subtidal habitats. Like the red sea urchin, this species is an important grazer, feeding on drift algae and kelp. In intertidal habitats in the North Central Coast, this species also plays an important role as a bioeroder, boring holes into the rock.

Trends in abundance of purple sea urchins are likely to reflect a complex interplay between ecological interactions and oceanographic conditions. Recruitment pulses are sporadic and unpredictable, owing partly to changing currents, and shifting ocean temperatures have a strong influence on kelp productivity and growth, indirectly influencing urchin populations. Monitoring results will be interpreted using additional oceanographic information as well as the vital signs data from monitoring the Kelp & Shallow Rock Ecosystem Feature.

VITAL SIGN: RED ABALONE ABUNDANCE & SIZE FREQUENCY

Ecosystem Features: Kelp & Shallow Rock Ecosystems, Rocky Intertidal Ecosystems

Red abalone (*Haliotis rufescens*) are important herbivores and detritivores within kelp and shallow rock and intertidal ecosystems, and also serve as important prey items for a range of other fish and invertebrates. Red abalone are one of five abalone species in California (along with pink, white, green and black abalone) that have experienced significant population declines in the last century. Today, a significant recreational fishery exists for red abalone in the North Central Coast region. Red abalone abundance inside and outside MPAs is a vital sign of both ecosystem condition and also the potential future viability of the recreational fishery.

The pelagic larval duration of red abalone is only a few days and larvae typically disperse only short distances. Thus, changes in the abundance and size structure of local populations are predicted to occur in response to MPA implementation. However, over longer time periods, population trends may also reflect changing sea temperatures. During El Niño periods, reductions in growth and decreases in settlement and recruitment have been observed. Some evidence indicates that increasing frequency of warm temperatures along the North Central Coast may also be leading to increased incidence and spread of withering foot disease. Trends in abalone abundance will be interpreted in the context of information on sea temperatures and trends in the recreational fishery take.

VITAL SIGN: RED SEA URCHIN ABUNDANCE & SIZE FREQUENCY

Ecosystem Feature: Kelp & Shallow Rock Ecosystems

Red sea urchins (*Strongylocentrotus franciscanus*) are the most abundant sea urchin species in kelp and shallow rocky subtidal habitats along the California coast. This species is an important grazer feeding on drift algae and bull kelp. A delicate balance between sea urchin grazing and kelp forest productivity leads to stable states that alternate between species-rich kelp forests and relatively species-depauperate sea-urchin barrens. Swings between these states have been particularly observed in southern California and may be less likely in more northern areas.

In the 1980s, landings of red sea urchins rose as high as 30 million pounds annually, but have since steeply declined. Trends in abundance of this species are likely to reflect a complex interplay between ecological interactions, including competition with red abalone and predation by sea otters (assuming further northern range expansion), and oceanographic conditions affecting recruitment and fishing intensity. These factors will be considered in analysis of vital signs data.

VITAL SIGN: ROCKFISH AVERAGE & MAXIMUM SIZE

Ecosystem Features: Kelp & Shallow Rock Ecosystems, Mid-depth Rock Ecosystems

Removal of individuals from fish populations has led to the decline in average size of many reef-associated fishes. However, MPAs generally lead to increases in the size and local density of protected fish populations. Fish size in particular is expected to change in response to protection more rapidly than other population characteristics (such as density), as fewer individuals are removed from the population and more individuals survive to larger sizes. Ecologically, increasing individual size within fish populations is an important vital sign of ecosystem condition. For individual species, larger females are typically more fecund and contribute to increased production of juvenile individuals. At the ecosystem scale, shifts in the diet of larger individuals can contribute to the restoration of previously observed predator-prey relationships. Increasing evidence suggests that such relationships are an important determinant of trophic and ecosystem stability.

In the North Central Coast region, rockfish (*Sebastes* spp.) are both an ecologically important species group as well as an important fishery resource. Individual species differ in their life history characteristics, however rockfish are typically long-lived and slow-growing species. Model predictions suggest that population recovery of these species is likely to take many decades. However, existing data indicate that fish size differences inside and outside MPAs may be detectable within 5-10 years. Implementation of this vital sign will require some additional specification of comparable species for inclusion and will most usefully focus on trends within a sampling location rather than differences between locations, which will be confounded by differing species assemblages between locations. Data from the North Central Coast MPA Baseline Program will be analyzed to refine this vital sign for implementation.

VITAL SIGN: ROCK CRAB ABUNDANCE & SIZE FREQUENCY

Ecosystem Features: Mid-depth Rock Ecosystems

Three species of rock crab occur in the North Central Coast region: yellow (*Cancer anthonyi*), brown (*C. antennarius*) and red (*C. productus*) although brown and red are more abundant in the region and show a greater association with rocky substrate. Rock crabs are both predators and scavengers feeding on a wide range of other invertebrates. As juveniles they are also preyed upon by fish including cabezon and several rockfish species. Monitoring rock crab numbers will provide useful insight into the trophic structure of deep reefs within MPAs. By comparison to Dungeness crab, rock crabs do not appear to migrate or to undertake large-scale movements. Effects of MPA implementation may therefore be observable in changes in local population densities. Data interpretation will also consider information on the spatial distribution of fishing mortality and fishery regulations, although the commercial and recreational fishery for this species is small in this region and typically focused on shallower habitats.

VITAL SIGN: SAND CRAB ABUNDANCE

Ecosystem Feature: Soft-bottom Intertidal & Beach Ecosystems

Sand crabs (*Emerita analoga*) are common beach residents through the North Central Coast region. Sand crab abundance may indicate a beach with sufficient nutrient input, and the size of beach populations has previously been related to the richness of inshore waters. This species forms an important link within the food web in beach habitats as prey for a diverse range of fish, birds and mammals.

Populations are generally robust, though they fluctuate annually depending on oceanic and climatic conditions. More importantly populations naturally vary between beaches, thus trends through time offer the greatest insight into changing ecosystem condition inside and outside MPAs.

VITAL SIGN: SEMI-PELAGIC/PELAGIC ROCKFISH AVERAGE & MAXIMUM SIZE

Ecosystem Feature: Nearshore Pelagic Ecosystems

As with the 'rockfish average & maximum size' vital sign within Kelp & Shallow Rock and Mid-depth Rock ecosystems, semi-pelagic and pelagic rockfish size in pelagic environments offers insight into ecosystem condition and the effects of MPA implementation. Pelagic or semi-pelagic species in the North Central Coast region include widow (*Sebastes entomelas*), yellowtail (*S. flavidus*), blue (*S. mystinus*) and shortbelly (*S. jordani*) rockfish. The most effective mechanism to target comparable species across locations is likely to be employment of a consistent fishing methodology that can effectively

sample fish in the water column. Given variable fish community structure between locations, change through time offers the strongest insight into the effects of MPA implementation.

VITAL SIGN: STARRY FLOUNDER ABUNDANCE & SIZE FREQUENCY

Ecosystem Features: Soft-bottom Subtidal Ecosystems, Estuarine & Wetland Ecosystems

Starry flounder (*Platichthys stellatus*) are probably the most easily recognizable of California's flatfishes (the dorsal and anal fins are prominently marked with alternating yellow or orange and dark bars, and the body is rough due to modified star-shaped scales) and are thus ideal for community monitoring programs. They are one of the most common fishes in bays and estuaries and are tolerant of brackish and even fresh water. Starry flounders consume a diverse range of prey items including crabs, polychaete worms, sand dollars, brittle stars and fish. Juveniles are prey to wading and diving seabirds such as herons and cormorants, as well as to marine mammals including harbor seals.

In the North Central Coast region, starry flounders are one of the most abundant flatfishes in estuaries north of San Francisco Bay, although they are also distributed in deeper soft-bottom habitats. Though seldom targeted, this species has been taken by commercial fishers seeking more economically valuable species such as petrale sole or California halibut. The recreational catch of starry flounders is from piers, boats, and shore, usually in estuarine and adjacent coastal waters.

Juvenile starry flounder exclusively inhabit estuaries and abundances are negatively affected by declining water quality resulting from the loss of wetland habitat and associated land-use changes surrounding estuarine habitats. Water quality information will be used to interpret trends in juvenile abundance in estuaries in the region. Trends in adult abundance following MPA implementation will also reflect a combination of changing fishing pressure and oceanographic conditions and this contextual information will be considered in analyses of these data.

DESCRIPTIONS OF SOCIOECONOMIC AND HUMAN-USE VITAL SIGNS

VITAL SIGNS: LANDINGS (WEIGHT & VALUE) OF KEY SPECIES PER FISHING BLOCK & PORT FOR THE COMMERCIAL FISHERY

Ecosystem Feature: Consumptive Uses

Commercial fishing contributes significantly to coastal community economies in the North Central Coast region, particularly the dominant fishing ports including Point Arena, Bodega Bay, San Francisco and Princeton/Half Moon Bay. Over the last 14 years, average annual landings in the study region totaled nearly 17 million pounds and included multiple fisheries.

Numbers of fishing vessels, trips and landings of key species illustrate the intensity of fishing efforts. This information is currently collected by the Department of Fish & Game through landing receipts. This information provides a valuable historical baseline from which to measure changing Ecosystem Feature condition. Species that are an important component of the fishery, play key ecological roles and are likely to respond to MPAs are the most informative for MPA monitoring. These include nearshore rockfish, Dungeness crab, red urchin and California halibut. Currently collected information has only broad spatial resolution and interpretation will focus on fishing block and port information. Interpretation of trends in commercial fishery landings will consider additional ecological and economic information including changes in fisheries regulations, economic indices and climate and oceanographic trends, and will primarily contribute to region-wide evaluations of Ecosystem Feature condition.

VITAL SIGNS: LANDINGS (NUMBER & WEIGHT) OF KEY SPECIES PER PORT BY COMMERCIAL PASSENGER FISHING VESSELS (CPFVS)

Ecosystem Feature: Consumptive Uses

CPFVs – Commercial Passenger Fishing Vessels, also called party boats – are an important component of consumptive use within the North Central Coast region. Comparable to landings from commercial operators, angler numbers and landings from CPFVs coarsely illustrate the intensity of fishing effort. Key species groups for monitoring include the rockfish/lingcod complex and California halibut. This information is currently collected as part of the Department of Fish & Game CPFV logbook program and the California Recreational Fisheries Survey (CRFS). In both cases the spatial resolution in the data limits detection of individual MPA effects. Landings will therefore be used in region-wide evaluations of Ecosystem Feature condition.

VITAL SIGN: NUMBER OF ABALONE HARVESTED

Ecosystem Feature: Consumptive Uses

Red abalone are recreationally harvested in intertidal areas during negative low tides or while free diving. This fishery provides important economic input into many coastal communities. During the abalone season, nearly every accessible cove in Sonoma and Mendocino counties, where effort is greatest, may experience harvesting. The annual abalone harvest coarsely illustrates the status of the recreational fishery and, where feasible, will be interpreted in the context of trends in abalone abundance (a vital sign of the Kelp & Shallow Rock Ecosystem Feature). Currently, information is collected via abalone report cards submitted to the Department of Fish & Game, and this information provides a valuable baseline to interpret potential future changes in harvest levels.

VITAL SIGN: NUMBER OF BOAT-BASED WILDLIFE VIEWING TRIPS AND VISITORS PER PORT AND VIEWING LOCATIONS

Ecosystem Feature: Non-consumptive Uses

Vital signs monitoring of the level of boat-based wildlife viewing trips is important for tracking trends in recreational use, and the data also provide important insight into MPA management questions such as disturbance effects of visitors on nesting bird colonies. Interpretation of trends in boat trips will take into account the effects of broader economic indices.

VITAL SIGN: NUMBER OF DIVING TRIPS AND DIVERS PER ACCESS POINT AND DIVE SITE

Ecosystem Feature: Non-consumptive Uses

Scuba diving is a popular non-consumptive recreational activity within the North Central Coast region, particularly in Sonoma and Mendocino counties. Annual numbers of divers to specific locations provides insight into this level of recreational use and also may be used to coarsely infer potential economic benefits to coastal communities. Interpretation of trends in diver numbers will take into account broader economic indices.

VITAL SIGN: NUMBER OF SHORELINE WILDLIFE VIEWERS IN ESTUARINE, WETLAND AND BEACH ECOSYSTEMS

Ecosystem Feature: Non-consumptive Uses

Shore-based wildlife viewing is distinguished here from tidepooling and encompasses bird and mammal viewing (e.g., harbor seal haulouts) along rocky shores, beaches and estuaries. Long-term trends in this vital sign provide insight into levels of recreational use as well as ecosystem condition. This information will also be used in integrated analyses with ecological vital signs (e.g., harbor seal abundance), where feasible, to monitor the potential disturbance effects of visitation.

VITAL SIGN: NUMBER OF VISITORS TO ROCKY INTERTIDAL ECOSYSTEMS FOR TIDEPOOLING

Ecosystem Feature: Non-consumptive Uses

Tracking numbers of visitors to rocky shores is important for monitoring recreational use within and outside MPAs, and also provides important insight into MPA management issues concerned with potential ecological damage caused by trampling within these habitats. Interpretation of trends in visitation will consider additional influences such as seasonality and access.

B-2. GUIDE TO THE METRICS (ATTRIBUTES & INDICATORS) OF ECOSYSTEM FEATURE ASSESSMENT

As described in Chapter 4, Ecosystem Feature Assessment is included in the monitoring plan as an implementation option for tracking the condition and trends of Ecosystem Features. Key attributes are identified as important ecosystem aspects required to maintain a functioning ecosystem through time. Each key attribute is assessed using three to five indicators or, where appropriate, focal species that collectively provide an indication of the condition and trends of the attribute. The following guide to the attributes and indicators is provided to supplement the summary information listed for each Ecosystem Feature in Chapter 4.

The key attribute and indicator descriptions include an overarching rationale for the collective set of attributes, rationale for selection of each individual attribute, and a brief consideration of other factors that will influence the interpretation of trends in attributes and indicators. As in Chapter 4, a set of attributes is provided to conduct an Ecosystem Feature Assessment. This set is considered adequate to collectively assess the condition and trends of the Feature, and comparably feasible to implement and interpret. Optional add-ons are also included. This information may provide additional insights, but the metrics are more difficult or expensive to implement, and more challenging to interpret. Thus these optional supplemental metrics should be added to monitoring only if or to the extent that resources permit, and used in addition to the set of Ecosystem Assessment metrics.

KELP & SHALLOW (0-30M) ROCK ECOSYSTEMS

The collective set of key attributes identified for the Kelp and Shallow Rock Ecosystem Feature has been chosen to capture the breadth of ecosystem structure, function and landscape context necessary to track the condition and trends of this Ecosystem Feature. The architecture formed by kelp growth, where it occurs, creates foraging and nursery habitat (i.e., biogenic habitat) for many of the other species found in these environments. The remaining key attributes identify critical components of the food web and trophic structure associated with kelp and shallow rock ecosystems. Integrated analyses of changes in attributes will provide insight into ecosystem changes following MPA implementation, taking into account ecological interactions and relationships among species in this ecosystem.

ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT: MACROALGAL ASSEMBLAGE

Focal Species/Indicators:

- Areal extent of surface kelp canopy (*Macrocystis pyrifera* & *Nereocystis leutkeana*)
- Kelp stipe density & size structure

Canopy-forming kelp species (*Macrocystis pyrifera* and *Nereocystis leutkeana*) are primary producers and provide habitat by serving as surface area for sessile organisms and refuges for young fish. This habitat provisioning role is therefore important for structuring the food web within the ecosystem. Both the total extent of surface canopy, as well as the characteristics, particularly area and density, of the kelp beds affect the species assemblages found in this habitat. Trends in kelp bed characteristics thus provide insight into ecosystem condition and also provide important information to interpret trends in fish and invertebrate populations. Kelp populations fluctuate seasonally and inter-annually depending on oceanographic conditions as well as herbivore pressure. Interpretation of trends in kelp cover will therefore consider additional information about physical drivers of this system, including temperature and swell heights.

STRONG ECOLOGICAL INTERACTORS: INVERTEBRATES

Focal Species/Indicators:

- Purple sea urchin (*Strongylocentrotus purpuratus*) density & size structure
- Red sea urchin (*Strongylocentrotus franciscanus*) density & size structure
- Red abalone (*Haliotis rufescens*) density & size structure
- Sea star (*Pisaster/Pycnopodia* spp.) density & size structure

In kelp and shallow rock ecosystems, many of the most abundant invertebrates play key roles as herbivores and detritivores within the food web. Strong ecological interactors are individual species that play these key roles and are functionally important within the ecosystem. Measures of detritivore abundance are indicative of the ability of the system to use internally generated detritus as well as to capture the energy and nutrients provided by the influx of detritus from outside the system. Similarly, measures of herbivore abundance are indicative of the extent to which primary production is made available to higher trophic levels. Some invertebrates (e.g., *Pisaster* spp.) also occupy functional niches at higher trophic levels and their presence indicates a functioning food web with a prey base that can support predatory species.

Collectively, the focal species encompass a range of functional roles played by the most abundant invertebrates in kelp and shallow rock ecosystems. Integrated analyses incorporating kelp and predator data will provide insight into the mechanisms of ecosystem change following MPA implementation, taking ecological interactions into account. Both red sea urchins and red abalone are also a component of the recreational fishery in the North Central Coast region. Increases in the local abundance of these species following MPA implementation may thus be expected to occur relatively rapidly (possibly within five years). Monitoring over longer time periods may also reveal changing population size structure as larger individuals are no longer removed from the population.

PREDATORS: PISCIVOROUS FISHES

Focal Species/Indicators:

- Black rockfish (*Sebastes melanops*) density & size structure
- Lingcod (*Ophiodon elongatus*) density & size structure
- Cabezon (*Scorpaenichthys marmoratus*) density & size structure

The piscivorous fish guild within kelp and shallow rock ecosystems encompasses a wide range of species that feed at multiple levels within the food web. However, in general, increased abundance of these higher level predators is indicative of the presence and functioning of multiple lower trophic levels. Monitoring piscivore populations also provides insight into energy inputs into this ecosystem from the pelagic environment as predatory fish consume transient coastal pelagic planktivores (e.g., sardines, jacksmelt). Within kelp ecosystems, piscivorous fish may also play key ecological roles in moderating food web structure through top-down control.

The focal species encompass a broad range of life history characteristics and prior levels of take. Existing evidence suggests that relatively sedentary fished predators, such as lingcod, may respond rapidly to MPA implementation, potentially within five years. Fish size in particular is expected to change in response to protection more rapidly than other population characteristics (such as density), as fewer large individuals are removed from the population. However, model predictions suggest that population recovery of many of the long-lived and slow growing species is likely to take many years. Long-term tracking of kelp and shallow rock ecosystems will be required to assess these potential MPA effects.

TROPHIC STRUCTURE: PLANKTIVOROUS FISHES

Focal species/Indicators:

- Blue rockfish (*Sebastes mystinus*) density & size structure

Measures of planktivore abundance and size structure are indicative of the ability of the system to capture nutrients provided by the influx of plankton. Some insight into this ecological process will likely also be garnered through monitoring of juvenile fish from other functional groups. Monitoring this key attribute thus provides important insight into a key component of the food web within this ecosystem. In the North Central Coast region, blue rockfish are one of the most abundant planktivorous species and provide insight into this functional group of fishes.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT

Focal Species/Indicators:

- Sub-canopy & turf algae cover
- Compound tunicate (multiple species) cover
- Diversity of habitat-forming species

The percent cover of sub-canopy and turf algal species may be especially important in providing habitat in areas with no top canopy (e.g., south of the Russian River). Sub-canopy and turf algae may also be relatively more important habitat-forming species in places where *N. leutkeana* is the canopy forming species, because *N. leutkeana* holdfasts are very small and do not provide as much structuring habitat as *M. pyrifera*. In addition, compound tunicates are also dominant space-holders in some locations and provide important biogenic habitat. Similar to the rationale and expectations for kelp, direct effects with MPA designation may not occur, but knowledge of the relative percent cover of sub-canopy, turf, tunicates and bare rock among others will be important for interpreting trends in other species. Habitat diversity measures, in particular, require detailed survey efforts and thus this information may be added to kelp and shallow rock monitoring where resources permit.

TROPHIC STRUCTURE: OMNIVOROUS FISHES

Focal species/Indicators:

- Black & yellow rockfish (*Sebastes chrysomelas*) density & size structure
- Gopher rockfish (*Sebastes carnatus*) density & size structure
- Kelp rockfish (*Sebastes atrovirens*) density & size structure
- Brown rockfish (*Sebastes auriculatus*) density & size structure
- Kelp greenling (*Hexagrammos decagrammus*) density & size structure

Among the functional fish guilds within kelp and shallow rock ecosystems, many species are omnivores, consuming a wide range of prey items. These species thus play important roles at multiple levels within a complex, functioning food web. Collectively, the selected focal species encompass species with varying life history characteristics and varying levels of recreational and commercial fishing to provide maximum insight into this functional group. Individual species are likely to vary in the magnitude and timing of response to local protection. As a group, increasing abundance of omnivorous fish is

predicted to result from MPA implementation. However, trends in these species are often the result of a wide range of drivers including biological interactions and physical processes. Monitoring these species will add greater insight into the mechanisms underlying potential MPA effects where survey efforts can include this additional information.

TROPHIC STRUCTURE: UNFISHED FISHES

Focal species/Indicators:

- Painted greenling (*Oxylebius pictus*) density & size structure

Unfished species are a key component of any marine ecosystem and often receive little attention. Many unfished species provide a critical prey base while others compete with fished species for similar resources.

The effects of trophic cascades may be best detected in unfished species. Many unfished species are also affected by changes in fishing pressure. For example, removal of larger piscivores may reduce competition and predation on juveniles, allowing for an increase in the abundance of unfished fishes. Since many fished species are predators, the effects of restoring predatory populations on multiple other trophic levels may be seen in trends in unfished species populations. Understanding the abundance of unfished species and interaction with fished species thus provides insight into community structure, functioning and recovery but requires detailed information to correctly interpret and analyze results. The abundance of unfished species in the North Central Coast region is also relatively unknown and focal species will be refined in accordance with the results of the NCC MPA Baseline Program. Some insights may be garnered through examination of trends in young (sub-legal sized) fished species such lingcod or rockfish.

DIVERSITY

Focal species/Indicators:

- Species richness (fish & invertebrates)
- Species diversity (functional groups of fish & invertebrates)

Direct measurements of species richness and diversity in kelp and shallow rock ecosystems can provide further insights into the ecological mechanisms underlying potential ecosystem change following MPA implementation. However, there are many challenges in collecting and correctly interpreting diversity data. By definition, measurement of diversity is relatively resource-intensive as all, or nearly all, species must be included. Some survey efforts may collect a subset of species information that can provide some insight into diversity changes. Interpretation of diversity measures must proceed with caution. Both increases and decreases in diversity can signify improved or declining ecosystem condition. For example, increases in diversity may result from natural or anthropogenic disturbance effects, or may be accounted for entirely by invasive species.

MID-DEPTH (30-100M) ROCK ECOSYSTEMS

The collective set of attributes selected to track the condition of the Mid-depth Rock Ecosystem Feature are conceptually similar to those identified for the Kelp and Shallow Rock Ecosystem Feature. A fundamental aspect of the ecosystem is the habitat provisioning role played by many species. In mid-depth rock ecosystems, the dominant component of biogenic habitat is sessile invertebrates. The remaining attributes identify core components of the community composition and trophic structure of mid-depth rock reefs. Inclusion of both fished and unfished sections of the community can provide

insight into the role of the MPAs in observed ecological trends. Again, integrated analyses incorporating multiple attributes will provide greater insight into the mechanisms underlying observed species trends.

ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT: SESSILE INVERTEBRATES

Focal species/Indicators:

- Density of structure-forming invertebrates
- Cover of structure-forming invertebrates

Sessile invertebrates encompass a wide range of species with dramatically different body types and ecologies. Common to many of these species is the role played in providing habitat. Although biogenic habitat is a key attribute of the ecosystem, potential changes in response to MPA designation may only occur through cascading interactions with other components of the food web or over longer time scales in response to changing oceanographic and climate conditions. However, this remains a key attribute to monitor in order to interpret changes seen in fish and invertebrate populations. Data collected as part of the North Central Coast MPA Baseline Program will be used to refine and improve these broad indicators.

TROPHIC STRUCTURE: MOBILE INVERTEBRATES

Focal species/Indicators:

- Density of rock crabs (*Cancer spp.*)
- Density of sheep (spider) crabs *(Loxorhynchus grandis*)
- Density of box crabs (*Lopholithodes foraminatusi*)

As in kelp and shallow rock ecosystems, many of the most abundant invertebrates in mid-depth rock habitats play key roles as herbivores and detritivores within the food web. Collectively, the recommended focal species encompass a range of functional roles played by invertebrates in mid-depth rock ecosystems and include species that have experienced differing prior levels of take. Increases in the density of each species may be predicted with MPA implementation, however lack of existing knowledge of the effectiveness of spatial closures for mobile species renders prediction of the timing and magnitude of population responses uncertain. Regardless, monitoring population trends may provide insight into the role of the regional MPA network in increasing species abundances.

PREDATORS: PISCIVOROUS FISHES

Focal species/Indicators:

- Bocaccio (*Sebastes paucispinis*) density &size structure
- Yelloweye rockfish (*Sebastes ruberrimus*) density & size structure
- Vermilion rockfish (*Sebastes miniatus*) density & size structure
- Lingcod (*Ophiodon elongatus*) density & size structure

Piscivorous fish are important predators of other fishes within mid-depth rock ecosystems. In these ecosystems, energy flow typically follows simpler pathways; phytoplankton (primary producers) are less abundant and less diverse,

subsequently primary consumers are fewer. Thus, piscivores play a particularly key regulatory role on deep rocky habitats and are key drivers of community structure.

Many piscivorous fish within the North Central Coast region are also key target fish within commercial and recreational fisheries. In the absence of fishing following MPA implementation, the size and abundance of focal species is predicted to increase. The species included here as focal species encompass a range of life history characteristics and are subject to differing levels of fishing take. In particular, the slow growth and late maturation of rockfish species renders detection of MPA effects unlikely within five to ten years. By comparison, bocaccio are relatively fast growing and lingcod are relatively sedentary – both characteristics which may reduce the time necessary to detect potential changes in response to MPA implementation. In all cases, interpretation of trends in piscivorous fish density and size structure will consider information on the spatial distribution and intensity of fishing effort and any associated changes in fishery regulations.

COMMUNITY STRUCTURE: DWARF ROCKFISHES

Focal species/Indicator:

- Total dwarf rockfish abundance

In rockfish communities, fishing disproportionally affects larger, slow growing and late maturing species. By comparison, the so-called dwarf rockfish (generally comprised of halfbanded (*S.semicinctus*), pygmy (*S. wilsoni*), squarespot (*S. hopkinsi*), stripetail (*S. saxicola*), swordspine (*S.ensifer*), and Puget Sound (*S. emphaeus*) rockfish) are relatively unfished. These dwarf rockfish are an important prey source for the larger rockfish species and may also compete with juveniles of the larger, competitively dominant species for habitat and prey resources. Historically, competition and predation are likely to have constrained population densities of the dwarf species, except in sub-optimal habitats. Overfishing of the larger species has substantially reduced their population densities and consequently reduced the predation and competition pressures on dwarf rockfish, which now dominate the rockfish community in some locations. Trends in the relative abundance of dwarf rockfish at sites inside and outside of MPAs are indicative of shifting community structure in response to protection. This attribute will provide useful insight into the effects of MPAs that extend beyond single species responses.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT: SESSILE INVERTEBRATES

Focal species/Indicators:

- Cover of encrusting invertebrates
- *Metridium* spp. bed cover
- Hydrocoral (*Stylaster californicus*) density
- Diversity of habitat-forming species

Encrusting invertebrates such as sponges and bryozoans create a biotic film that forms micro-habitat for other small motile invertebrates (e.g., amphipods), which in turn form the base of a trophic web. Further, encrusting invertebrates regulate community composition through competition for space.

Metridium farcimen and *Metridium senile* are two prominent anemones, the former of which is best known and can grow to nearly 1 m in height. Understanding the distribution and extent (cover) of *Metridium* spp. beds provides an insight into nursery habitats for many species of fish in deep water environments. In general *Metridium* are long lived and affected by

water quality, therefore large beds also suggest some measure of environmental stability. Similarly, the hydrocoral *Stylaster californicus* is slow growing, fragile and generally found in areas of clear water. Interpretation of trends in these focal species requires adequately accounting for implementation conditions, since low initial densities may reflect habitat suitability and not current condition.

These focal species, together with measures of habitat diversity, require more detailed survey efforts. Where feasible, this information can provide increased insights into the dynamics of community change, strengthening interpretation of changes in key fish and invertebrate species.

KEY ATTRIBUTE: OMNIVOROUS FISHES

Focal species/Indicators:

- China rockfish (*Sebastes nebulosus*) density & size structure
- Gopher rockfish (*Sebastes carnatus*) density & size structure
- Copper rockfish (*Sebastes caurinus*) density & size structure

Among the functional fish guilds within mid-depth rock ecosystems, many species are omnivores, consuming a wide range of prey items. These species thus play important roles at multiple levels within a complex, functioning food web. Collectively, the selected species encompass varying life history characteristics and varying levels of take. Individual species are likely to vary in the magnitude and timing of response to local protection. However, overall increases in fish abundance and size are expected to occur in response to ecosystem protection. Monitoring species with differing life history characteristics will provide insight into the role of MPAs in population trends. However, trends in these species are often the result of a wide range of drivers including biological interactions and physical processes. Monitoring these species will add greater insight into the mechanisms underlying MPA effects where survey efforts can include this additional information.

DIVERSITY

Focal species/Indicators:

- Species richness (fish & invertebrates)
- Species diversity (functional groups of fish & invertebrates)

As in kelp and shallow rock ecosystems, direct measurements of species richness and diversity in mid-depth rock ecosystems can provide further insights into the ecological mechanisms underlying ecosystem change following MPA implementation. However, there are many challenges in collecting and correctly interpreting diversity data. By definition, measurement of diversity is relatively resource-intensive as all, or nearly all, species must be included. Some survey efforts may collect a subset of species information that can provide some insight into diversity changes. Interpretation of diversity measures must proceed with caution. Both increases and decreases in diversity can signify improved or declining ecosystem condition. For example, increases in diversity may result from natural or anthropogenic disturbance effects, or may be accounted for entirely by invasive species.

ROCKY INTERTIDAL ECOSYSTEMS

At the upper end of the intertidal, physical processes primarily regulate community composition and species distribution, thus the key attributes at the upper limits of the Rocky Intertidal Ecosystem Feature may provide insights into ecosystem

responses to physical drivers such as sea level rise or storm events. On the other extreme, the lower distributional limits of many intertidal organisms are frequently regulated primarily by biological processes such as competition, predation or space. Thus the lower limits of many of the key attributes presented here provide insights into trophic and ecosystem structure and function. Analyzed together, trends in key attributes will reveal key ecosystem changes that may follow MPA implementation and will provide insights into the mechanisms underlying changes in species/functional groups.

ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT

Focal species/Indicators:

- Cover of turf algae
- Cover of foliose red algae
- Cover of fucoids (fleshy brown algae)
- Cover of mussels (*Mytilus* spp.)
- Cover of feather boa kelp (*Egregia menziesii*)
- Cover of surf grass (*Phyllospadix* spp.)

The suite of biogenic habitats in intertidal ecosystems plays a key role in providing refuge from predators and exposure while increasing rugosity and space. Thus, intertidal biogenic habitats are critical in regulating community structure and food web dynamics. Unlike many subtidal ecosystems, biogenic habitats in the rocky intertidal may directly respond to MPA designation if implementation results in increased or decreased human disturbance such as trampling, harvesting or illegal take. Interpretation of trends in biogenic habitat will be aligned with data on non-consumptive and consumptive uses to examine potential MPA effects, taking into account visitation rates and allowed uses. This information is also important for interpretation of trends in key invertebrate populations, taking into account key ecological interactions (e.g., herbivory) linking functional groups.

STRONG ECOLOGICAL INTERACTORS: INVERTEBRATES

Focal species/Indicators:

- Black abalone (*Haliotis cracherodii*) density & size structure
- Red abalone (*Haliotis rufescens*) density & size structure
- Sea star (*Pisaster ochraceous, Pycnopodia* spp.) density & size structure
- Purple sea urchin (*Strongylocentrotus purpuratus)* density & size structure
- Giant/owl limpet (*Lottia gigantea)* density & size structure

Invertebrates are a diverse group of organisms within rocky intertidal ecosystems that play many different and important ecological roles. Species such as limpets, mussels, and abalone provide a prey base for many higher trophic level organisms including other larger invertebrates, birds, and humans. Importantly, invertebrates are also critical bio-regulators of community structure in intertidal habitats; abalone, limpets and snails are grazers that create space among the rocky substrate for new organisms to settle. Other invertebrates such as sea stars are important predators that help drive food web interactions. Many intertidal invertebrates such as red abalone are harvested while others are affected by various factors ranging from human disturbance to climate change. Trends in densities of these species will be interpreted in the

context of trends in ecologically associated species (e.g., habitat-forming species) and will consider information on the spatial distribution and intensity of fishing take.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

PREDATORS: PREDATORY BIRDS

Focal species/Indicators:

- Total abundance of piscivorous birds & shorebirds
- Diversity of piscivorous birds & shorebirds
- Abundance of black oystercatchers (*Haematopus bachmani*)

Together with soft-sediment intertidal habitats, rocky intertidal ecosystems are important foraging for resident and migratory bird populations. Piscivorous birds and shorebirds forage on a wide range of fish and invertebrate prey. Although population abundances vary dramatically in response to external drivers, including climate and oceanographic variation and trends, over long time periods trends such as increased total abundance and diversity of bird species will be indicative of an abundant and diverse prey population.

In addition, black oystercatchers have been identified as a potential focal species within rocky intertidal habitats. Populations of this species are highly dependent on nearshore resources, including invertebrate prey (primarily mussels and limpets) in rocky intertidal zones and undisturbed, rocky open ocean shores for breeding. Oystercatcher abundance is thus indicative of undisturbed sites with available prey. However, responses to MPA designation are likely to be highly dependent on human access to, and disturbance of, rocky intertidal habitats. If data collection is implemented, trends in abundance will therefore be interpreted with additional information including human visitation rates and access.

HABITAT PROVISIONING: JUVENILE FISHES

Focal species/Indicator:

- Total YOY (young-of-the-year) rockfish abundance

Intertidal fishes provide a valuable bridge from the rocky intertidal ecosystems to the submerged shallow rock ecosystems – and this is particularly reflected in one of the focal species groups: rockfish. Tidepools are important juvenile habitat for some rockfish species, particularly black rockfish in the North Central Coast region. This includes nearshore rockfish populations that have undergone significant population declines. MPAs could lead to increases in adult population size and enhanced larval import, which should result in increased juvenile abundance. However, given variability in recruitment, reliable trends in juvenile rockfish abundance are likely to take many years to detect (i.e., more than 10 years). Nonetheless, given the importance of this indicator, it is appropriate to include as an optional supplemental indicator.

TROPHIC STRUCTURE: INTERTIDAL FISHES

Focal species/Indicator:

- Monkeyface prickleback (*Cebidichthys violaceus*) density
- Rock prickleback (*Xiphister mucosus*) density

Rocky intertidal habitats are home to several fishes, some residing year round and others seasonally or only during juvenile life stages. Pricklebacks form a component of the recreational shore-based fishery in the region and have small home range sizes. These species are predicted to increase in response to MPA designation. This species may therefore reveal direct MPA effects but our understanding of the ecosystem-level consequences is limited. This information may be usefully collected where resources allow expansion of Ecosystem Feature Assessment survey efforts.

DIVERSITY

Focal species/Indicators:

- Species richness (fish & invertebrates)
- Species diversity (functional groups of fish & invertebrates)

In rocky intertidal ecosystems, species diversity may fluctuate dramatically as a result of natural and anthropogenic disturbances. Indeed, physical disturbance results in complex and patchy species distributions in this ecosystem complicating detection of potential MPA-related effects. Monitoring diversity can provide insight into the frequency and intensity of disturbance effects, providing information that can assist in interpreting trends in individual species.

As noted for the other Ecosystem Features, collecting information to calculate diversity metrics is resource-intensive. However, this may be most feasibly accomplished in intertidal habitats. Many of the same caveats apply – both increases and decreases in diversity may indicate increasing or declining ecosystem condition, so care in interpreting observed changes is essential.

SOFT-BOTTOM SUBTIDAL (0-100M) ECOSYSTEMS

Soft-bottom ecosystems can be highly dynamic and experience significant changes in response to wave action and ocean currents. Significant aspects of the ecological structure and functioning of these ecosystems remain unknown. However, these habitats frequently support a relatively simple community structure dominated by invertebrates and fishes living both within and closely associated with the substrate. The key attributes below encompass these dominant macrofaunal groups within these habitats.

ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT

Focal species/Indicator:

- Total cover of biogenic habitat
- Biogenic habitat diversity

Consistent with other Ecosystem Features, biogenic habitat is predicted to play an important role in soft-bottom habitats. Our knowledge of the key habitat-forming species is incomplete, especially in deeper waters, but many species ranging from tubeworms to bivalves and echinoderms are likely to play a habitat-forming role. This is reflected in the broad indicators initially selected for inclusion in monitoring. Additional information, when available, will be used to refine these indicators for implementation.

TROPHIC STRUCTURE: BENTHIC INFAUNA

Focal species/Indicator:

- Functional diversity (feeding guilds) of benthic infauna
- Sand dollar (*Dendraster excentricus*) abundance and size structure

The infaunal species assemblage (species living within the substrate) in soft-bottom subtidal habitats encompasses multiple species functional groups with key ecological roles. Very little is known about many of these species within the region, including the spatial scale and mechanisms of population regulation. In the context of MPA monitoring, where MPAs are designed to protect habitats and ecosystems, the most informative species may be those likely to respond to reductions in physical habitat disturbance. Trends in functional diversity may indicate changing ecosystem condition and may also serve a sentinel function to detect emerging stresses or threats associated with changing sediment quality or disturbance. As an additional focal species for monitoring, the principal epifaunal member of most shallow west coast exposed sand habitats is the sand dollar *Dendraster excentricus,* which occurs in immense numbers in distinct beds, stabilizing the substrate and providing structure for a diverse community of organisms. Sand dollars are filter-feeders, and serve as prey for multiple predators including starry flounder and sea stars.

PREDATORS: BENTHIC INVERTEBRATES & DEMERSAL FISH PREDATORS

Focal species/Indicators:

- Dungeness crab (*Cancer magister*) density & size structure
- Sea star (*Pycnopodia helianthoides/Pisaster* spp.) density & size structure
- California halibut (*Paralichthys californicus*) density & size structure
- Starry flounder (*Platichthys stellatus*) density & size structure
- Sanddab (*Citharichthys* spp.) density & size structure

In soft-bottom habitats, predators may play important roles in structuring community composition. The abundance of multiple focal species, each feeding on a range of prey species, can indicate the presence of multiple functioning trophic levels. Here, benthic predators are assumed to include those species with a strong association with the substrate and are distinguished from other pelagic predators that also feed on soft-bottom benthic infauna. Many of the most abundant benthic predators are both highly mobile and subject to fishing pressure. Trends in abundance and sizes will be interpreted in the context of additional information, including the spatial distribution of fishing effort, and will also primarily contribute to region-wide assessments of Ecosystem Feature condition.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

DIVERSITY

Focal species/Indicators:

- Species richness (fish & invertebrates)
- Species diversity (functional groups of fish & invertebrates)

There are few existing measures of diversity in soft bottom ecosystems and thus little existing knowledge on which to base interpretation of changing diversity metrics. Monitoring species richness and diversity, when feasibly implemented, can

provide an additional source of information to increase our understanding of the factors maintaining a resilient soft-bottom ecosystem.

ESTUARINE & WETLAND ECOSYSTEMS

Estuarine & wetland ecosystems within the North Central Coast region encompass soft sediment habitats, including open water, tidal mudflats and eelgrass beds. Estuaries play a key role as nursery habitat for many invertebrates and fish. In addition, these habitats host thousands of migratory shorebirds and waterfowl and provide important foraging habitat for both migratory and resident bird populations. The attributes selected to track the condition of estuarine & wetland ecosystems reflect these key ecological roles as well as components of the associated food web structure that create a functioning estuarine & wetland ecosystem.

ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT

Focal species/Indicator:

- Eelgrass (*Zostera marina*) areal extent

Biogenic habitat, in particular the habitat provisioning role played by eelgrass, is critical in maintaining the ecological roles of estuaries as nursery and foraging habitat. *Zostera marina*, the dominant eelgrass species on the Pacific North American coast, ranges from the northern Bering Sea south to the Gulf of California and provides important nearshore habitat for a diverse assemblage of aquatic organisms. *Zostera marina* habitats typically support higher diversity and biomass than surrounding unvegetated areas.

Increases in areal extent in response to MPA designation are predicted in locations where protection results physical habitat disturbance (for example, via a reduction in bottom contact fishing gear or propeller disturbance). Trends in eelgrass areal extent are also important to interpret changes observed in other components of the estuarine food web. Interpretation of these trends will also incorporate contextual information such as water quality information to determine potential MPA- effects.

TROPHIC STRUCTURE: INFAUNAL ASSEMBLAGE

Focal species/Indicators:

- Mud shrimp (*Upogebia pugettensis)* abundance
- Ghost shrimp (*Neotrypaea californiensis*) abundance
- Fat innkeeper worm (*Urechis caupo*) abundance
- Pacific gaper clam (*Tresus nuttalli*) abundance
- Littleneck clam (*Protothaca staminea*) abundance

The infaunal species assemblage encompasses multiple species and functional groups with key ecological roles, including bioturbators, filter-feeders and tube-builders. Collectively, these form a key component of an estuarine food web that also provides important habitat modification effects. The recommended focal species encompass a breadth of ecological roles and also vary in life history characteristics, allowing detection of potential MPA effects at a range of temporal and spatial scales. Further, species including gaper and littleneck clams are also subject to recreational fishing take within the North

Central Coast region. Although the timing and magnitude of potential responses to MPA implementation are uncertain, increases in local abundance are predicted where MPA implementation results in reduced habitat disturbance and reduced take. Interpretation of monitoring results will consider information on the spatial distribution of recreational harvest to assess potential MPA-effects.

PRODUCTIVITY: RESIDENT FISHES

Focal species/Indicators:

- Shiner (*Cymatogaster aggregata*) & striped (*Embiotoca lateralis*) surfperch abundances

Resident fish populations within estuarine environments serve as important energy linkages within a naturally functioning food web. Population abundances are broadly indicative of available prey and habitat condition. Increases in resident fish populations may be expected in direct response to reduced fishing as well as indirect responses to increased prey availability and reduced habitat disturbance.

Shiner surfperch are abundant in estuaries throughout California, while striped surfperch are more frequently reported in northern California. Both species are a component of the recreational fishery and may increase in abundance in areas where fishing is reduced. Analysis of monitoring results will consider information on the spatial distribution of fishing to interpret potential MPA effects.

PREDATORS: PREDATORY BIRDS

Focal species/Indicators:

- Total abundance of piscivorous birds & shorebirds
- Total diversity of piscivorous birds & shorebirds

Coastal bays, estuaries and beaches in the North Central Coast region are an important part of the Pacific Flyway and host thousands of migrating shorebirds. In addition, several of the estuaries in the region are important foraging and nesting areas for resident bird populations. Increased total abundance and diversity of these bird species is indicative of an abundant and diverse prey population. Individual populations are sensitive to habitat modification (for example, loss of foraging or nesting habitat or decreased water quality) and also fluctuate naturally in response to climate and oceanographic variation. Thus while MPA implementation may rapidly result in increased populations due to reduced disturbance, long time-series data will be collected to detect overarching trends in diversity and abundance.

PREDATORS: PISCIVOROUS FISHES

Focal species/Indicators:

- Leopard shark (*Triakis semifasciata*) abundance
- Bat ray (*Myliobatis californica*) abundance

Apex predators, by virtue of their position at the top of the food web within estuarine environments, are indicative of the presence and functioning of multiple lower trophic levels. Both bat rays and leopard sharks are seasonally abundant in bays and estuaries within the North Central Coast region, where they feed on a diverse range of prey items including clams, shrimp, crabs and polychaetes. Both species also form a component of the recreational fishery in the region and their numbers may be expected to increase with decreased take, decreased disturbance and decreased take of benthic and

infaunal species resulting in increased prey populations. Integrated analyses of multiple attributes will be used to reveal indirect ecological changes that may follow MPA implementation.

HABITAT PROVISIONING: HARBOR SEAL HAULOUT SITES

Focal species/Indicators:

- Harbor seal (*Phoca vitulina richardsi*) abundance (colony size)

Harbor seals are important apex predators feeding on a diverse range of fish and invertebrates in nearshore waters including herring, anchovies, sardines, hake, flounder, sole, octopus, squid and crabs. Abundances of this species declined early in the century but have since stabilized. However, harbor seals spend approximately half of the time on land at haulout sites, rendering them vulnerable to human disturbance. In the North Central Coast region, haulout sites are widely distributed along the mainland and on offshore islands in estuarine habitats, intertidal sand bars, rocky shores and beaches. Individuals haulout on land for rest, thermal regulation, social interaction and to give birth. Haulout sites thus offer an opportunity to conduct local sub-population assessments. Interpretation of data on this vital sign will consider additional information including evidence of disturbance as well as oceanographic data.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

BIOGENIC HABITAT

Focal species/Indicators:

- Eelgrass (*Zostera marina*) shoot density
- Areal extent of common pickleweed (*Salicornia virginica*)
- Areal extent of sea lettuce (*Ulva* spp.)
- Native oyster abundance

As noted above, biogenic habitat is critical in maintaining the ecological roles played by estuaries as nursery and foraging habitat. These additional focal species also provide habitat within estuarine and marsh ecosystems and will provide additional insight into potential habitat changes following MPA implementation when feasibly implemented. Common pickleweed is a California native that is the dominant vascular plant of many saline marshes on the west coast, and it is commonly found in bays and estuaries where it is protected from wave action. Sea lettuce mats can occur on gently sloping sand and mud flats, with abundances increasing during warmer months. Sea lettuce blooms have been linked to high nutrient concentrations and excessive growth can be sufficient to inhibit the growth of eelgrass. Finally, native oysters are now rare through much of their range but historically provided important habitat within bays and estuaries in the region. Changing physical conditions, particularly water quality, will be an important consideration in interpreting trends in abundance of all these species.

KEY ATTRIBUTE: INFAUNAL ASSEMBLAGE

Focal species/Indicators:

- Total abundance of shorebirds
- Foraging rates of shorebirds

Infaunal species in estuarine intertidal flats are often exploited by humans, shorebirds and wading birds. The harvesting of shellfish has been shown to affect shorebird foraging rates by changing the sediment composition and reducing the abundance of food items. Increases in the total abundance and foraging rates of shorebirds may be predicted in areas under MPA designation with reduced harvest of prey items and decreased disturbance of foraging areas. This metric will require dedicated survey methods to measure foraging rates. In addition, foraging rates are likely to be an indirect effect of MPA implementation. Thus it is most appropriate to include as an optional metric , added where resources permit.

PRODUCTIVITY: RESIDENT FISHES

Focal species/Indicators:

- Starry flounder (*Platichthys stellatus*) abundance & size structure
- California halibut (*Paralichthys californicus*) density & size structure

Resident fish populations within estuarine environments serve as important energy linkages within a naturally functioning food web. Population abundances may be broadly indicative of available prey and habitat condition. Increases in resident fish populations may be expected in direct response to reduced fishing as well as indirect responses to increased prey availability and reduced habitat disturbance.

Starry flounder are frequently the most abundant flatfish in North Central Coast estuaries and are also taken in the recreational fishery. As adults, individuals do not travel long distances and abundances may be expected to increase within protected estuarine habitats. California halibut inhabit shallow water bays and also deeper soft-bottom habitat. Monitoring this species offers opportunity to link population trends across ecosystem features. In particular, shallow water habitats are particularly important habitat for juvenile halibut. Trends in adult abundance of both species following MPA implementation will also reflect a combination of changing fishing pressure and oceanographic conditions and this contextual information will be considered in analyses of this data. Given the range of population drivers these metrics are included as an optional attribute and focal species.

DIVERSITY

Focal species/Indicators:

- Species richness (fish & invertebrates)
- Species diversity (functional groups of fish & invertebrates)

As in many of the other Ecosystem Features, monitoring species diversity may provide useful insight into ecosystem stability (through monitoring fluctuations in diversity) but this information is challenging to collect, and challenging to interpret in terms of MPA effects on ecosystem condition.

SOFT-BOTTOM INTERTIDAL & BEACHES

Communities inhabiting sandy beaches are supported almost entirely by external inputs of nutrients and energy, as little primary production occurs on the beach itself. In addition, beach morphodynamics and swash climate have an important influence on community structure. In some locations beach habitats are highly dynamic and variable environments that change significantly with wind and waves. The key attributes identified below encompass key functional groups in this ecosystem, focusing on those species more likely to respond to MPA designation through reduced human impact or indirect

ecological interactions. Given the spatial variability among beaches, trends through time will offer the greatest insight into potential MPA effects.

ECOSYSTEM FEATURE ASSESSMENT

TROPHIC STRUCTURE: SUSPENSION FEEDERS

Focal species/Indicators:

- Sand crab (*Emerita analoga*) abundance & size structure
- Razor clam (*Siliqua patula*) abundance & size structure

Suspension feeders play an important role in ecosystems, rapidly converting phytoplankton to biomass and, as prey organisms, making energy available to higher trophic levels. The focal species offer insight into the functioning of this component of the food web and also are important for interpretation of the condition and trends of higher trophic level predators, such as predatory shore birds.

The presence of sand crabs may indicate a beach with sufficient nutrient input, and the size of beach populations can be closely related to the richness of inshore waters. Sand crab populations are generally robust, though they fluctuate annually depending on oceanic and climatic conditions. Razor clams are of one of the longest-lived organisms in the sandy intertidal, so they offer the potential to integrate information about conditions over long time frames. Long time-series data will be most useful in assessing potential MPA effects on this key attribute.

PRODUCTIVITY: SURF ZONE FISH ASSEMBLAGE

Focal species/Indicators:

- Surfperch abundance (Embiotocidae, multiple species)
- Surf smelt (*Hypomesus pretiosus*) abundance & size structure

Nearshore shallow-water habitats are home to a range of fish species, including juveniles that seek refuge from predators in the shallow water as well as resident species that forage in the surf zone on fish and invertebrate prey. Surfperch play a major link in trophic transfer in the near-shore: their diets consist of isopods, amphipods, copepods, molluscs and polychaete worms. They, in turn, are prey for larger fish such as kelp bass, California halibut, sturgeon, rockfishes and salmon and are also eaten by harbor seals and birds. Both fishery-dependent and fishery-independent data suggest that populations of surf perches may be declining in California. Recreational surf smelt collection by hand using beach nets or dip nets is allowed in many conservation areas where the majority of other take is prohibited. Interpretation of trends in abundance and size structure will consider available fisheries information to assess potential MPA-specific effects.

PREDATORS: MARINE BIRDS

Focal species/Indicators:

- Total abundance of predatory birds
- Species diversity of predatory birds

Coastal bays, estuaries and beaches in the North Central Coast region are an important part of the Pacific Flyway and host thousands of migrating shorebirds. In addition, beaches and estuaries in the region are important foraging and nesting areas for resident bird populations. Individual populations are frequently sensitive to changing prey abundance as well as broader habitat modification (for example, loss of foraging habitat or decreased water quality). Broad metrics that capture the total abundance and diversity of these bird populations are thus indicative of the overall condition of the habitat and the supporting food web structure. Population and diversity trends will be interpreted in the context of information on climatic and oceanographic drivers as well as other contextual information.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

DIVERSITY

Focal species/Indicators:

- Species richness (fish & invertebrates)
- Species diversity (functional groups of fish & invertebrates)

As in many of the other Ecosystem Features, monitoring species diversity may provide useful insight into ecosystem stability (through monitoring fluctuations in diversity) but this information is challenging to collect, and challenging to interpret in terms of MPA effects on ecosystem condition. Thus, diversity is currently included as an optional supplemental attribute.

NEARSHORE PELAGIC ECOSYSTEMS

As noted in Chapter 3, the Nearshore Pelagic Ecosystem Feature is defined for the purposes of MPA monitoring as the water column habitat within state waters. The selected key attributes identify key components of the trophic structure within pelagic environments, focusing particularly on upper level predators that may be expected to benefit from MPA implementation, specifically piscivorous fish and seabirds. These key attributes also offer opportunities to gain insight into pelagic–benthic links, which may be important in interpreting and understanding the condition of, and change in, both pelagic and benthic habitats.

ECOSYSTEM FEATURE ASSESSMENT

PREDATORS: PISCIVOROUS/PLANKTIVOROUS FISHES

Focal species/Indicators:

- Widow rockfish (*Sebastes entomelas*) abundance & size structure
- Yellowtail rockfish (*Sebastes flavidus*) abundance & size structure
- Blue rockfish (*Sebastes mystinus*) abundance & size structure
- Shortbelly rockfish (*Sebastes jordani*) abundance & size structure

Increased abundance of high trophic level predators is indicative of the presence and functioning of multiple lower trophic levels. The focal species encompass differing life history characteristics and prior levels of take, and focus on resident species within nearshore environments. Density or population responses within the semi-pelagic rockfish included here

may also be dependent on ecological changes within reef and deep soft-bottom habitats. Integrated analyses using long time-series data from pelagic and benthic habitats will be used to assess potential MPA effects on this key attribute.

TROPHIC STRUCTURE: SEABIRDS

Focal species/Indicators:

- Brandt's cormorant (*Phalacrocorax penicillatus*) colony size (abundance) & fledging rate
- Pelagic cormorant (*Phalacrocorax pelagicus*) colony size (abundance) & fledging rate
- Pigeon Guillemot (*Cepphus columba*) abundance & fledging rate
- Common Murre (*Uria aalge*) colony size (abundance) & fledging rate

A diverse range of seabird species depends on myriad different prey species and forages in areas ranging from shallow estuarine and nearshore waters to deeper pelagic habitats. Many seabird populations fluctuate significantly in response to broad oceanographic and climatic changes. Long-term changes in population sizes thus integrate changing marine ecosystem condition together with broader physical environmental changes. However, populations may also benefit from local protection reducing disturbance of nesting sites and this may be revealed in increased fledging rates on shorter time scales. The focal species encompass a range of foraging, nesting and other life history variables and interpretation of trends in abundance and fledging rates will consider information on broader system drivers.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

PRODUCTIVITY: ICHTHYOPLANKTON

Focal species/Indicators:

- Total ichthyoplankton abundance
- Density of rockfish larvae
- Ratio of fished species to unfished species

Ichthyoplankton (the eggs and larvae of fish) can be an accurate indicator of the transient spawning population size of adults. On small spatial scales, it is unclear whether ichthyoplankton abundance is informative about ecosystem condition or the ecosystem effects of MPA implementation because it is challenging to disentangle the effects of larval transport from local production. However, on larger scales, trends in species abundances as recorded in ichthyoplankton samples can indicate the broader effects of climate and oceanographic effects on fish distribution and abundance. If implemented, this attribute will contribute information towards a region-wide assessment of Ecosystem Feature condition.

CONSUMPTIVE USES

INDICATORS

For each consumptive use or activity, the indicators follow a similar overarching structure. The indicator categories are also ranked and can be implemented as resources allow.

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 (catch per unit effort) 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

MPA monitoring of consumptive uses is focused on detecting the changes in consumptive uses following MPA implementation. To achieve this, survey and other data collection programs will collect data at high spatial resolution, detailing the specific locations of fishing effort. This therefore extends data collection beyond most existing monitoring of consumptive uses, which generate data at lower spatial resolutions, making evaluation of MPA effects problematic. Long-term MPA monitoring of consumptive uses is also complicated by many other factors. These include changing fishing effort inside and outside MPAs, changes in fisheries regulations, climate and oceanographic shifts causing natural fluctuations in fish stocks, and the broader economic environment. In all cases accurate interpretation of the attributes and indicators below will include integrated analyses that consider this broad range of contextual information. Further, long-term trends in consumptive uses depend, in part, on the trends and condition of the ecological ecosystem features. Data collection and analyses will be aligned to facilitate these interpretive links between the ecological and human uses Ecosystem Features.

CONSUMPTIVE USES TO BE MONITORED

For each consumptive use or activity, key species for MPA monitoring are noted. These are species which form an important component of the fishery, play important ecological roles, and are likely to benefit from MPAs. The indicator framework above can be applied to each consumptive use and associated fishery species.

COMMERCIAL FISHING

Key fishery species:

- Nearshore rockfish (*Sebastes* spp.)
- Dungeness crab (*Cancer magister*)
- California halibut (*Paralichthys californicus*)
- Red sea urchin (*Strongylocentrotus franciscanus)*

Commercial fishing contributes significantly to coastal community economies in the North Central Coast region, particularly the dominant fishing ports including Point Arena, Bodega Bay, San Francisco and Princeton/Half Moon Bay. The port of San Francisco is out of the North Central Coast region but many vessels from that port fish within the region. Over the last 14 years, average annual landings in the study region totaled nearly 17 million pounds and included multiple fisheries.

Trends in the number of individuals or vessels engaged in commercial fishing activity and the number of fishing trips per vessel indicate the level of commercial fishing activity. These metrics may be applied at varying spatial scales including inside and outside of specific MPAs and at key ports. Landings of key species (measured by the total pounds of key species and including available size information) and CPUE illustrate the intensity of fishing efforts and also provide informative links to ecological indicators, such as fish biomass and density within MPAs. Where resources and capacity permit, data

collection may also be extended to incorporate economic valuations including ex-vessel value, and ultimately net revenue. The latter is dependent upon many different factors and will primarily contribute to region-wide assessments of Ecosystem Feature condition.

RECREATIONAL FISHING – COMMERCIAL PASSENGER FISHING VESSELS (CPFVS)

Key fishery species:

- Rockfish (*Sebastes* spp.)
- Lingcod (*Ophiodon elongatus)*
- California halibut (*Paralichthys californicus*)

CPFVs, also called party boats, are an important component of consumptive use within the North Central Coast region. The number of active CPFVs, along with the number of trips these boats make, provides a metric for evaluating the level of supply for the industry. Comparably, the number of clients per vessel and total number of clients is an indicator of consumer demand. Trends for this indicator will be closely linked to public attitudes and perception about the MPAs. Landings of key species by CPFVs, measured by the total pounds of key species and including available size information, illustrate the intensity of CPFV efforts and also provide informative links to ecological indicators, such as fish biomass and density within MPAs. Landings will be highly dependent on yearly ecological conditions for the area and other fishery management regulations and this information will be used to interpret results and assess MPA-specific effects. In all cases, highly spatially resolved data, including specific fishing locations, will be collected to reliably detect MPA-specific effects.

RECREATIONAL FISHING – ABALONE DIVING

Abalone is recreationally harvested in intertidal areas during negative low tides or while free diving. This fishery provides important economic input into several coastal communities. During the abalone season nearly every accessible cove in Sonoma and Mendocino counties, where effort is greatest, may experience harvesting. Monitoring this recreational fishery offers significant opportunity to link ecological and socioeconomic data to understand the relative effects of MPA implementation on abalone populations and recreational fishing opportunity. As with other consumptive uses, data collection will include specific location information to allow detection of MPA-specific effects.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

RECREATIONAL FISHING – PRIVATE VESSELS

Key fishery species:

- Rockfish (*Sebastes* spp.)
- Lingcod (*Ophiodon elongatus)*
- California halibut (*Paralichthys californicus*)
- Dungeness crab (*Cancer magister*)

Recreational fishing employing private vessels forms a smaller component of consumptive uses within the North Central Coast region. Within the region, the coastline near Bodega Bay, Marin County and Half Moon Bay receive the majority of fishing effort, with fishing concentrated on Dungeness crab, rockfish and lingcod nearshore, and salmon at greater

distances from shore. If implemented, this information will contribute to information collected for other consumptive uses to provide a more detailed description of changes following MPA implementation.

RECREATIONAL FISHING – CLAMMING

Within the North Central Coast region, clam harvesting targets common littleneck clams, gaper clams and geoduck clams, particularly within and around Bodega Bay and Tomales Bay. Although data are limited, significant annual harvests have previously been recorded. If implemented, monitoring of recreational clam harvest will be aligned with ecological monitoring in estuaries to assess the specific effects of MPA implementation.

SCIENTIFIC COLLECTING

Scientific collecting inside and outside MPAs may increase or decrease following MPA implementation. MPAs are predicted to lead to increased opportunity for research but collecting is also regulated through the scientific permitting process. Data collection for this consumptive use will be most efficiently implemented in combination with the scientific permitting and reporting process.

NON-CONSUMPTIVE USES

INDICATORS

For each non-consumptive use or activity, indicators follow a similar overarching structure. This structure also indicates increasing implementation intensity:

1. Level of activity
    a. Number and location of trips (spatial use and intensity)
2. Knowledge, Attitudes and Perceptions (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

SCUBA DIVING

Scuba diving is a popular activity within the study region, especially within Sonoma and Mendocino counties where recreational scuba divers provide valuable economic contributions to coastal communities. Here the focus is on non-consumptive scuba diving. The recommended indicator structure provides a means to track the spatial and temporal patterns in recreational diving opportunity following MPA implementation. Evaluating the number of divers in an MPA and the number of trips that an individual diver engages in within in an MPA provides a means of monitoring the level of diving activity in an MPA. This can be combined with assessment of diver motivation and level of satisfaction to determine the role of the MPA in diving site choice. Level of satisfaction may be indicated by metrics such as travel distance or costs. Interpretation of these data will incorporate consideration of weather and seasonality effects that could affect diving visitation rates, as well as historical trends in diving site popularity.

WILDLIFE VIEWING – BOATING AND KAYAKING

Boating and kayaking for non-consumptive recreational activities form a relatively small proportion of the boating in the region. However, wildlife viewing tours provide important economic input, and are an important activity around the Farallon Islands. Monitoring the level of this activity is important for tracking trends in recreational use, and the data can also provide important insight into MPA management questions such as disturbance effects of visitors on nesting bird colonies.

WILDLIFE VIEWING – SHORE-BASED

Shore-based wildlife viewing is distinguished here from tidepooling and encompasses bird and mammal viewing (e.g., at harbor seal haulouts) along rocky-shores, beaches and estuaries. Long-term trends in this vital sign provide insight into levels of recreational use as well as ecosystem condition. As noted above, monitoring efficiencies can be obtained by linking data collection to MPA design and management evaluations pertaining to disturbance effects, where these are prioritized for implementation.

TIDEPOOLING

Tracking numbers of visitors to rocky shores is important for tracking recreational use within and outside MPAs and also provides important insight into MPA management issues, such as those concerned with potential ecological damage caused by trampling within these habitats or those focused on educational and outreach programs to build MPA awareness.

OPTIONAL ADD-ONS FOR ECOSYSTEM FEATURE ASSESSMENT

RECREATIONAL BEACH USE

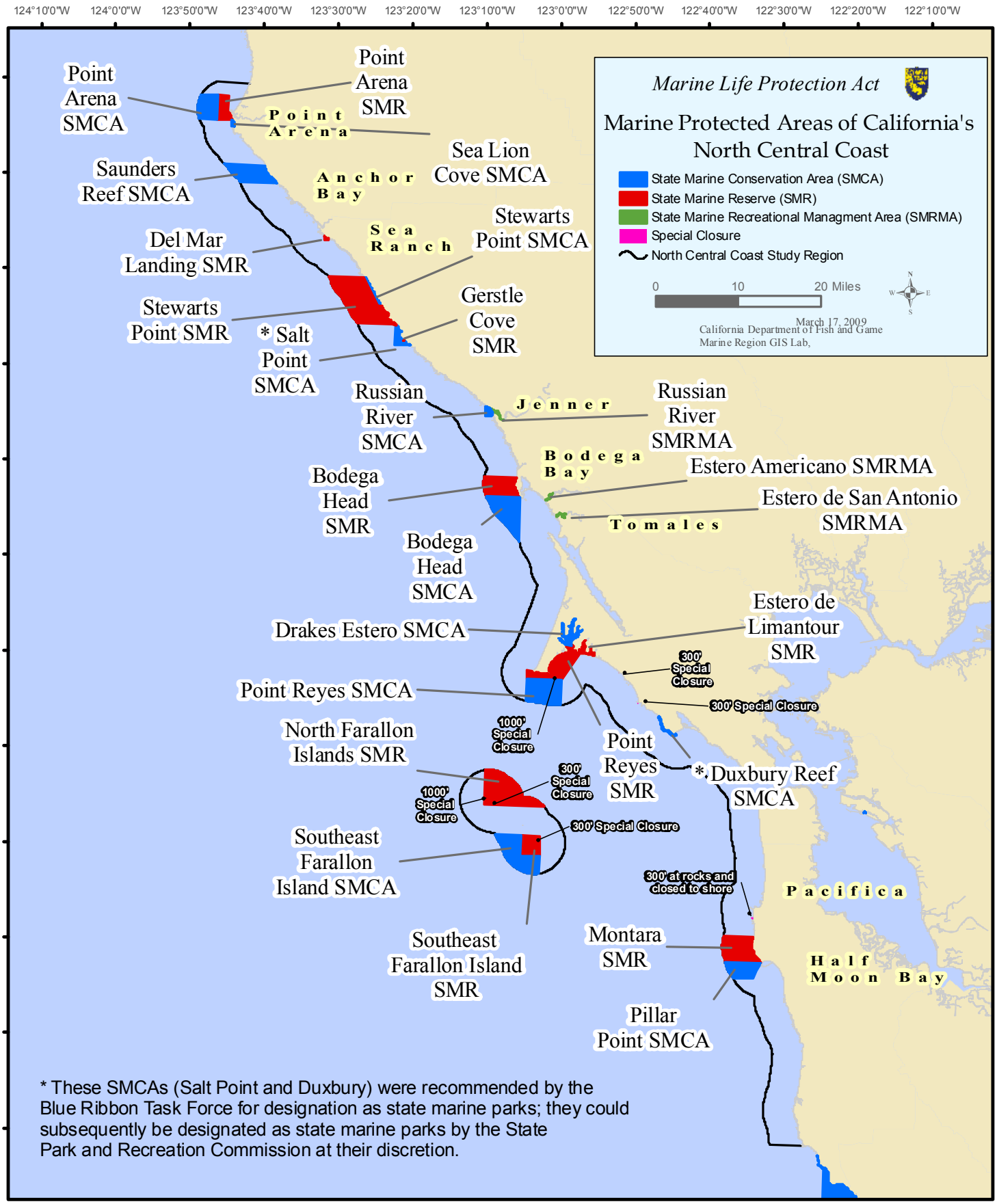
Coastal recreation in California generates significant economic benefits for coastal communities, and a broad spectrum of residents visit the coast and beaches each year. Monitoring recreational beach use is an important element of patterns of human use in the coastal environment. However, trends in the spatial distribution or intensity of use are likely to vary in response to a complex suite of economic and environmental variables. Distinguishing potential MPA effects is challenging, particularly at broader regional scales, but will be approached through collection and analysis of time-series data.

EDUCATIONAL USE

MPAs offer both education and study opportunities, through a potentially broad range of mechanisms. Grade school and high school visits to intertidal environments within MPAs offer opportunities to learn about marine ecosystems as well as potential resource management options. Students can also become involved in monitoring themselves through carefully designed community monitoring projects. Similarly MPAs offer opportunities to increase our scientific understanding of the marine environment and of the ways in which MPAs work to enact changes in marine ecosystems.

APPENDIX C-1. NORTH CENTRAL COAST REGION MAP INCLUDING THE ARRAY OF MPAS RECENTLY ADOPTED BY THE CALIFORNIA FISH & GAME COMMISSION

This plan has been designed for the monitoring of MPAs implemented in the North Central Coast study region, which includes all state waters along the California coastline from Alder Creek, near Point Arena, to Pigeon Point, including the Farallon Islands. The regional MPA network adopted for the region includes 24 MPAs, of three different types (state marine reserves (SMRs), state marine parks (SMPs), and state marine conservation areas (SMCAs)), and additional special closures and state marine recreational managed areas (SMRMAs).



* These SMCAs (Salt Point and Duxbury) were recommended by the Blue Ribbon Task Force for designation as state marine parks; they could subsequently be designated as state marine parks by the State Park and Recreation Commission at their discretion.

North Central Coast Study Region

California Fish and Game Commission Preferred Alternative

This marine protected area (MPA) proposal was selected on June 11, 2008 by the California Fish and Game Commission (CFGC) as its preferred alternative. The proposal integrated elements from three proposals developed by the North Central Coast Regional Stakeholder Group (NCCSRG) (proposals 1-3, 2-XA, and 4). The preferred alternative was subsequently adopted by the Commission on August 6, 2009 and went into effect on May 1, 2010.

APPENDIX C-2. NORTH CENTRAL COAST MPA BASELINE REQUEST FOR PROPOSALS (RFP)

This plan focuses on providing guidance for long-term monitoring, building on the foundations of information and knowledge to be developed through the North Central Coast MPA Baseline Program. The Baseline Program was developed to address the most time-sensitive aspects of MPA monitoring, which are:

1. Characterizing key aspects of the ecology and socioeconomics of the North Central Coast region near the time of MPA implementation,
2. Documenting initial changes in the two to three years after the MPAs take effect.

The North Central Coast MPA Baseline Program is being implemented through a Request for Proposals (RFP) process led by California Sea Grant. The full RFP text is provided in this appendix.

Request for Proposals

North Central Coast Marine Protected Areas Baseline Program

I. Funding Opportunity Description

The North Central Coast Marine Protected Areas (MPA) Baseline Program is a collaborative effort among the State Coastal Conservancy, Ocean Protection Council (OPC), California Department of Fish and Game (DFG), California Ocean Science Trust, MPA Monitoring Enterprise, and California Sea Grant. The program seeks to provide a summary description, assessment and understanding of ecological and socioeconomic conditions, inside and outside North Central Coast MPAs to be designated under the Marine Life Protection Act, at or near the time of MPA implementation. It also seeks to document the initial socioeconomic effects of MPA implementation and initial ecological changes in select ecosystem elements predicted to respond rapidly to protection.

$4,000,000 has been authorized to support the North Central Coast MPA Baseline Program. Proposals will be accepted for projects of up to three years in duration and including total funding requests of up $3,720,000, with a maximum indirect cost rate of 25%. A bidders' conference will be held on Tuesday, August 25, 2009, from 10:00 am to 5:00 pm in the San Francisco Airport Commission Aviation Library & Louis A. Turpen Aviation Museum, located in the International Terminal of the San Francisco airport, to provide more information to potential applicants and promote partnerships among applicants and collaborators. Additional details of this conference are available on the Sea Grant website. Project proposals will be due no later than 5:00 pm PDT September 28, 2009, and awards are expected to be made by December 18, 2009. Selected projects may begin any time after award contracts have been fully executed, but must commence within one year of the date of adoption of new MPA regulations by the FGC and preferably prior to implementation of regulations. Additional information and project requirements are provided below.

A. Background

The 1999 Marine Life Protection Act (Chapter 10.5 of the California Fish & Game Code, §2850-2863) directs the state to reevaluate and redesign California's system of marine protected areas (MPAs) to meet the following goals:

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 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.

The Marine Life Protection Act (MLPA) further requires monitoring of MPAs, specifically "monitoring, research, and evaluation at selected sites to facilitate adaptive management of MPAs and ensure that the [MPA] system meets the goals stated in this chapter".[1] The MLPA Master Plan for Marine Protected Areas directs that MPA monitoring programs be

[1] California Marine Life Protection Act, Fish and Game Code section 2853(c)(3). See also sections 2852(a), and 2856(a)(2)(H).

developed sequentially as planning is completed for each region.[2] The MPA Monitoring Enterprise has been established under the auspices of the California Ocean Science Trust to lead development of MPA monitoring that will meet MLPA requirements efficiently and cost-effectively. Accordingly, the MPA Monitoring Enterprise, in close collaboration with DFG and in consultation with stakeholders, scientists, and others, is leading development of a North Central Coast MPA Monitoring Plan.

The North Central Coast MPA Monitoring Plan is being built around an innovative, scientific framework designed to meet MLPA monitoring requirements. The framework includes: an assessment of the condition of North Central Coast marine ecosystems and changes in conditions over time, inside and outside MPAs; evaluation of changes in human uses of marine ecosystems following MPA implementation; and approaches to long-term evaluations relating to the design of the regional MPA network, such as MPA size and spacing. The framework has been designed to facilitate adaptive management of MPAs, help ensure that the regional MPA network component meets the goals of the MLPA, and improve understanding of the interaction of different elements within marine systems, as required under the MLPA. A draft of the monitoring plan, incorporating the framework, is scheduled for release for public review and comment in the fall of 2009. The final plan is expected to be submitted to the FGC in early 2010.

B. Program Purposes

The North Central Coast MPA Baseline Program (Baseline Program) is designed to be consistent with the monitoring framework and is essential for providing a foundation for ongoing monitoring.

The purposes of the Baseline Program are:

1. **Baseline Characterization**
   To provide a broad ecological and socioeconomic baseline characterization, meaning a characterization of the system at the time of MPA implementation or prior to MPA related changes occurring. This baseline characterization will provide a frame of reference to support subsequent assessment of MPA network performance against MLPA goals and facilitate future adaptive management. Baseline characterization includes:

   a. *Description of North Central Coast ecosystems inside and outside MPAs*
      Describe ecosystem structure and function, habitats, species assemblages and socioeconomic patterns at specific sites, inside and outside MPAs, and across the study region.
   b. *Initial data points for long-term tracking of condition and trends in North Central Coast ecosystems*
      Establish the initial or "time zero" point(s) to begin long-term monitoring of changes in ecological and socioeconomic elements of the system, inside and outside MPAs, after MPA implementation.
   c. *Assessment of ecosystem condition at MPA implementation*
      Interpret ecological and/or socioeconomic data and results in the context of historical trend data, physical and other system drivers, and data from other protected or unprotected locations to understand the context of the implementation conditions.
   d. *Long-term monitoring recommendations*
      Inform long-term monitoring planning and implementation, for example through:
      i. Assessment and recommendation of new approaches to broad ecosystem assessment;
      ii. Initial examination of draft monitoring indicators provided in the framework, recommendation of refinements or alternatives to these indicators, and recommendation of a minimum or sufficient

[2] California Marine Life Protection Act Master Plan for Marine Protected Areas. California Department of Fish and Game. Revised Draft. January 2008. p. 73

set of indicators to assess long-term status and trends for one or more Ecosystem Features (defined later in this document);

iii. Surveys of sites inside and outside MPAs to identify and characterize appropriate test and reference or control sites for long-term monitoring, or;

iv. Pilot testing of new or improved methods (analyses, technologies, etc.) for long-term monitoring.

2. Assessment of Initial Socioeconomic and Ecological Changes

To identify and measure initial socioeconomic and ecological changes occurring following MPA implementation, with a focus on those considered likely to be rapid and important effects of the MPAs and investigation of the extent to which such changes can or cannot be attributed to the establishment of the MPAs or other causal or contributing factors. Priorities for assessing initial changes following MPA implementation are:

a. Description of changes in commercial and recreational fishing
Describe changes in commercial and recreational fishing effort, catch and value that are or seem likely to be attributable to MPA implementation.

b. Description of changes in non-consumptive recreational use
Describe changes in recreational boating, shore/beach visitation, marine wildlife viewing, scuba diving, and other recreational activities that are or seem likely to be attributable to MPA implementation.

c. Description of changes in selected ecological components of North Central Coast marine ecosystems
Identify and select habitat, species, or other ecosystem elements considered to be sensitive and rapid in responding to MPA implementation and describe any changes observed that may or seem likely to be due to the MPAs.

This Request for Proposals (RFP) seeks proposals that collectively will best address the above Baseline Program purposes. Proposed projects should include project goals that are explicitly linked to the Baseline Program purposes. Individual projects will be evaluated on their contribution towards the Baseline Program purposes. Proposals addressing multiple purposes and/or ecosystems are encouraged.

C. Program Scope & Timeframe

Priority will be accorded to projects with specific project goals that effectively and efficiently meet one or more of the Baseline Program purposes described above, although consideration will also be given to proposals presenting a compelling case for additional purposes and project goals. Proposals will be accepted for projects up to three years in duration. However, applicants should carefully consider the project duration necessary to achieve stated project goals and should articulate the need for multi-year approaches, where proposed.

The North Central Coast region extends along the California coastline from Alder Creek near Point Arena in Mendocino County to Pigeon Point in San Mateo County and includes all state waters within this region, including the Farallon Islands. Proposals that include data collection outside the North Central Coast region may be considered, but applicants should clearly justify why this is important and necessary to achieve the Baseline Program purposes. The final MPA network for the region is expected to include MPAs of three different types: state marine reserves, state marine parks, and state marine conservation areas as well as other special closures (see Supporting Information, North Central Coast Draft Environmental Impact Report for definitions and more information). All of these are included within the Baseline Program.

Projects may include analysis of existing data and/or collection of new data. Projects to conduct baseline characterization should involve collection of new data only if, or to the extent that, existing data are insufficient to describe and interpret system conditions at the time of MPA implementation. Projects to assess initial socioeconomic or ecological changes

following MPA implementation are expected to require collection of new data; the duration of data collection should be scaled to match the timeframe of expected initial changes to a maximum of three years.

D. Program Priorities

As noted above, priority will be given to proposals that best contribute towards achieving the Baseline Program purposes. In order to provide information allowing future assessment of progress toward meeting MLPA goals and to support adaptive management, proposed projects should also align with planned long-term MPA monitoring as described below.

Draft MPA Monitoring Framework

The MPA Monitoring Enterprise, in collaboration with the DFG, has developed a North Central Coast draft MPA Monitoring Framework as the foundation for long-term MPA monitoring. The central focus of this framework is to collect monitoring information that can be interpreted at an ecosystem level – i.e., that can provide information about the condition of, and trends within, whole ecosystems over long time scales, and which also assesses the effectiveness of the regional MPA network toward achieving MLPA goals. The following ecosystem types and human-use categories have been identified as the focuses for MPA monitoring in the region:

- Rocky intertidal ecosystems
- Kelp and shallow (0-30m depth) rock ecosystems
- Deep (30-116m depth) rock ecosystems
- Estuarine ecosystems
- Beaches and soft-bottom intertidal ecosystems
- Subtidal (0-100m depth) soft-bottom ecosystems
- Pelagic ecosystems (defined here as the water column habitat within state waters)
- Consumptive uses
- Non-consumptive uses

These seven ecosystem types and two use categories are collectively referred to as “Ecosystem Features” within the draft monitoring framework, explicitly including humans within ecosystems. These Ecosystem Features collectively represent and encompass the North Central Coast region for the purposes of MPA monitoring, providing a focus for long-term monitoring and a framing for baseline characterization.

Priority will be accorded to proposals that are consistent with this draft framework, and thus will contribute to providing a robust foundation for long-term monitoring. Summary descriptions of the draft long-term monitoring recommendations for the Ecosystem Features are included in Attachment 1 to assist development of project proposals that are consistent with the draft framework.

Priorities for MPA Baseline Characterization

To meet the overall objectives of baseline characterization and align with the long-term draft MPA Monitoring Framework the following priority topics have been identified:

- Description of each Ecosystem Feature including ecosystem structure, ecosystem processes, habitat characteristics, species assemblages, human-uses and socioeconomic structures and patterns inside and outside MPAs
- Analysis and interpretation of habitat mapping data to describe the distribution and characteristics of the Ecosystem Features within the region, inside and outside MPAs

- Provision of the initial data points for ongoing monitoring through collection of data on all candidate metrics for each Ecosystem Feature (see Attachment 1 for summary of candidate metrics)
- Assessment of the implementation conditions for each Ecosystem Feature, inside and outside MPAs, using historical and other existing contextual information (such as economic, fisheries or oceanographic information) where available
- Evaluation of the candidate metrics for each Ecosystem Feature and recommendations for modifications as necessary

In addition, proposals will also be accepted that suggest an alternative approach to meet the Baseline Program purposes. Innovative approaches may be proposed that retain aspects of the draft MPA monitoring framework (e.g., Ecosystem Features) or which include an entirely novel approach to baseline MPA characterization, but compelling justification for the alternative should be provided.

Priorities for Assessment of Initial Socioeconomic and Ecological Changes Following MPA Implementation

The following topics have been identified as priorities for assessment of initial socioeconomic and ecological changes following MPA implementation, aligning with the long-term draft MPA monitoring framework:

- Description of initial changes in consumptive uses, focused on changes in commercial and recreational fishing effort, catch and value associated with individual MPAs, regional ports and across the full North Central Coast region
- Description of changes in non-consumptive uses, focused on changes in the level of recreational boating, shore/beach visitation, marine wildlife viewing and scuba diving activity associated with individual MPAs, coastal communities, access locations and across the full North Central Coast region
- Identification and selection of habitats, species or other ecosystem elements within the Ecosystem Features that are considered to be sensitive and likely to respond to MPA implementation, and description of the changes (or lack of changes) observed inside and outside MPAs
- Assessment of the observed socioeconomic and ecological changes using historical and other contextual information (such as economic indicators, fishing regulations, oceanographic information) to evaluate whether the observed changes may be attributable to MPA implementation

Proposals will also be accepted that suggest alternative focuses for assessment of initial socioeconomic and ecological effects of MPA implementation but compelling justification for the alternative focal topics should be provided.

Project Characteristics (for all projects)

To incorporate the priorities identified above and provide a foundation for a subsequent synthesis of results across all projects and topic areas, projects should strive to include the following elements:

- Inclusion of multiple MPAs and, where appropriate, reference or control sites outside MPAs
- Generalized regional results and conclusions in addition to MPA- or location-specific analyses and conclusions
- For projects addressing MPA baseline characterization, complete baseline characterization for one or more Ecosystem Features including data collection encompassing the draft long-term monitoring recommendations and additional data as necessary to broadly characterize and assess implementation conditions

Given these desired project characteristics, partnerships are strongly encouraged - including partnerships between and among academic scientists and citizen-groups, and partnerships that build upon existing programs and relevant data. The

creation of these partnerships will be facilitated by a bidders' conference and participation in this meeting is strongly recommended (additional details described below).

E. Project Deliverables

Primary Investigators are responsible for the production and delivery of the following project products: (1) raw data and metadata; (2) annual progress report(s) for projects exceeding 16 months duration; and (3) final report.

Data and Metadata

Raw data and associated metadata should be delivered to DFG and the MPA Monitoring Enterprise before or as part of the completion of the project. Final project payment will not be made until data and metadata have been received. Raw data products may include, but are not limited to, text reports, databases, spreadsheets, maps, GIS layers, photographs and other images. All projects should employ a standardized reporting protocol. Sufficient metadata should also be provided to fully describe the raw data, collection methods, and data reporting structure. Ecological Metadata Language (EML) is adopted here as a minimum metadata reporting standard. Projects not employing this standard should include justification and description of how their alternative standard meets the minimum requirements.

Upon delivery to DFG and the MPA Monitoring Enterprise and thereafter, all data and metadata will be widely available to the public and other researchers. Investigators, however, will retain the right to publish results before and after project completion.

Annual Progress Reports

For projects exceeding 16 months duration, annual progress reports are required at 12-month intervals following the contract start date. Annual progress reports should briefly describe progress towards specified project goals, and provide timelines (progress in meeting milestones) for work completed and remaining. They should also provide updated financial information including budgeted costs and actual expenditures and justifications for variances. Incurred or anticipated budget (positive or negative) variances in excess of 10% of the budgeted amount should be approved by the Sea Grant Office.

Final Reports

Each project is required to produce and deliver a final report to California Sea Grant. Final reports must include the following sections:

1. A narrative accounting of the project's progress towards program purposes and project goals.
2. A financial report showing budgeted and actual costs and variances, with explanations of any positive or negative variances of greater than 10% of the budgeted amount.
3. For projects including baseline characterization components, a final baseline characterization report, which should include appropriate methods descriptions, data summaries, analyses and interpretation to describe, assess and understand the implementation conditions. Reports should include explicit reference to the Baseline Characterization objectives (Section B, item 1) and the supporting results, analyses and interpretation required to meet each objective. In addition, reports should include MPA or site characterizations as well as a regional assessment.
4. For projects including identification of initial socioeconomic or ecological changes following MPA implementation, a final report of changes observed (or explored but not observed), the rationale for focusing on those (potential) changes to document potential initial MPA effects, and an interpretation of the causes and contributing factors for the changes or lack of changes observed.

5. An Executive Summary, summarizing methods and key findings and conclusions, in 1-2 pages of text and, if needed, an additional 1-2 pages of figures. The Executive Summary should be written to be appropriate for broad public release (e.g., posting on MPA Monitoring Enterprise website, provision to the FGC).

Final reports will be reviewed by California Sea Grant, DFG, and the MPA Monitoring Enterprise. The sections of final reports consisting of baseline characterization reports and/or reports of initial changes following MPA implementation will also be subject to scientific peer review. Final reports should be revised in accordance with reviewer comments before final submission and acceptance by California Sea Grant. Final project payments will be made following receipt and acceptance of all deliverables.

Following completion of all projects and receipt and acceptance of all final project reports, a synthesis of major findings will be prepared and a final public summary report will be produced. Project Leaders will be given the opportunity to review a draft of the summary report.

F. Supporting Information

MLPA Master Plan
http://www.dfg.ca.gov/mlpa/masterplan.asp

North Central Coast Regional Profile
http://www.dfg.ca.gov/mlpa/nccprofile.asp

North Central Coast Draft Environmental Impact Report (includes detailed descriptions, maps, objectives, and rationale for proposed MPAs)
http://www.dfg.ca.gov/mlpa/impact_ncc.asp

Additional documents relating to regulatory process for North Central Coast MPAs, including proposed regulatory language
http://www.fgc.ca.gov/regulations/new/2009/proposedregs09.asp#632ncc

Additional background information for the North Central Coast MLPA planning process and documents
http://www.dfg.ca.gov/mlpa/northcentralhome.asp

MPA Monitoring Enterprise
http://www.calost.org/monitoring_ent.html

II. Award Information

$4 million is available to support the North Central Coast MPA Baseline Program. Funding is available for projects of any duration up to three years. No limit has been placed on the budget for individual proposals so that multiple investigators can submit collaborative proposals that address numerous issues identified under Program Priorities. Funds are expected to be awarded in December, 2009. Full payment of awards may be contingent on continued availability of state funding.

III. Eligibility Information

A. Eligible Applicants

Individuals, institutions of higher education, nonprofit organizations, commercial organizations, and state, local, and Indian tribal governments are all eligible to submit proposals.

B. Cost-sharing or Match Requirement

Projects must include at least a 25 percent match in funds (cash and/or in-kind contributions) from applicants. Larger matches or additional cost sharing arrangements are encouraged and will be taken into consideration when evaluating proposals (see Evaluation Criteria for more information).

IV. Application and Submission Information

A. Application Package

The entire application package is available online through California Sea Grant's website:
http://www.csgc.ucsd.edu/FUNDING/APPLYING/NorthCentralCoastMPA2009-10.html

If you do not have internet access, please contact Carol Bailey-Sumber at 858-534-7855 or sgproposal@ucsd.edu.

B. Content and Form of Application Submission

Preliminary proposals are *not required*. Only full proposals will be considered. Proposals should include all required elements; incomplete proposals may not be accepted.

Please submit an electronic copy of the full proposal (see Submission Information and Date). The number of pages must be in accordance with the page limitation specified under "Required Elements." All files in the full proposals when printed must measure 8.5" x 11" with an 11 point, san serif font (Arial or Helvetica).

C. Required Elements

Cover Sheet

A cover sheet template is located on the California Sea Grant website. Please provide all requested information and obtain the required signatures. If you are applying from an academic institution, send your original proposal to your Campus research office for local campus approval. If your proposal encompasses more than one campus, please obtain approval from each campus and all required signatures. Make sure to send your original, signed coversheet with your full proposal.

Percentage of time should be shown for the Project Leader and the Co-Project Leader. This should agree with the amount shown on the Sea Grant Project Summary Form and should be converted to "Months of Effort." (Example: 10 percent time=1.2 months of effort.) Please leave the trainee section blank.

Project Summary

A project summary form is located on the California Sea Grant website. The form is a PDF that can be filled out electronically. You may save your information at any time. In addition, there are detailed instructions available that should help you to accurately complete the form. Please follow them carefully - the project summary is the most widely consulted description of your project.

Narrative

Proposal format may vary, however proposals should include all the information listed below. The proposal narrative should not exceed 15 pages (excluding references, illustrations, charts, tables, and figures).

- *Project Title* – Project titles should be constructed to provide as much information as possible but must not exceed two lines (approximately 16 words).

- *Project Leader(s) and Associated Staff* - The roles of the project leader(s) and associated staff should be included.
- *Project Goals and Objectives* – This section should identify the scope of the proposed project in relation to the Baseline Program purposes and priorities identified above.
- *Rationale* – The project rationale should articulate the significance of the proposed project in contributing towards the Baseline Program purposes. Projects will be evaluated on the basis of criteria which include innovative approaches to MPA monitoring. New approaches included in the proposal should be identified and discussed, including discussion of the potential value of the approach for long-term monitoring.
- *Approach to be Used (Plan of Work)* – This section should describe the proposed methods and analytical approaches, and should explicitly consider the utility of existing information and the need for new data collection. Where projects propose new data collection, a rationale for the proposed temporal and spatial scale of sampling should be provided, including rationale for MPA selection. A description of the intended mechanism or analytical framework to provide a regional assessment of the studied ecosystem component should also be included.
- *Outcomes and Deliverables* – Project outcomes should be clearly related to the initial project goals. A clear description of the intended project deliverables should be provided, including description of final reports, data and other products, and associated timelines for development and delivery.
- *Milestones Chart* – Projects may be proposed for up to three years in duration. A graphical representation of the total project duration and sequence of key steps or tasks over the course of the project, with associated timing, should be provided with clear justification for the duration of each key step or task (see example on Sea Grant website).
- *References* – List all included references alphabetically following the list format from the Chicago Manual of Style.

Note: Project Leader(s) will be required to execute a non-disclosure agreement with DFG for awarded projects that require DFG confidential information (such as landings or license information) and/or may be asked to sign a mutually agreed-upon Memorandum of Understanding regarding data expectations (e.g., data housing, maintenance, and protection) for awarded projects that generate their own confidential information as part of the scope of work.

Budget and Budget Justification

Applicants are strongly encouraged to use the California Sea Grant budget form, available to download from the California Sea Grant Proposal web page. Applicants may use their own form as long as it includes the same information as the California Sea Grant form. Each budget should include a separate budget justification page that itemizes all budget items in sufficient detail to enable reviewers to evaluate the appropriateness of the funding requested. Please see the California Sea Grant website for detailed instructions.

Current and Pending Support

Applicants must provide information on all current and pending support where this is relevant to conducting the proposed project. Please use the Current and Pending Research form on the California Sea Grant website.

Vitae

Curriculum vitae should include relevant experience, skills and publications. Publications should be provided in reverse chronological order. A complete list is not required; however applicants should include those publications that are relevant to the proposal. Full vitae should not exceed two pages, single-spaced per individual.

C. Submission Information and Date

Proposals are due in the California Sea Grant office by 5:00 pm (PDT) on Monday, September 28, 2009. Late proposals will not be accepted.

Please upload an electronic copy of all proposal items, with required signatures. The electronic version of your proposal must be submitted as PDFs using the California Sea Grant proposal submission link:

https://csgc.ucsd.edu/wpe/submissions/PILogin.php

IMPORTANT: Contact us at sgproposal@ucsd.edu to obtain a password to use the website link BEFORE submitting any files.

Please make sure to include your last name in the file name for each section of the proposal (e.g., Smith_budget.pdf or Smith_cv.pdf). Once submitted through the website, PDFs may not be edited. To change a PDF, it must be deleted and resubmitted. The maximum size of a PDF submitted online is 6 MB. To submit larger files, please contact sgproposal@ucsd.edu.

For questions regarding the proposal submission website itself, please contact Roberto Chavez at: (858) 534-4441; email rachavez@ucsd.edu.

D. Funding Restrictions

Your total request may not exceed $3,720,000 and in addition, research conducted with North Central Coast MPA Baseline Program funds must limit the indirect cost rate to 25% or less. There are no other funding restrictions.

E. Bidders' Conference

A bidders' conference will be held on Tuesday, August 25, 2009, from 10:00 am to 5:00 pm in the San Francisco Airport Commission Aviation Library & Louis A. Turpen Aviation Museum, located in the International Terminal of the San Francisco airport. Staff from California Sea Grant, the MPA Monitoring Enterprise and DFG will use this opportunity to more fully discuss the objectives of the program with all applicants. The conference will be an opportunity for applicants to ask specific questions or request additional data. Individual applicants or potential collaborators and partners can use it as an opportunity to form collaborations with the objective of submitting joint applications.

All potential applicants are strongly encouraged to attend. Potential public partners, including fishermen and other citizens interested in taking part in monitoring efforts, are also encouraged to attend to explore potential collaborations.

Additional information about the bidders' conference, including directions to the Aviation Museum, is available on the Sea Grant website.

V. Proposal Review Information

A. Evaluation Criteria

Proposals will be evaluated against the following criteria:

1. *Relevance and applicability to the North Central Coast MPA Baseline Program purposes and priorities.* Assessment of the alignment of project goals, objectives, and rationale with Baseline Program purposes and with the North Central Coast draft MPA Monitoring Framework or a clearly justified alternative approach.

2. *Scientific/technical merit*
   Assessment of the conceptual framing and technical approaches proposed to achieve project goals. Proposals should seek efficiencies in collecting data that answer multiple questions and address multiple program purposes and priorities.

3. *Innovation*
   Innovative approaches to monitoring that take into account new and/or recently proven monitoring methods or approaches are encouraged particularly where these test efficient approaches for ecosystem assessment including ecosystem structure, function and integrity.

4. *Collaboration and partnerships*
   Inclusion of partnerships between and among, academic scientists, citizen science groups and other community organizations, and partnerships with existing organizations and programs to leverage the financial resources and support from existing efforts. Priority will be given to projects that address multiple MPA Baseline Program purposes through partnerships and collaboration.

5. *Project costs and funding leverage*
   A minimum 25% funding match is required in all proposals. Additional matching funds or cost-sharing is encouraged and will be considered during proposal evaluation. Project costs should appropriately reflect the goals and objectives and proposed methods and should seek efficiencies via collaboration and careful work plan design.

6. *Qualifications of investigator(s)*
   Assessment of whether the applicants possess the necessary knowledge, experience, training, facilities and resources to complete the project.

7. *Project management experience, expertise, and skills*
   Assessment of multiple facets of project management, including a proven track record in completing contracts on time and within budget, experience managing and working in multi-party, multidisciplinary teams, and communication skills. Communication skills include the ability to provide clear and effective communication of project goals, approaches and results to diverse audiences interested in monitoring information.

8. *North Central Coast knowledge & experience*
   Where proposals are ranked equally on the basis of the above criteria, additional priority will be given to those projects that take best advantage of the knowledge and capacity existing within the North Central Coast region, through demonstrated knowledge, partnerships, collaborations or other mechanisms.

B. Review & Selection Process

Selection is competitive. Proposals will be subject to peer-review on the basis of scientific & technical merit. Applications must be submitted to the California Sea Grant College Program Office no later than 5:00pm (PDT) on September 28, 2009 in order to be considered for peer-review and funding. The Baseline Program management team, including representatives of California Sea Grant, the MPA Monitoring Enterprise, DFG, and the OPC will make the final project selection based on the peer-review results and the criteria outlined above. All applicants will be notified of the selection decision by mid-December, 2009.

C. Selection Factors

The Baseline Program management team shall award in rank order unless the proposal is justified to be out of rank order based on any of the following criteria: availability of funds, distribution of funds, duplication of other projects, program priorities, and applicant's prior performance.

Applicants may be asked to modify objectives, work plans, or budgets prior to award funding. Applications must reflect the total budget necessary to accomplish the project. Applicants will be bound by the percentage of cost sharing reflected in the grant award.

D. Announcement & Award Dates

September 28, 2009 (5:00 pm PDT) - Applications due at California Sea Grant College Program
December 7, 2009 (approximate) - Applicants notified of selection results
December 18, 2009 (approximate) - Funds awarded for selected applicants

VI. Award Administration

A. Award Notices

A member of the Baseline Program management team will notify successful applicants by telephone shortly after the review panel meeting in mid-November. A subsequent letter with reviewer comments will follow.

B. Reporting

Applicants who receive a grant award will be responsible for submitting both financial and technical (progress and final) reports to California Sea Grant, as described above.

VII. Program Contacts

A. California Sea Grant

Assistance with overall RFP process and information about the bidders' conference

- Shauna Oh, Assistant Director, California Sea Grant College Program
  Phone: (858) 822-2708
  Email: sgproposal@ucsd.edu

General Proposal Help (assistance with forms, format and submission)

- Carol Bailey-Sumber, Grants Specialist
  Phone: (858) 534-7855
  Email: sgproposal@ucsd.edu

Budget Help

- Catherine Hughes, Business Office
  Phone: (858) 534-4440
  Email: sgbudget@ucsd.edu

Computer/Internet-related Help

- Roberto Chavez , Programmer
  Phone: (858) 534-4441
  Email: webadmin@seamail.ucsd.edu

B. MPA Monitoring Enterprise

Assistance with Baseline Program and proposal objectives

- Liz Whiteman, Lead Scientist
  Phone: (510) 251-8317
  Email: mpamonitoring@calost.org

C. Department of Fish and Game

Assistance with DFG programs, priorities, or data

- Jason Vasques, Associate Marine Biologist, MPA Project
  Phone: (650) 631-6759
  Email: jvasques@dfg.ca.gov

Attachment 1: Summary of North Central Coast Draft MPA Monitoring Framework

The following pages provide a summary of aspects of the draft monitoring framework for on-going monitoring of the North Central Coast MPAs. This framework has been developed through consultations with scientists and stakeholders, including members of the former North Central Coast Regional Stakeholder Group and Science Advisory Team. This framework is still under development. It will form the core of the draft North Central Coast MPA Monitoring Plan, which is scheduled for release for public review and comment in October 2009.

The North Central Coast MPA Baseline Program responds to the most time-sensitive needs for collecting data to support monitoring: data to describe system conditions at or near the time of MPA implementation in order to provide one frame of reference for future comparisons; and identification and measurement of key socioeconomic and ecological changes in the first two to three years following MPA establishment. Thus, the North Central Coast MPA Baseline Program is being launched before completion of the North Central Coast MPA Monitoring Plan, which focuses more on long-term monitoring and will take several additional months to complete.

The Baseline Program aligns with the North Central Coast MPA Monitoring Plan. It has been designed to complement the monitoring framework, thereby providing a robust foundation on which to implement long-term monitoring. As described in the RFP, the Baseline Program also offers the opportunity to collect data which can help refine this framework and inform long-term monitoring, for example by testing candidate metrics or informing selection of long-term monitoring sites. Priority will thus be given to proposals which are consistent with the draft monitoring framework, as described in the RFP.

Each of the following pages summarizes the current draft approach to monitoring the condition and trends of one of the identified Ecosystem Features. For each Feature, candidate monitoring metrics are presented. Candidates for inclusion in "Ecosystem Feature Checkup" are being developed to facilitate community-based monitoring. Candidates for use in "Ecosystem Feature Assessment" are being developed to provide a finer-grained evaluation of the specified ecosystem. Either or both of "Ecosystem Feature Checkup" and "Ecosystem Feature Assessment" approaches may be used in long-term monitoring to track the condition of the Ecosystem Features, inside and outside MPAs, and how conditions change over time. Possible monitoring configurations will be included in the draft North Central Coast MPA Monitoring Plan.

SUMMARY: KELP & SHALLOW ROCK ECOSYSTEMS

Kelp ecosystems and shallow rock ecosystems occur in areas of rocky substrate between mean lower low tide and 30m water depth. Kelp beds are highly dynamic and canopy extent, for example, may vary dramatically among seasons and years. Many of the same fish and invertebrate species, including economically important species, are found in shallow rock substrate habitats regardless of the presence of kelp. These habitats have therefore been combined into one ecosystem feature. Important drivers of these ecosystems include water temperature and geomorphological context, as well as salinity, nutrients, light, and turbidity.

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Red sea urchin abundance
- Purple sea urchin abundance
- Red abalone abundance
- Average & maximum rockfish size
- Lingcod average size and abundance

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Biogenic Habitat: Macroalgae assemblage	Areal extent of surface kelp canopy (*Macrocystis pyrifera* & *Nereocystis leutkeana)*
	Kelp stipe density & size structure
Invertebrates	Purple sea urchin (*Strongylocentrotus purpuratus*) density & size structure
	Red sea urchin (*Strongylocentrotus franciscanus*) density & size structure
	Red abalone (*Haliotis rufescens*) density & size structure
	Sea star (*Pisaster/Pycnopodia* spp.) density & size structure
Piscivorous fishes	Black rockfish (*Sebastes melanops*) density & population size structure[1]
	Lingcod (*Ophiodon elongatus*) density & population size structure[1]
	Cabezon (*Scorpaenichthys marmoratus*) density & population size structure[1]

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

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Biogenic Habitat: Macroalgae assemblage	Sub-canopy & turf algae cover
	Compound tunicate (multiple species) cover
Planktivorous fishes	Blue rockfish (*Sebastes mystinus*) density and population size structure[1]
Omnivorous fishes	Black & yellow rockfish (*Sebastes chrysomelas*) density & population size structure[1] AND Gopher rockfish (*Sebastes carnatus*) density & population size structure[1]
	Kelp rockfish (*Sebastes atrovirens*) density & population size structure[1]
Unfished fishes	Giant kelpfish (*Heterostichus rostratus*) abundance
	Painted greenling (*Oxylebius pictus*) abundance

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

SUMMARY: DEEP ROCK ECOSYSTEMS

Deep rock ecosystems are defined as those areas of rock substrate occurring between depths of 30m and 116m, the maximum depth at which this ecosystem type is found within state waters in the North Central Coast. However most of the deep rock ecosystems in this region occur at depths of 30-50m and monitoring focuses on gathering information most appropriate for the habitats and species assemblages occurring in this depth range. Important physical drivers and contextual information for this ecosystem include geomorphological context and habitat characterization/complexity.

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Dungeness crab abundance
- Average & maximum rockfish size
- Lingcod average size and density
- Total dwarf rockfish abundance

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Sessile Invertebrates	Density of structure forming invertebrates
	Cover of structure forming invertebrates
Mobile Invertebrates	Density of Dungeness crab (*Cancer magister*)
	Density of sheep (spider) crabs (*Loxorhynchus grandis*)
	Density of box crabs (*Lopholithodes foraminatusi*)
Piscivorous fishes	Bocaccio (*Sebastes paucispinis*) density and size structure
	Yelloweye rockfish (*Sebastes ruberrimus*) density and size structure[1]
	Vermilion rockfish (*Sebastes miniatus*) density and size structure[1]
	Lingcod (*Ophiodon elongatus*) density and size structure
Dwarf rockfish	Total dwarf rockfish abundance

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

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Sessile Invertebrates	Cover of encrusting invertebrates
	Metridium spp. bed cover
	Hydrocoral density
Omnivorous fishes	China rockfish (*Sebastes nebulosus*) density and size structure[1]
	Gopher rockfish (*Sebastes carnatus*) density and size structure[1]

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

SUMMARY: ROCKY INTERTIDAL ECOSYSTEMS

Rocky intertidal ecosystems are defined as areas of rock substrate occurring within the zone between mean high tide and mean lower low tide. In the North Central Coast region this includes exposed rocky cliffs, boulder rubble, exposed wave cut platforms and sheltered rocky shores. Important drivers of this ecosystem include geomorphology, temperature, swell, sediment flux, freshwater input, and disturbance (e.g., trampling).

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Mussel bed cover
- Purple sea urchin abundance
- Owl limpet abundance
- Ochre sea star abundance
- Black abalone abundance
- Red abalone abundance
- Abundance of black oystercatchers

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Biogenic Habitat	Cover of turf algae
	Cover of foliose red algae
	Cover of Fucoids (fleshy brown algae)
	Cover of mussels (*Mytilus* spp.)
	Cover of feather boa kelp *(Egregia* sp.)
	Cover of surf grass (*Phyllospadix* spp.)
Invertebrates	Black abalone (*Haliotis cracherodii*) density and size structure
	Red abalone (*Haliotis rufescens*) density and size structure
	Sea star (*Pisaster ochraceous, Pycnopodia*) density
	Purple sea urchin (*Strongylocentrotus purpuratus*) density
	Giant/owl limpet (*Lottia gigantea)* density and size structure

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Predatory birds	Total abundance of piscivorous birds and shorebirds
	Diversity of piscivorous birds and shorebirds
	Abundance of black oystercatchers (*Haematopus bachmani*)
Intertidal fishes	Total YOY (young-of-the-year) rockfish abundance
	Monkeyface prickleback (*Cebidichthys violaceus*) density
	Rock prickleback (*Xiphister mucosus*) density

SUMMARY: SOFT-BOTTOM SUBTIDAL ECOSYSTEMS

Soft-bottom subtidal ecosystems are defined as areas of sediment substrate occurring between mean lower low tide and 100m depth. This ecosystem feature encompasses both nearshore and offshore environments, including sediment habitats in flat expanses and on slopes. This is the predominant habitat type on the continental shelf and slope throughout the region. Important drivers of this ecosystem include oceanographic features (e.g., subsurface currents), sediment supply and characteristics (e.g. grain size), and physical disturbance.

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Sea star abundance and size structure
- Dungeness crab abundance
- Starry flounder abundance
- Halibut abundance and average size
- Total flatfish abundance

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Biogenic habitat	Total cover of biogenic habitat (multiple species)
	Biogenic habitat diversity
Benthic Infauna	Functional diversity of benthic infauna (feeding guilds)
	Sand dollar (*Dendraster excentricus*) abundance and size structure
Benthic Invertebrate Predators	Dungeness crab (*Cancer magister*) density and size structure
	Sea star (*Pycnopodia/Pisaster* spp.) abundance and size structure
Demersal Fish Predators	California halibut (*Paralichthys californicus*) density & size structure
	Starry flounder (*Platichthys stellatus*) density and size structure
	Sanddab (*Citharichthys* spp.) density and size structure

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

None currently.

SUMMARY: ESTUARINE ECOSYSTEMS

Estuarine ecosystems within the North Central Coast region encompass soft-sediment habitats, including coastal marsh, tidal mudflats and eelgrass beds, and areas of open water. The shoreward boundary of this ecosystem feature is drawn at the extent of tidal reach and salt water associated vegetation. Lagoons that are rarely open to the ocean and characterized by more freshwater species are not included. Important drivers of this ecosystem include freshwater regime (flow, sedimentation, nutrients), invasive species, contaminant loads, and geomorphology (grain size).

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Areal extent of eel grass
- Ghost and mud shrimp abundance
- Clam abundance & size structure (Geoduck, gaper, littleneck clams)
- Starry flounder abundance
- Total diversity and abundance of piscivorous & shore birds
- Harbor seal abundance (colony size)

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Biogenic Habitat	Eelgrass (*Zostera marina*) areal extent
Infaunal Assemblage	Mud shrimp (*Upogebia pugettensis)* abundance
	Ghost shrimp (*Neotrypaea californiensis*) abundance
	Fat innkeeper worm (*Urechis caupo*) abundance
	Pacific gaper clam (*Tresus nuttalli*) abundance
	Littleneck clam (*Protothaca staminea*) abundance
Resident Fish	Shiner (*Cymatogaster aggregata*) and striped (*Embiotoca lateralis*) surfperch abundances
Predatory Birds	Total abundance and diversity of piscivorous birds and shorebirds
Predatory Fish	Leopard shark (*Triakis semifasciata*) abundance
	Bat ray (*Myliobatis californica*) abundance
Harbor seal haulout sites	Harbor seal (*Phoca vitulina richardsi*) abundance (colony size)

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Biogenic Habitat	Eelgrass (*Zostera marina*) shoot density
	Areal extent of common pickleweed (*Salicornia virginica*)
	Areal extent of sea lettuce (*Ulva* spp.)
	Native oyster abundance
Infaunal Assemblage	Abundance and foraging rates of shorebirds

SUMMARY: SOFT-BOTTOM INTERTIDAL & BEACH ECOSYSTEMS

Soft sediment intertidal and beach ecosystems are defined as wave-dominated areas of sand and gravel substrate occurring below the mean high tide and above mean lower low water. In the North Central Coast region this includes continuous expanses of sandy shores as well as enclosed or pocket beaches. Habitats with mud substrates, including tidal flats and coastal marsh, and barrier beaches forming at the mouths of rivers are included within the estuarine ecosystem feature for the purposes of identifying key attributes and indicators. Important drivers of this ecosystem include wave regime and nutrient inputs.

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Abundance of sand crabs
- Total diversity and abundance of piscivorous & shore birds
- Harbor seal colony size

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Suspension feeders	Sand crab (*Emerita analoga*) abundance and size structure
	Razor clam (*Siliqua patula*) abundance and size structure
Surf zone fish assemblage	Surfperch abundance (Embiotocidae, multiple species)
	Surf smelt (*Hypomesus pretiosus*) abundance and size structure
Predatory birds	Total abundance of predatory birds
	Predatory birds species diversity

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

None currently.

SUMMARY: PELAGIC ECOSYSTEMS

The pelagic ecosystem feature is defined as the water column habitat occurring within state waters, and includes waters overlaying the continental shelf to 116m deep. This ecosystem feature includes oceanographic features such as upwelling and retention areas that affect the productivity and species assemblages within the pelagic environment and influence benthic habitats. During upwelling seasons, nutrient-rich waters fuel highly productive and diverse ecosystems linking pelagic and benthic habitats. Important drivers of this ecosystem include physical oceanography (PDO; temperature; multivariate ENSO index), water quality (oxygen; temperature; HAB occurrence; chlorophyll concentration; nutrients).

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

Vital Signs:

- Pelagic/semi-pelagic rockfish average & maximum size
- Brandt's cormorant abundance (colony size)
- Pelagic cormorant abundance (colony size)
- Pigeon guillemot abundance (colony size)
- Cassin's Auklet breeding success

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Piscivorous Fishes	Widow rockfish (*Sebastes entomelas*) abundance and size structure
	Yellowtail rockfish (*Sebastes flavidus*) abundance and size structure
	Blue rockfish (*Sebastes mystinus*) abundance and size structure
	Shortbelly rockfish (*Sebastes jordani*) abundance and size structure
Seabirds	Brandt's cormorant (*Phalacrocorax penicillatus*) colony size (abundance) and fledgling rate
	Pelagic cormorant (*Phalacrocorax pelagicus*) colony size (abundance) and fledgling rate
	Pigeon Guillemot (*Cepphus columba*) abundance and fledgling rate
	Common murre (*Uria aalge*) colony size (abundance) and fledgling rate

POTENTIAL ADDITIONAL METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Candidate Attributes	Candidate Focal Species/Indicators
Ichthyoplankton	Total ichthyoplankton abundance
	Total abundance of rockfish larvae
	Ratio of fished species to unfished species

SUMMARY: CONSUMPTIVE USES

Consumptive uses include those activities involving extraction or consumption of living marine resources and reflect the activities discussed within the MLPA Initiative planning process. Important drivers of consumptive uses include changing fishing effort inside and outside MPAs, changes in fisheries regulations, climate and oceanographic shifts causing natural fluctuations in fish stocks, and the broader economic environment.

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

[Under revision]

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

DRAFT INDICATOR FRAMEWORK

For each consumptive use or activity, indicators may follow a similar overarching structure:

1. **Number of people engaged in the activity**
2. **Level of activity** (e.g. number of trips, landings of key species per vessel/port/region, CPUE)
3. **Economic value or quality of activity** (e.g. landings value of key species per vessel/port/region, ex vessel value, net revenue)
4. **Knowledge, Attitudes and Perceptions (KAP) of participants**

DRAFT CONSUMPTIVE USES FOR MONITORING

For each consumptive use or activity, potential key fishery species for monitoring are noted. The indicator framework above can be applied to each consumptive use and associated fishery species.

- Commercial Fishing
    - Nearshore rockfish (*Sebastes* spp.)
    - Dungeness crab (*Cancer magister*)
    - California halibut (*Paralichthys californicus*)
    - Red sea urchin (*Strongylocentrotus franciscanus)*
- Recreational Fishing – Commercial passenger fishing vessels (CPFVs)
    - Rockfish (*Sebastes* spp.)
    - Lingcod (*Ophiodon elongates)*
    - California halibut (*Paralichthys californicus*)
- Recreational fishing – Abalone diving

DRAFT ADDITIONAL CONSUMPTIVE USES FOR MONITORING

- Recreational Fishing – Private vessels
- Recreational Fishing – Clamming
    - Pacific gaper clams (*Tresus nuttalli*)
    - Littleneck clams (*Prortothaca staminea*)

SUMMARY: NON-CONSUMPTIVE USES

Non-consumptive uses include activities that do not involve removal of marine resources. Both recreational and commercial aspects of non-consumptive uses are included within this ecosystem feature. Important divers include economic indicators (e.g., fuel costs, unemployment level, GDP, county income statistics), education & outreach activities, and ecological conditions.

CANDIDATE METRICS FOR ECOSYSTEM FEATURE CHECKUP

[Under revision]

CANDIDATE METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

DRAFT INDICATOR FRAMEWORK

For each non-consumptive use or activity, indicators may follow a similar overarching structure:

1. **Level of activity** (spatial use and intensity)
2. **Knowledge, Attitudes and Perceptions (KAP) of participants**

DRAFT NON-CONSUMPTIVE USES FOR MONITORING

The indicator framework above can be applied to each non-consumptive use or activity. Draft non-consumptive uses for monitoring include:

- Scuba diving
- Wildlife viewing – boating and kayaking
- Wildlife viewing – shore based
- Tidepooling

DRAFT ADDITIONAL NON-CONSUMPTIVE USES FOR MONITORING

- Recreational beach use
- Educational opportunity

APPENDIX C-3. SUMMARY REPORT FROM THE NORTH CENTRAL COAST MPA MONITORING PLANNING WORKSHOP 1, OCTOBER 22-23, 2008

Summary Report

Note: This document has been revised as of Nov. 24, 2008, reflecting a rescheduling of the second workshop previously scheduled for Dec 8-9, 2008.

North Central Coast Marine Protected Areas Monitoring Planning Workshop

October 22-23, 2008
Pacifica, California

Prepared by Eric Poncelet and Janet Thomson
Kearns & West

INTRODUCTION – WORKSHOP PURPOSE AND ORGANIZATION

This report summarizes the key outcomes from the North Central Coast Marine Protected Areas Monitoring Workshop held October 22-23, 2008 in Pacifica, California.[1] The workshop was convened by the California Marine Protected Areas Monitoring Enterprise (Monitoring Enterprise) and the California Department of Fish and Game (CDFG).

Workshop Objectives and Intended Outcomes
The purpose of the workshop was to help inform the development of a monitoring plan for North Central Coast marine protected areas (MPAs), which are expected to be implemented in 2009. *Key objectives of the workshop were to:*

1. Develop a set of *ecosystem features* that define the scope of status and trends monitoring for the North Central Coast ecosystem. Note: Status and trends monitoring describes the status of, and change in, key components of the system that collectively encompass and represent the North Central Coast system.
2. Define a prioritized set of *effectiveness questions* most important and feasible for monitoring to address in order to inform future management decisions. Note: these questions explore the link between particular MPA network design aspects or decisions and their effects on the system or parts of the system.
3. Launch Scientific Working Groups charged with a) developing, evaluating and recommending attributes and indicators for each ecosystem feature, and b) developing and evaluating approaches to address categorized effectiveness questions and recommending methods and associated indicators that will best address these questions. Note: the Scientific Working Groups will summarize their analyses and present their recommendations to a second workshop, to be held Dec 8-9, 2008 (*update: the second workshop will be held in early 2009)*, in Pacifica, CA.

[1] This report represents our efforts to synthesize the key outcomes from the workshop; it is not intended to serve as a transcript of all issues discussed or points made.

Workshop Participation and Conveners

Twenty-eight invited participants participated in the October 22-23, 2008 workshop.[2] The attendees included 12 scientists and 16 former members of the North Central Coast Regional Stakeholder Group.[3] *The list of workshop participants is attached as Appendix 1*. Together, the invited participants represented a broad variety of stakeholder interests and scientific expertise. Members of the public were also invited to attend the workshop as observers. Approximately 20 members of the public attended.

California Fish and Game Commission President Richard Rogers and MLPA Initiative Executive Director Ken Wiseman opened the meeting with welcoming comments and support for the new and innovative approach to monitoring being implemented for the North Central Coast region. Cheri Recchia, Director of the Monitoring Enterprise, and John Ugoretz, Resource Assessment Program Manager, Marine Region, for the CDFG, additionally welcomed participants and convened the workshop.

Cheri Recchia provided a brief overview of the Monitoring Enterprise. The Monitoring Enterprise is housed within the California Ocean Science Trust and was created in 2007 to lead the development of sustainable, informative, and innovative monitoring of California's MPA network. The mission of the Monitoring Enterprise is to provide timely information that enables assessment of the condition and functioning of MPAs, identifies emerging threats, informs MPA management, and improves understanding of marine ecosystems. The Monitoring Enterprise has three core elements of its work: science, to support and encourage development, testing, and refinement of new monitoring approaches and tools needed to provide timely and useful monitoring information; information management, to manage, assemble, and provide online access to MPA monitoring data; and communications, to develop and deliver monitoring information products to decision-makers, resource managers, researchers, stakeholders, and the public.

Workshop Organization

The workshop took place over a 1.5-day period. The first day was structured to provide an overview and introduction to the concepts and policy context surrounding development of a North Central Coast MPA monitoring plan. Invited participants also recommended the key *ecosystem features* (both ecological and socioeconomic) they felt best encompassed and represented the North Central Coast system. The ecosystem features will provide the focus for status and trends monitoring. On the morning of the second day of the workshop, invited participants suggested and then categorized *effectiveness questions* linking MPA network design aspects or decisions with ecosystem features or elements of features. The focus of the workshop was on identifying high-level questions that could most usefully inform adaptive management of the MPAs in future.

The workshop agenda is included as Appendix 2. Workshop PowerPoint presentations and other supporting materials can be found on the MPA Monitoring Enterprise website at: http://www.calost.org/monitoring_ent.html.

[2] In all, fifty individuals were invited to participate in the workshop. All of the former members of the North Central Coast Regional Stakeholder Group were asked to indicate their interest in participating in the workshop. Some of these North Central Coast Regional Stakeholder Group members indicated that they were not interested in participating or did not respond to the inquiry.

[3] In one case, a regional stakeholder group member who could not attend was replaced by another member of his organization.

PROCESS OVERVIEW AND PLANNING APPROACH

Process Overview

At the workshop, Monitoring Enterprise staff provided an overview of the process and timeline for developing a monitoring plan for the North Central Coast MPAs. The monitoring plan will consist of both baseline and long-term monitoring components.

The timing for developing the North Central Coast MPA monitoring plan is driven by several key factors:

- The California Fish and Game Commission is expected to adopt MPAs for the North Central Coast region by early 2009.
- Given that the North Central Coast MPAs are expected to take effect in 2009, baseline monitoring should begin as soon as feasibly possible, likely in the summer of 2009
- To facilitate the initiation of baseline monitoring in summer 2009, a request for proposal (RFP) for baseline monitoring fieldwork needs to be distributed by mid-January 2009.

The process for developing the monitoring plan for North Central Coast MPAs is proceeding in two main phases:

1. Develop the monitoring framework. The framework establishes the structure for monitoring, identifying the key components of monitoring and how they fit together. The framework includes the ecosystem features, the attributes and indicators used for status and trends monitoring, the effectiveness questions, and the approaches and indicators for effectiveness monitoring. Initial input for the development of the framework was provided through the Oct. 22-23 workshop and is being used to launch analyses by several Scientific Working Groups of possible and recommended attributes, approaches and indicators for North Central Coast MPA monitoring. At the second workshop, scheduled for December 8-9, 2008 (*update: the second workshop will be held in early 2009*), stakeholders and scientists will consider the recommendations of the Scientific Working Groups and provide additional input on the monitoring framework.
2. Develop the monitoring plan. The monitoring framework will be used to develop baseline and long-term monitoring plans, which will be designed to fit together and collectively implement the framework. The baseline monitoring plan will be used to guide development of the North Central Coast Baseline MPA Monitoring Request for Proposals, which is scheduled to be released in mid-January, 2009. The long-term monitoring plan will be circulated in draft form for review, likely in the spring of 2009. The plan will also be submitted to the California Fish and Game Commission for adoption or approval.

For additional details on process and timing, please see *Appendix 3: Planning Overview and Timeline.*

Planning Focus

To help focus workshop discussions, Monitoring Enterprise staff provided an overview of several key factors guiding the Monitoring Enterprise's approach to MPA monitoring.

The Marine Life Protection Act (MLPA) and the MLPA Master Plan provide an important policy context for North Central Coast MPA monitoring. These documents specify that monitoring should evaluate the MPA network's performance relative to MLPA goals, facilitate adaptive management, improve understanding of marine systems, and assess selected individual MPAs,

regional MPA network components, and the statewide network. Additionally, the North Central Coast Regional Stakeholder Group adopted goals and objectives for the North Central Coast region and identified site-specific objectives for each proposed MPA. All of this information served as guidance to the workshop participants in considering which ecosystem features and effectiveness questions should serve as the basis for North Central Coast MPA monitoring.

Monitoring Enterprise staff also described several key principles intended to guide monitoring planning. Given the large geographical scale of the North Central Coast region and the broad scope of the MLPA goals, it is critically important for the monitoring framework to clearly articulate monitoring priorities, explaining what information monitoring should produce and why that information is important. Monitoring must focus on providing information that will be most useful for making management decisions in the future, working in an adaptive management framework as stipulated by the MLPA and the MLPA Master Plan. The North Central Coast MPA Monitoring Plan will not "reinvent" the wheel but will build on the existing wealth of expertise and data in California and elsewhere. Lastly, the Plan will be integrated within the policy context mentioned above.

Planning Approach

To develop a monitoring plan, it is important to identify what information monitoring should produce, and how that information will be obtained (for a schematic of the monitoring framework, please see *Appendix 4: Monitoring Framework Schematic*). For the North Central Coast MPA Monitoring Plan, these decisions will be made and articulated through development of the monitoring framework. The central piece of the framework is the ecosystem features. Features are ecological or non-ecological, and are chosen to collectively represent the North Central Coast system. Ecosystem features provide the basis for two complementary types of monitoring: status and trends monitoring, which will provide information about how the North Central Coast system is doing; and effectiveness monitoring, which will assess how particular MPA network design aspects or decisions are affecting the North Central Coast System.

Status and trends monitoring is developed by identifying key *attributes* for each ecosystem feature. Key attributes are those characteristics of the ecosystem feature required to sustain that feature over time, reflecting, for example, aspects of the feature's structure or function. Then *indicators* are identified for each attribute – indicators are what are actually measured to describe the status of and change in the attribute, and thus the status of and change in the corresponding ecosystem feature.

Effectiveness monitoring is developed by identifying key MPA design aspects or decisions, and assessing the effects of those design aspects or decisions on ecosystem features or components of features. Effectiveness monitoring also uses indicators, which are selected to measure the specific way or ways that a design aspect or decision may affect the system. It is important to note that effectiveness monitoring is not a determination of whether MPAs are an effective management tool, but rather the effect of specific MPA design aspects and/or decisions on the overall system. This type of monitoring will most directly inform adaptive management, as required by the MLPA.

Clarifying Questions Raised

During the workshop, invited participants asked a series of questions of Monitoring Enterprise and CDFG staff that helped to clarify the scope and intent of the process. Key questions included:

Q. What is the relationship between the long-term and baseline monitoring plans?

A. Both plans will be guided by the same monitoring framework being developed, and they will be designed to fit together to meet the identified monitoring priorities. Because an RFP for baseline monitoring must be released in January 2009, the baseline portion of the monitoring plan will have to be completed sooner than the entire monitoring plan can be developed. The long-term monitoring plan will be fleshed out and reviewed through the spring of 2009. While techniques and methods may be the same for baseline and long-term monitoring, frequency, locations or other factors may differ.

Q. Will we be dealing with monitoring separately on a system level and a specific MPA level?
A. No. The intent is to create one monitoring framework that operates on multiple spatial scales, focusing on ecosystem features (i.e., aspects of the North Central Coast region that collectively represent and encompass the whole of the system), and enabling monitoring at the regional scale and at selected individual MPAs, as well as contributing to monitoring at the statewide scale once the full MPA network is completed.

Q. How will the baseline for monitoring be characterized? Will it take historical and recent conditions into consideration?
A. In establishing baseline, it is important to characterize temporal and spatial variability, so historical and recent data, where available, will be taken into account. Baseline needs will be identified for each monitoring indicator as part of the planning process, and may involve analysis or re-analysis of existing data, and collection of new data, depending on what is needed. While a baseline is in some ways a "snapshot" in time, it must be collected over a long enough period to account for natural variability and sampling protocols.

Q. Who will make the final decision on a monitoring approach?
A. The monitoring plan will be submitted to the Fish and Game Commission for approval or adoption, as appropriate. We expect that RFP processes will be used to determine who gathers which monitoring data, and how.

INPUT TOWARD DEVELOPING THE MONITORING FRAMEWORK

Ecosystem Features

Elizabeth Whiteman, Lead Scientist for the Monitoring Enterprise and Nick Salafsky of Foundations of Success described the ecosystem features approach, in which a small number of ecological and non-ecological features are identified to collectively represent and encompass the North Central Coast system. The ecosystem features form the core of the monitoring framework, and guide both status and trends monitoring and effectiveness monitoring. Invited participants were then tasked with proposing sets of up to 10 ecosystem features they felt best met this requirement.

Workshop participants collectively developed the following list of key ecosystem feature. *Additional details can be seen in Appendix 5: Ecosystem Features Proposed by Participants*.

Proposed Ecosystem Features	
Ecological Features (in no particular order)	*Non-Ecological Features (in no particular order)*
Estuarine systems	Viable coastal communities
Kelp systems	Consumptive use
Soft-bottom sub-tidal systems	Non-consumptive use
Soft-bottom intertidal and beach systems	
Rocky sub-tidal systems (deep and shallow)	

Rocky intertidal systems	
Apex predators	
Open ocean systems	

Effectiveness Questions

To explain the policy context and purpose of effectiveness monitoring, Liz Whiteman highlighted relevant text from the MLPA and the Master Plan. The MLPA states that monitoring must occur at selected sites to facilitate adaptive management of MPAs. The Master Plan states that marine reserves and protected areas must be monitored and evaluated to determine if goals are being met and to provide information for refining the design of current and future MPAs and reserves. The overarching theme of these documents is that the intent is to gather monitoring information that can inform adaptive management.

The intent of effectiveness monitoring is to help inform future management decisions, uncover relationships between MPA network design aspects and system response, and improve the best available science. It is not intended to set targets for performance, provide "yes/no" or "pass/fail" answers, or recommend changes in management action in and of itself. Effectiveness monitoring is difficult and raises many legitimate questions, some of which cannot feasibly be answered with current scientific capabilities, cannot be robustly answered with the array of MPAs, or may take years to answer.

Effectiveness monitoring explores the link between MPA network design aspects and decisions and ecosystem features. As an example of an approach to inform an *effectiveness question*, monitoring can assess the effect of MPA size on kelp forest habitat. In order to understand that relationship, monitoring must explore the *mechanisms and effects* involved. For example, a mechanism might involve the possible movement of adult fish, and a range of *indicators or methods* (such as tagging) can measure the functioning of that mechanism.

Elizabeth Whiteman and Nick Salafsky then tasked invited workshop participants with identifying 3-6 specific possible management effectiveness questions that explicitly linked an MPA design aspect or decision with an ecosystem feature or component of a feature. The identified questions were then categorized.

Workshop participants identified effectiveness questions in the following main categories. Additional details, including the specific effectiveness questions posed, can be seen in *Appendix 6: Effectiveness Questions Proposed by Participants*.

Proposed Effectiveness Question Categories (in no particular order)	
Clusters and configurations of MPAs	Levels of protection
Size and spacing of MPAs	Special closures
Habitat siting	Enforcement and compliance
Network effect	Socioeconomics and resource usage
State Marine Reserves (SMR) vs. State Marine Conservation Areas (SMCA)	

CHARGE TO THE SCIENTIFIC WORKING GROUPS

After workshop participants had completed development of a set of ecosystem features and categories of effectiveness questions, Monitoring Enterprise staff provided an overview of how the Scientific Working Groups would build on this information to inform the second workshop

scheduled for December 8-9, 2008 (u*pdate: the second workshop will be held in early 2009).* Several scientist participants met following the workshop to begin coordinating Scientific Working Group activities for the interim period.

Scientific Working Groups on Status and Trends Monitoring

At this workshop, invited participants proposed a set of ecosystem features. The status and trends scientific working groups will spend the next six weeks developing a set of recommended attributes and indicators for the ecosystem features. The scientific working groups will present their deliberations, advice, and recommendations on these attributes and indicators to the participants at workshop 2 (December 8-9, 2008; *update: the second workshop will be held in early 2009*) and will seek comments and suggestions from participants on the content. The groups will then consider and address the input received.

Scientific Working Groups on Effectiveness Questions

The invited participants developed and categorized a list of effectiveness questions that may be useful to inform adaptive management (e.g., what is the effect of MPA size on kelp forest habitat?). The effectiveness scientific working groups will develop recommendations of mechanisms/effects and indicators/methods to test these effectiveness questions. As with the status and trends scientific working groups, the effectiveness scientific working groups will present their deliberations, advice, and recommendations to the participants at workshop 2 (December 8-9, 2008; *update: the second workshop will be held in early 2009*) and will seek comments and suggestions from participants on the content. The groups will then consider and address the input they receive.

A summary of the monitoring framework that shows the components to be developed by the Scientific Working Groups is attached in *Appendix 6: Monitoring Framework Schematic*.

PUBLIC COMMENT AND PARTICIPANT REFLECTIONS

Members of the public were given the opportunity to ask questions and make comments during designated public comment periods on both days of the workshop. Several members of the public suggested that their organizations would be available and eager to assist with providing or gathering monitoring data. This included the Point Reyes Bird Observatory (PRBO) and the Central and Northern California Ocean Observing System (CeNCOOS).

Invited participants were also given the opportunity to reflect on the workshop. Key comments from invited participants included:

- Encouraging connections between this effort and volunteer/academic efforts would be useful, as would connections across scientific disciplines and ensuring that the program is using existing sources of data.
- Finding ways to increase available funds for monitoring will be crucial.
- Participants requested that information from the meetings be made available so that participants can assist with broader outreach and education to broader constituencies about monitoring plan development.

NEXT STEPS

Key next steps in the North Central Coast MPA monitoring planning process are summarized below:

1. Facilitation staff to prepare a workshop summary report and post this on the Monitoring Enterprise website (http://www.calost.org/monitoring_ent.html).
2. Monitoring Enterprise staff to assist in the convening and charging of Scientific Working Groups. Note: a logistical meeting for the Scientific Working Groups was convened immediately following the adjournment of the workshop on October 23, 2008.
3. Scientific Working Groups to draw on the information provided by the invited workshop participants to develop recommendations on both status and trends attributes and indicators, and effectiveness methods and indicators. Scientific Working Groups to prepare summary materials for presentation and discussion at the second workshop.
4. Invited workshop participants participate in second workshop, scheduled for December 8-9, 2008 (*update: the second workshop will be held in early 2009)* in Pacifica, CA. The focus of the second workshop will be reviewing the recommendations of the Scientific Working Groups and providing additional input to the monitoring plan framework.
5. Scientific Working Groups to consider and address comments from invited participants.
6. Monitoring Enterprise staff to draw on the above information to develop a draft baseline monitoring plan and an associated RFP for conducting baseline monitoring work by mid-January 2009.
7. Monitoring Enterprise staff to draw on the above to develop a draft North Central Coast Long-Term MPA Monitoring Plan for public and scientific review and submission to the Fish and Game Commission.

APPENDICES

1. Roster of attendees
2. Workshop Agenda
3. Planning Overview and Timeline
4. Monitoring Framework Schematic
5. Ecosystem Features Proposed by Participants
6. Effectiveness Questions Proposed by Participants

Appendix 1: North Central Coast MPA Monitoring Planning Workshop 1

Roster of Invited and Attending Participants

October 22-23, 2008, Pacifica, CA

Name	Affiliation
Debbie Aseltine-Nielsen*	California Department of Fish and Game
Ben Becker	National Park Service
Bill Bernard*	Abalone Advisory Group
Eric Bjorkstedt*	NOAA Southwest Fisheries Science Center /Humboldt State University
Bob Breen*	Educator
Mark Carr*	University of California, Santa Cruz
Josh Churchman*	Commercial Fisherman
Jim Estes*	University of California, Santa Cruz
Ellen Faurot-Daniels*	CA Coastal Commission
John Field	NOAA Southwest Fisheries Science Center
Steve Gaines	University of California, Santa Barbara
Karen Garrison*	Natural Resources Defense Council
Mary Gleason	The Nature Conservancy
Aaron Golbus*	Port of San Francisco
Dominic Gregorio*	State Water Quality Control Board
Jim Hobbs	University of California, Berkeley
Jules Jaffe	University of California, San Diego
Patty King*	Ocean Conservationist and Docent
Francesca Koe	Recreational Diver
Irina Kogan*	Gulf of the Farallones National Marine Sanctuary
Tony Koslow	CalCOFI/ University of California, San Diego
Chris La Franchi*	Channel Islands National Marine Sanctuary
John Largier	Bodega Marine Laboratory, University of California, Davis
Phil Levin	NOAA Northwest Fisheries Science Center
James Lindholm	California State University Monterey Bay
Alec MacCall	NOAA Southwest Fisheries Science Center
Tom Mattusch*	F/V Huli Cat
Gerry McChesney	US Fish and Wildlife Service
Lance Morgan*	Marine Conservation Biology Institute
Samantha Murray	Ocean Conservancy
Kellyx Nelson*	San Mateo Resource Conservation District
Karina Nielson	Sonoma State
Jeff Paduan	Naval Postgraduate School
Ed Parnell*	Scripps Institution of Oceanography
Carrie Pomeroy	California Sea Grant Extension Program, University of California, Davis
Pete Raimondi*	University of California, Santa Cruz
Laura Rogers-Bennett*	California Department of Fish and Game
Jim Sanchirico	University of California, Davis
Fred Smith	Environmental Action Committee of West Marin
Jay Stachowicz*	University of California, Davis
Rick Starr	UC Cooperative Extension Sea Grant Program
Bill Sydeman	Farallon Institute
Lynn Takata*	California Department of Fish and Game
Ed Tavasieff*	California Fresh Fish
Nick Tipon*	Federated Indians of Graton Rancheria
Jason Vasques*	California Department of Fish and Game
Dean Wendt	California Polytechnic University San Luis Obispo
Bob Wilson*	The Marine Mammal Center
Dan Wolford*	Coastside Fishing Club
Jay Yokomizo*	F/V New Huck Finn

*Attending Participants

Appendix 2: Agenda

North Central Coast MPA Monitoring Planning – Workshop 1

Best Western Lighthouse Hotel, Pacifica, CA
Wednesday, October 22, 2008 (9:30 AM – 5:30 PM)
Thursday, October 23, 2008 (8:00 AM – 1:00 PM)

Meeting Objectives

1. Develop a set of ecosystem features that define the scope of status & trends monitoring for the North Central Coast ecosystem.
2. Define a prioritized set of management/effectiveness questions most important and feasible for monitoring data to address in order to inform future management decisions.
3. Launch scientific working groups charged with a) developing, evaluating and recommending attributes and indicators for each ecosystem feature, and b) developing and evaluating approaches to address priority effectiveness questions and recommending information to be collected that will address these questions.

Agenda

Note that this agenda is constructed for 2 days starting on the morning of the first day.

Day 1

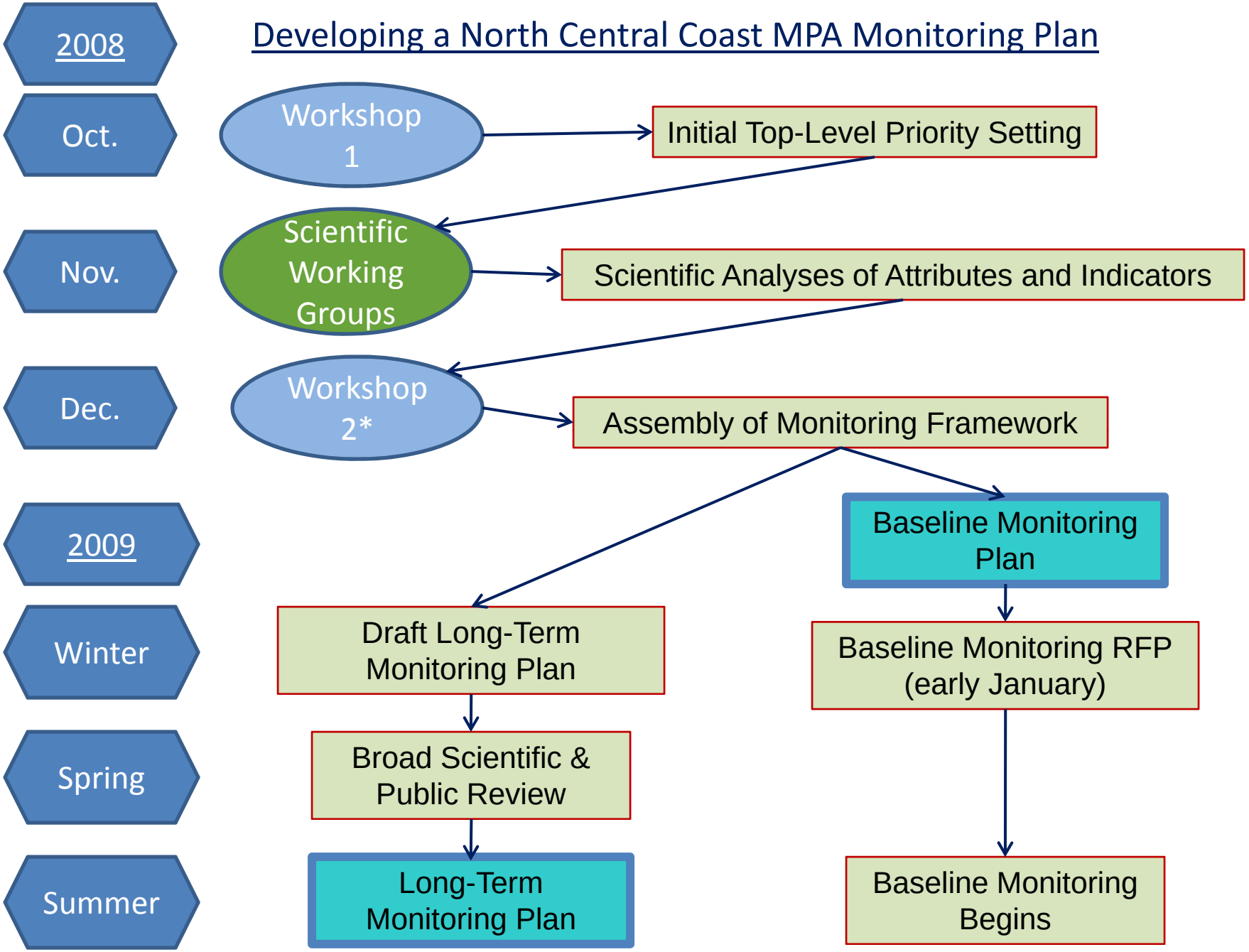
9:30 – 10:00	Breakfast (provided for invited participants) and Sign-in
10:00 – 11:00	Introduction • Welcome and introductions • Agenda review and process guidelines
11:00 – 12:00	Overview and Project Framing • Overview of overall process • Overview of planning methods • Context within MLPA goals and policies
12:00 – 1:00	Lunch (provided for invited participants)
1:00 – 3:30	Introduction to Status & Trends Measures and Ecosystem Feature Selection • Overview of types of monitoring • Introduction to ecosystem features • Group identification of ecosystem features
3:30 – 4:00	Coffee Break
4:00 – 4:45	Charge to Scientific Working Groups: Status & Trends Measures • Presentation of viability concepts, attributes, and indicators • Presentation of charge to scientific working groups developing and evaluating attributes and indicators for each ecosystem feature
4:45 – 5:30	Public Comment and Participant Reflections
5:30	Plenary Adjourns
6:30	Dinner (provided for invited participants)

Day 2

7:00 – 8:00	Breakfast (provided for invited participants) and Sign-in
8:00 – 8:15	Recap and Review
8:15 – 11:00	Introduction to Effectiveness Measures and Identification of Effectiveness Questions • Examples and explanation of management effectiveness questions • Group identification of effectiveness questions
11:00 – 11:30	Coffee Break
11:30 – 12:00	Charge to Scientific Working Groups: Effectiveness Measures • Presentation of effectiveness monitoring and results chains concepts • Presentation of charge to scientific working groups developing and evaluating approaches to effectiveness questions
12:00 – 12:30	Public Comment and Participant Reflections
12:30 – 1:00	Next Steps and Workshop Close • Discuss next steps • Conduct evaluation
1:00	Adjourn

Appendix 3: Planning Overview and Timeline

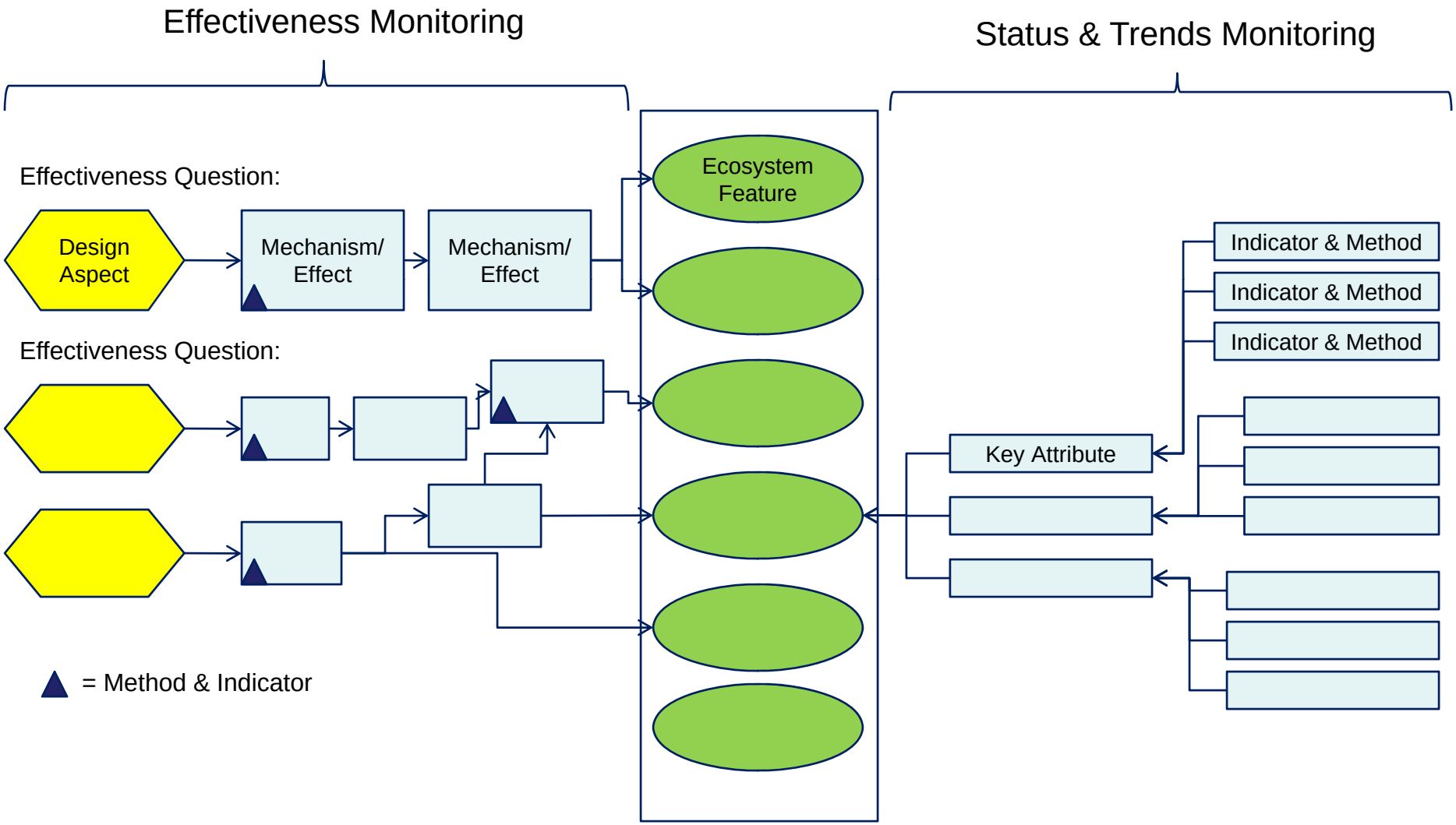
Developing a North Central Coast MPA Monitoring Plan



** Note: Workshop 2 has been deferred until early 2009.*

Appendix 4: Monitoring Framework Schematic

MPA Monitoring Framework



Appendix 5: Ecosystem Features Proposed by Participants

Proposed Ecosystem Features, North Central Coast MPA Monitoring Planning Workshop 1, October 22-23, 2008, Pacifica, CA

Estuarine Systems	Kelp System	Apex Predators	Soft-bottom Systems and Sub-tidal	Rocky Sub-tidal (shallow and deep) Systems	Open Ocean Systems	Rocky Intertidal Systems	Soft Bottom Intertidal and Beach Systems	Consumptive Use	Non-consumptive Use	Viable Coastal Communities
Bays/ Estuaries	Kelp System	Sharks	Soft-bottom Habitats	Deep Rock	Water Column	Rocky Intertidal	Sandy Beach	Sustainable recreational and commercial fishing	Economics for coastal communities (1/2 card)	Profits for charter industry and key local businesses
Seagrass Systems	Kelp Forests (shallow rock)	Apex Predators	Soft Bottom	Rocky Reef (½ card)	Pelagic Systems	Rocky Reef Ecosystem	Intertidal Habitat (½ card)	Fishing	Non-consumptive uses	Economics for coastal communities (1/2 card)
Wetland Systems	Rocky Reef (½ card)	Marine Mammals	Soft Sediment Systems	Rocky Reef System	Water Column	Intertidal Habitat (½ card)		Salmon	Participation in recreational activities	Viable coastal communities
Estuaries	Kelp Forest System	Seabirds	Shallow Soft-bottom	Rocky Reefs	Ocean Water Conditions	Rocky Intertidal		Fisheries	Recreational and educational non-consumptive viability	Seabirds
Estuarine System	Kelp Forest	Rookery, Roost, Haul out Areas	Soft-bottom	Hard-bottom Communities	Upwelling Areas	Rocky Intertidal Communities		Fishing Fleets		Rookery, roost, haul out areas
Estuaries	Kelp Communities	Nesting Seabirds	Deep Soft-bottom					Persistance of consumptive activities		Nesting Seabirds
								Cultural Uses		

KEY:

CLUSTER

CARD

Card colors correspond to input from different participant groups

Additional suggested ecosystem features included:
-Islands - viewed by the group as captured under combination of rocky intertidal and rocky subtidal.
-Access - viewed by the group as not an ecosystem feature.

Note: Ecosystem features are a limited suite of key aspects of the North Central Coast region that together can collectively represent and encompass the region. These will provide a high-level framing of monitoring moving forward.

Appendix 6: Effectiveness Questions Proposed by Participants

Proposed Effectiveness Question Clusters, North Central Coast MPA Monitoring Planning Workshop 1, October 22-23, 2008, Pacifica, CA

Clusters and Configuration	Size and Spacing	Habitat Siting	Network Effect**	SMR vs. SMCA**	Levels of Protection	Special Closures	Enforcement and Compliance	Socioeconomic and Usage	Socioeconomic and Usage
MPA Design: stacked vs. east-west	MPA Sizing: is bigger better ±	Effects of habitat diversity on feature response within MPA	Network Effect ±	Effect of SMR vs SMCA on enforceabilty and compliance	Effect of pelagic fishing shallower than 50m on rockfish (rocky reef) and halibut (soft bottom)	Special closure dimension on apex predators (birds) ±	Effect of community based enforcement ±	MPAs and community involvement access ±	What is the effect of the NCC MPAs on the recreational abalone fishery
Habitat Partitioning: non-ecological vs. ecological features	Is the spatial scale of protection sufficient to recover natural biodiversity ±	What's effect of habitat rugosity/ complexity on rocky subtidal systems and species diversity ±	Structure of network vs. experimental design	What are the effects of multiple fishing targets on SMCA vs SMR	Effect of salmon fishing on rockfish populations in shallow rocky subtidal zones ±	Effect of special closures on bird colony productivity?	Community support on enforcement cost and effectiveness ±	Ecotourism and MPAs ±	Minimization of socioeconomic impacts on goals and objectives
Effect of distance between MPA and similar habitat on fishing success	Size vs. ecological features	What's effect of encompassing 2 or more diverse habitats on ecosystem features	Were size and spacing sufficient to achieve connectivity / larval dispersal ±	How does MPA type affect community stability and productivity? Bio-community	Effect of shore-based fishing on intertidal ±	Will the special closures help recover the species of interest ±		How does the Salt Point / Stewarts Point complex affect tourism in that community ±	Siting adjacent to parks ±
Effect of size and replication of MPAs on concentrating fishing effort (also socioeconomics)	MPA sizing: many small vs. few large MPAs (rocky) ±	What's effect of initial diversity on recovery potential	Larval drift and recruitment ±	What measures could be employed in SMCA to avoid serial depletion issue for abalone	Designation of levels of protection on all ecological features ±			MPA locations bordering north and south of a launch point affect behavior ±	
What is effect of split reef on rocky subtidal and consumptive use	Network effects on community structure ±	Effect of discharges on features. Runoff ±	Percent fishing range vs. port economics (cons. vs. non-cons.) ±		Comparative effect of allowing/ disallowing urchin taken on kelp systems			MPAs and socioeconomic effects ±	
Effect of coupled shallow-deep MPAs and habitats on system response ±		Siting adjacent to parks-education ±	Does/can network provide resilience to climate change		Effect of disallowing dungeness crab take on crab populations and soft bottom community ±			What are the effects of MPAs on cultural and religious practices ±	
					Effect of multiple take in a single level of protection category on overall protection of rocky and soft communities				

KEY:

CLUSTER

FRONT of CARD

Card colors correspond to different participant groups

± Symbol indicates that additional information was provided on the back of card (see page 2)

Note: Effectiveness questions explore the link between MPA network design aspects or decisions and ecosystem features or feature components.

*Participants discussed climate change as a potential effectiveness question and decided that it should be subsumed under all of the other effectiveness questions. The specific question raised asked: Do MPAs protect and buffer vis-à-vis climate change?

**These two categories were viewed as linked.

Front of Card-- Potential Effectiveness Question	Back of Card--Additional Details Regarding Effectiveness Questior
Effect of coupled shallow-deep MPAs and habitats on system response?	Are responses in MPAs greater if they include completed nearshore and offshore component MPAs (SMRs-SMCAs) habitats (continuous reefs)
MPA sizing - is bigger better?	Benefit of minimum vs. preferred size MPAs
Is the spatial scale of protection sufficeint to recover natural biodiversity?	1) What was pristine (pre-human) state of system? 2) How close will reserve array return to that state? 3) How much is difference attributable to large mobile predators? What is magnitude of response in reserves relative to pristine ecosystem state?
MPA sizing: many small vs few large MPAs (rocky)	Single large or several small
Network effects on community structure	Effect of network on community structure within each habitat/feature
What's effect of habitat rugosity/complexity on rocky subtidal systems and species diversity	Would Bodega Mraine Reserve (and cluster) be more effective at protecting rocky subtidal and biodiversity if shifted northward to encompass high relief rocky habitat and pinnacles?
Effect of discharges on features? Runoff.	Proximity to discharge influence response on MPA? Especially intertidal?
Siting adjacent to parks - education	Does siting adjacent to parks and protected areas on land help promote education and enforcement (e.g. Fitzgerald, non-consumptive and education uses; southern portion of Stewarts Point enforcement, etc.)
Network effect	Individual reserve and network (region) effects on groundfish production
Were size and spacing sufficient to achieve connectivity / larval dispersal	Kelp beds / hard bottom
Larval drift and recruitment	What is effect of species diversity from larval drift on neighboring MPAs (effectiveness of spacing guidelines)
Percent fishing range vs. port economics (cons. Vs. non-cons.)	How much of a port's fishing grounds are in protection - size, location, fleet (range of oeprations - speed, fuel dollars, safety)
Effect of salmon fishing on rockfish populations in shallow rocky subtidal zones	Does salmon trolling have significant bycatch issues with respect to rockfish species
Effect of shore-based fishing on intertidal	Effect of shore hook and line fishign on intertidal systems and what is the area ("foot print") of that effect?
Designation of levels of protection on all ecological features	Cumulative effects of multiple takes. Specific takes: salmon trolling vs. rocky reefs, halibut vs. rocky reefs and soft bottoms, SWB vs. reefs, etc.
Effect of disallowing dungeness crab take on crab populations and soft bottom community	Related to levels of protection guidelines validation
Special closure dimension on apex predators (birds)	How do disturbance rates change? How do fledgling consequences change?
Will the special closures help recover the species of interest?	Stellar sea lions, birds
Effect of community based enforcement	Are there differences in response of human communities to traditional enforcement (wardens) vs. "community based"
Community support on enforcement cost and effectiveness	How does local community support affect ability to enforce regulations. Sea Ranch/Stewarts Point is the target region. How does poaching / peer group?
MPAs and community involvement access	What is effect of public vs private land on access to MPAs
Ecotourism and MPAs	Do MPAs enhance ecotourism
How does the Salt Point / Stewarts Point complex affect tourism in that community	Tourism dollars, campground dollars, launches, fishing (effort shift, overuse, and other effects)
MPA locations bordering north and south of a launch point affect behavior	Effort shift, # of launches, fishing effort, Point Arena / Montara / Bodega
MPAs and socioeconomic effects	Can we measure effectiveness of MPAs on socioeconomic factors (salmon and crab fisheries)
What are the effects of MPAs on cultural and religious practices	Need to understand cultural and religious values of Native Americans; identify specific plants and animals of cultural significance; gather baseline info; collection guidelines. Viable coastal communities
Siting adjacent to parks	Does siting adjacent to parks and protected areas on land help promote education and enforcement (e.g. Fitzgerald, non-consumptive and education uses; southern portion of Stewarts Point enforcement, etc.)

APPENDIX C-4. SUMMARY REPORT FROM THE NORTH CENTRAL COAST MPA MONITORING PLANNING WORKSHOP 2, MARCH 11-12, 2009

Summary Report

North Central Coast Marine Protected Area Monitoring Planning Workshop 2

March 11-12, 2009
Pacifica, California

Prepared by Eric Poncelet and Janet Thomson
Kearns & West

INTRODUCTION – WORKSHOP PURPOSE AND ORGANIZATION

This report summarizes the key outcomes from the North Central Coast Marine Protected Area (MPA) Monitoring Workshop held March 11-12, 2009 in Pacifica, California. The workshop was convened by the California Marine Protected Areas Monitoring Enterprise (Monitoring Enterprise) and the California Department of Fish and Game (CDFG). It was facilitated by Kearns & West.

Workshop Objectives and Intended Outcomes
The workshop ("workshop 2") was a follow-up to an initial workshop that took place October 22-23, 2008 in Pacifica, CA. The purpose of workshop 2 was to help inform the development of a monitoring plan for North Central Coast marine protected areas (MPAs), which are expected to be implemented in late 2009 or early 2010. Key *objectives* of the workshop were to*:*

1. Provide an update on the North Central Coast MPA monitoring planning process (baseline characterization and long-term monitoring).
2. Review and discuss the MPA Monitoring Enterprise's draft key attributes and indicators for status and trends monitoring of ecosystem features. [Note: Status and trends monitoring describes the status of, and change in, key components of the system that collectively encompass and represent the North Central Coast system.]
3. Receive an update and discuss the development of the MPA Monitoring Enterprise's draft approaches to effectiveness monitoring. [Note: effectiveness monitoring questions explore the specific effects of particular MPA management and network design decisions on the ecosystem in order to inform adaptive management]
4. Provide guidance on how to submit written comments, if desired, following the workshop.

Invited participants were invited to comment on the draft approaches at the workshop and to provide additional written comments in the 10 days following the workshop (through March 23) if desired.

The workshop agenda is included as *Appendix 1.*

Workshop 2 was a step within an ongoing process to develop and refine recommendations for the draft North Central Coast MPA Monitoring Plan. This summary report is focused on the monitoring framework, as details within this framework are subject to continued modification. The facilitation team took detailed notes of all comments made at the workshop. The Monitoring Enterprise will consider all of these comments in its ongoing development of the draft monitoring plan.

Workshop Participation and Conveners

Twenty-four invited participants attended the March 11-12, 2009 workshop.[1] The list of workshop participants is attached as *Appendix 2*. Together, the invited participants represented a broad variety of stakeholder interests and scientific expertise. Members of the public were also invited to attend the workshop as observers. Approximately 8 members of the public attended and were provided with opportunities to provide comment on both days.

Ken Wiseman, MLPA Initiative Executive Director, and Craig Shuman, Marine Advisor to the California Fish and Game Commission, opened the meeting with welcoming comments and continued support for the new and innovative approach to monitoring being implemented for the North Central Coast region. Cheri Recchia, Director of the Monitoring Enterprise, and Jason Vasques, of CDFG, additionally welcomed participants and convened the workshop.

UPDATE ON NORTH CENTRAL COAST MPA MONITORING PLANNING PROCESS

Cheri Recchia provided the following updates on the north central coast MPA monitoring planning process with regard to the state budget crisis:

- The monitoring planning process is largely unaffected by the state budget crisis (with the exception of baseline data collection, see below).
- The Monitoring Enterprise intends to continue development of the draft monitoring framework, considering the input received during Workshop 2, the comment period following the workshop, and additional scientific input. The Monitoring Enterprise will send the draft framework out for scientific review later in the year. Once the scientific review is completed, the Monitoring Enterprise will prepare a draft Monitoring Plan that will go out for public review.
- The request for proposals (RFP) process for north central coast baseline characterization is currently on hold until state bond funds are released.

OVERVIEW AND DISCUSSION OF MONITORING APPROACH

Cheri Recchia provided an overview of the Monitoring Enterprise's draft approach to MPA monitoring in the north central coast and highlighted some of the specific challenges faced.

Cheri explained the Monitoring Enterprise's role as an intermediary between "information producers" (e.g., scientific community, agencies, citizen scientists, etc.) and "information users" (e.g., resource managers, stakeholders, etc.).

Cheri outlined the intended products of the north central coast MPA monitoring as:

[1] In all, fifty individuals were invited to participate in Workshop 2. This included all of the individuals who participated in Workshop 1 as well as additional scientists who had participated in scientific working group discussions with the Monitoring Enterprise.

- Clear, understandable and useful results for decision-makers, resource managers, and stakeholders
- Information that is directly applicable to assessing performance against MLPA goals and supporting adaptive management
- Timely and useful reports for 5-year and later reviews

Cheri also provided a brief overview of both status and trends monitoring and effectiveness monitoring.

Status and trends monitoring:

- The purpose of status and trends monitoring is to track the status of, and changes in, key aspects of marine ecosystems, including ecological and human elements of ecosystems and resource use
- Key components of status and trends monitoring include:
    - Ecosystem features: collectively represent and encompass ecological and human aspects of the north central coast system
        - Key attributes: critical aspects of each ecosystem feature required to maintain ecosystem condition
            - Indicators and focal species: collectively gauge the condition of each key attribute. Key considerations in selecting indicators include:
                - What collectively represents north central coast ecosystems?
                - What is most useful for management?
                - What do audiences care about most?
                - What is affordable?
                - Weighing amount of information or detail against costs

Effectiveness monitoring:

- The purpose of effectiveness monitoring is to assess the effects of specific management decisions or actions in order to inform adaptive management. Cheri emphasized that effectiveness monitoring is not intended to provide "pass/fail" type answers with regard to specific MPAs or the MPA network.
- Key components of effectiveness monitoring include prioritized questions and recommended approaches to answer those questions.

Comments on Monitoring Approach

Throughout the workshop, invited participants offered comments on the proposed monitoring approach and MPA monitoring more broadly. Many of the comments were directed to elements of the monitoring plan that extended beyond the monitoring framework that was the focus of Workshop 2. Key comments included:

- There are a variety of key factors that need to be taken into consideration in developing the north central coast MPA monitoring plan. Key factors discussed included the following:
    - Funding availability
    - Existing data and monitoring programs, including citizen science efforts
    - External and contextual factors. Participants discussed a variety of possible external drivers that may have impacts on MPAs and ecosystem health, including:

        - Oceanographic features (e.g., water temperature, upwelling, currents, PDO: Pacific Decadal Oscillation)
        - Water quality and pollution
        - Non-biological factors (e.g., water chemistry)
        - Climate change
        - Meteorological factors
        - Existing fishery regulations, including seasonal fishing restrictions
        - Enforcement and management of MPAs
        - Socioeconomic factors

      This type of information will be important for data interpretation.
    - Data collection methods and analytical methods/models. Participants stated that both should both be taken into account to determine appropriate attributes and indicators for status and trends monitoring.

- Given limited funding, the intensity of monitoring may vary at different MPA locations.
    - Some participants expressed concern that it would be difficult to draw conclusions in areas lacking comprehensive monitoring.
    - Several participants pointed out that the cost to survey all of the species in some cases may be the same as the cost of surveying a small number of focal species, but this of course depends on the methods being used. In these cases, these participants recommended collecting as much information as possible. Monitoring Enterprise staff clarified that the monitoring program will likely rely on a number of different data sources. As the program will not be able to monitor everything in all places, it will be important to be selective about what will give the best information given a limited budget for monitoring.

- For socio-economic data to be valuable, they need to be as spatially and temporally explicit as possible. Spatially and temporally explicit data are currently lacking in many data collection efforts (e.g., logbook data).

- Development of the monitoring framework should consider the extent and timing of the expected changes for particular ecosystem features.

- Status and trends monitoring and effectiveness monitoring may be linked in many instances and need to be closely coordinated. These linkages need to be made explicit in the monitoring plan.

- The monitoring plan should be adaptive so that new monitoring methods and ideas can be incorporated when more is known.

- Monitoring and data collection methods should be standardized across locations and study regions.

- The monitoring plan should clarify that monitoring will seek to identify and understand trends (both short-term and long-term) and not just determine the current status of the system.

DISCUSSION OF DRAFT ECOSYSTEM FEATURE ATTRIBUTES AND INDICATORS

At the workshop, Liz Whiteman, Lead Scientist for the Monitoring Enterprise, presented a suite of key ecosystem features, along with initial draft attributes and focal species/indicators for monitoring status and trends of each feature. These ecosystem features, listed below, were derived from an original list developed by invited participants at Workshop 1.

Ecosystem Features	
Proposed at Workshop #1	**Revised List**
Rocky intertidal systems	Rocky intertidal ecosystems
Kelp systems*	Kelp and shallow rock (0-30 m depth) ecosystems
Rocky subtidal systems (deep and shallow)	Deep rock (30-100 m depth) ecosystems
Estuarine systems	Estuarine ecosystems
Soft-bottom intertidal and beach systems	Soft-bottom intertidal and beach ecosystems
Soft-bottom subtidal systems	Soft-bottom subtidal (5-100m depth) ecosystems
Open Ocean	Pelagic ecosystems
Apex predators**	
Consumptive use	Consumptive uses
Non-consumptive use	Non-consumptive uses
Viable coastal communities***	

Notes

* Kelp and shallow (0-30m water depth) rock ecosystems are considered to form a natural group and cohesive ecosystem feature, while deep (30-100m water depth) rock systems are considered a separate feature.

** Apex predators are important considerations in all ecosystems and thus are best addressed in the context of each of the other features, rather than as a separate feature.

*** Viable coastal communities is considered to encompass many aspects that are beyond the scope of the MLPA; viability of consumptive and non-consumptive uses will be reflected through the key attributes and indicators for those features.

The revised list of ecosystem features together with draft attributes and focal species/indicators were developed through detailed conversations with dozens of scientists in the period between Workshop 1 and Workshop 2. The draft attributes and focal species/indicators represent an amalgamation of scientists' views but not a consensus of views expressed.

For each ecosystem feature, Monitoring Enterprise staff presented a list of both ideal (but potentially scientifically out of reach for the present) and currently selected attributes.

After presenting each set of draft attributes, Monitoring Enterprise staff asked invited participants to respond to the following *organizing questions* for each of the ecosystem features under consideration:

- Are there key aspects of the ecosystem feature that are not captured by these attributes?
- Can you suggest attribute refinements or replacements

Workshop participants offered a variety off comments in response to these questions. Most comments focused at the level of focal species or indicators, and many included suggestions for specific additions or replacements. Participants also suggested some attribute refinements or

replacements. All of these comments were captured to inform continued development of the monitoring framework.

DISCUSSION OF PRELIMINARY APPROACH TO EFFECTIVENESS MONITORING

Liz Whiteman described the Monitoring Enterprise's preliminary approach to effectiveness monitoring for an MPA network. This preliminary approach identifies two main components to effectiveness monitoring for an MPA network:

1) Questions that relate to the effects of design on ecosystems and people
2) Questions that related to the effects of people on ecosystems

Assessing effects of design on ecosystems and people

Liz Whiteman briefly presented four MPA design aspects currently being considered for effectiveness monitoring. These design aspects were derived from a broader list developed at workshop 1.

Design Aspects	
Proposed at Workshop #1	**Current Proposed List**
Size and spacing	Size and spacing
Clusters and configuration	Placement/siting
Habitat siting	
Network effect	
SMR vs. SMCA	Level of protection
Level of protection	
Socioeconomics and use	Socioeconomics and use

The Monitoring Enterprise plans to continue discussing and developing these design aspects with scientists following Workshop 2.

Assessing effects of people on ecosystems

Liz situated effectiveness questions to assess the effects of people on ecosystems within goal 3 of the MLPA, which states: "To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbances and to manage these uses in a manner consistent with protecting biodiversity."

Liz then presented two draft effectiveness questions to assess the effects of people on ecosystems. The first was on the topic of habitat degradation, and the second was on the topic of wildlife disturbance.

1) Are there trampling impacts of increased visitors to rocky intertidal ecosystems in MPAs?
2) What are the impacts of increased beach visitation on marine mammals and nesting seabirds?

Monitoring Enterprise staff asked invited participants to respond to the following *organizing question*: Do these questions capture the most important predicted impacts of increased recreational, educational, and study opportunities on ecosystems within MPAs?

Invited participants commented that the draft effectiveness questions reflect pertinent management issues and offered some suggestions for refining the effectiveness questions.

Key criteria for developing effectiveness questions

Liz Whiteman reiterated that the goal for developing effectiveness monitoring is to recommend a small number of good questions for the monitoring plan. She then outlined a list of key criteria by which "good" effectiveness questions could be evaluated. These include:

- Be scientifically feasible
  - Provide reasonable certainty
  - Answerable in management-relevant timeframe
  - Empirically verifiable
- Be useful for management
- Have policy relevance
- Be cost-effective
- Be broadly applicable

Invited participants considered these criteria, expressed general support for them, and did not offer additional criteria or modifications.

PUBLIC COMMENT AND PARTICIPANT REFLECTIONS

Members of the public were given the opportunity to ask questions and make comments during designated public comment periods on both days of the workshop. Some comments included suggested refinements or revisions of the draft attributes, focal species and indicators. Other comments recommended that the Monitoring Enterprise coordinate closely with existing monitoring efforts. Still others pointed toward the need for good enforcement and the importance of cooperating effectively with local communities.

POST WORKSHOP FOLLOW UP AND NEXT STEPS

Workshop participants were invited to submit written comments, if desired, on the draft monitoring approaches discussed at the workshop. The purpose was to provide them with additional time for reflection. Written comments were due by March 23, 2009.

Monitoring Enterprise staff will consider all of the input received at Workshop 2 and in subsequent written comments as they continue to further develop and refine the approaches to status & trends and effectiveness monitoring. Revision of the MPA monitoring approach will also be informed by additional discussions with scientists.

Monitoring Enterprise staff will then submit the monitoring framework (consisting of draft approaches to status & trends and effectiveness monitoring) for scientific review. Input from the scientific review will be used in the development of a draft North Central Coast MPA Monitoring Plan for public review later this year.

APPENDICES

1. Workshop Agenda
2. Roster of attendees

Appendix 1

Proposed Agenda

North Central Coast MPA Monitoring Planning – Workshop 2

Best Western Lighthouse Hotel, Pacifica, CA
Wednesday, March 11, 2009 (9:30 AM – 5:45 PM)
Thursday, March 12, 2009 (8:00 AM – 4:30 PM)

Introduction

The March 11-12, 2009 North Central Coast Marine Protected Area (MPA) Monitoring Planning Workshop is a follow-up to an initial workshop that took place October 22-23, 2008 in Pacifica, CA. The focus of the current workshop is to present and discuss draft MPA Monitoring Enterprise approaches to MPA monitoring for the North Central Coast. Invited participants will have opportunities to discuss and provide comments on the draft approaches at the workshop, and are invited to provide additional written comments in the 10 days following the workshop (through March 23) if they wish to do so.

Members of the public may attend as observers and will have the opportunity to provide comment during public comment periods scheduled for late morning on Day 1 and mid-afternoon on Day 2.

Meeting Objectives

1. Provide an update on the North Central Coast MPA monitoring planning process (baseline and long-term).
2. Review and discuss the MPA Monitoring Enterprise's draft key attributes and indicators for status and trends monitoring of ecosystem features.
3. Review and discuss the MPA Monitoring Enterprise's draft approaches to effectiveness monitoring.
4. Provide guidance on how to submit written comments, if desired, following the workshop. Agenda

Note that this agenda is constructed for 2 days starting on the morning of the first day. The times listed are tentative pending the flow of group discussion.

Day 1

9:30 – 10:00 *Breakfast (provided for invited participants) and sign-in*

10:00 – 11:30 Introduction
- Welcome and introductions
- Agenda review, process guidelines, and anticipated outcomes
- North Central Coast MPA monitoring planning process update
- Review of monitoring approach

11:30 – 12:00 Public comment

12:00 – 12:45 *Lunch (provided for invited participants)*

12:45 – 2:30	Rocky ecosystems: presentation and discussion of Monitoring Enterprise draft approaches • Kelp and shallow rock ecosystems
2:30 – 3:00	*Coffee Break*
3:00 – 4:30	Rocky ecosystems continued • Deep rock ecosystems • Rocky intertidal ecosystems
4:30 – 5:30	Pelagic ecosystems: presentation and discussion of Monitoring Enterprise draft approaches
5:30	Wrap-up and preview of day 2
5:45	*Adjourn for day*
6:30	*Dinner (provided for invited participants)*

Day 2

7:00 – 8:00	*Breakfast (provided for invited participants) and sign-in*
8:00 – 8:15	Recap and agenda review
8:15 – 10:15	Soft-bottom ecosystems: presentation and discussion of Monitoring Enterprise draft approaches • Estuarine ecosystems • Soft-bottom subtidal ecosystems • Soft-bottom intertidal and beach ecosystems
10:15 – 10:45	*Coffee break*
10:45 – 12:30	Consumptive and non-consumptive uses: presentation and discussion of Monitoring Enterprise draft approaches
12:30 – 1:15	*Lunch (provided for invited participants)*
1:15 – 3:30	Effectiveness monitoring: presentation and discussion of Monitoring Enterprise draft approaches
3:30 – 3:45	*Coffee break*
3:45 – 4:15	Public comment
4:15 – 4:30	Next steps
4:30	*Adjourn*

Appendix 2

List of Workshop 2 Participants

North Central Coast MPA Monitoring Planning – Workshop 2

Best Western Lighthouse Hotel, Pacifica, CA
Wednesday, March 11, 2009 (9:30 AM – 5:45 PM)
Thursday, March 12, 2009 (8:00 AM – 4:30 PM)

Name	Affiliation
Aaron Golbus	Port of San Francisco
Bill Bernard	Abalone Advisory Group
Bob Breen	Educator
Bob Wilson	The Marine Mammal Center
Cassidy Teufel	California Coastal Comm.
Chris La Franchi	Channel Islands National Marine Sanctuary
Dominic Gregorio	State Water Quality Control Board
Ed Tavasieff	California Fresh Fish
Irina Kogan	Gulf of the Farallones National Marine Sanctuary
Jay Yokomizo	F/V New Huck Finn
John Field	NOAA
Jules Jaffe	SIO/UCSD
Karen Garrison	Natural Resources Defense Council
Kellyx Nelson	San Mateo Resource Conservation District
Kip Laws	UCSC
Lance Morgan	Marine Conservation Biology Institute
Mark Carr	University of California, Santa Cruz
Nick Tipon	Federated Indians of Graton Rancheria
Pete Raimondi	University of California, Santa Cruz
Rick Starr	Moss Landing Marine Laboratories
Russ Moll	California Sea Grant
Samantha Murray	The Ocean Conservancy
Shauna Oh	California Sea Grant
Tom Mattusch	F/V Huli Cat
Tony Koslow	Scripps Institute of Oceanography

APPENDIX C-5. SUMMARY OF MPA MONITORING FRAMEWORK ADDITIONAL TECHNICAL CONSULTATION

MPA Monitoring Framework Additional Technical Consultation

Summary

August 2009

Prepared by Eric Poncelet and Janet Thomson
Kearns & West

This document has been prepared to summarize a process undertaken by the MPA Monitoring Enterprise to seek additional technical comments on a proposed monitoring framework and draft metrics to support monitoring of the North Central Coast regional marine protected area (MPA) network. This document summarizes comments received through this consultation and includes:

- A summary of major themes of comments received, prepared by Kearns & West
- Summaries of comments of individual respondents, prepared by Kearns & West and approved by the respondents

Purpose and Design of Additional Technical Consultation

The Marine Protected Areas Monitoring Enterprise initiated a process to obtain additional technical comments on a new conceptual framework for long-term monitoring and specific monitoring recommendations for California's North Central Coast MPA network. The proposed framework is intended to serve as an innovative basis for long-term MPA monitoring that will provide information and results that are useful and informative for MPA management.

The MPA Monitoring Enterprise had engaged numerous scientists from California and elsewhere, including members of the former Marine Life Protection Act Master Plan North Central Coast Science Advisory Team, to develop the draft monitoring framework and the proposed specific monitoring metrics. To gather additional technical input on the framework and the metrics, the MPA Monitoring Enterprise decided to seek further technical comments from additional scientists, focusing on scientists who had been little involved or not at all involved in previous workshops or discussions, in order to obtain fresh insights and perspectives.

Working through California Sea Grant, the MPA Monitoring Enterprise received comments on the Draft North Central Coast MPA Monitoring Framework from 18 scientists. Three of these scientists were independently selected by California Sea Grant to provide "blind comments." The scientists were collectively selected to have different and complementary areas of expertise, including with terrestrial and tropical marine ecosystems, socioeconomics, MPA and natural resource management, and specific expertise in California's marine ecosystems. The additional technical comments received will be used by the MPA Monitoring Enterprise to revise the framework and metrics, and will serve to inform the development of a full draft MPA monitoring plan. The draft MPA monitoring plan will be commented on by the Department of Fish & Game and the public prior to being finalized.

Technical Questions Posed to Scientists

The MPA Monitoring Enterprise sought high-level comments on the conceptual framework. Respondents were asked to address the following questions:

- Given the purposes of and constraints on MPA monitoring, does the overall approach seem appropriate, and how might it feasibly be improved?

- Do the proposed "vital signs" comprise a reasonable set of metrics to provide a window into the status and trends of marine ecosystems in the region, focused on simple, feasible metrics and methods that can be implemented by diverse groups including citizen scientists and community associations?
- Do the top tier "Ecosystem Assessment" metrics seem appropriate to provide a more technical, if nonetheless limited, depiction of the status and trends of marine ecosystems in the region?
- Are the additional metrics and research priorities the most important and useful elaborations of, or additions to, monitoring, resources permitting?
- Can you identify approaches towards effectiveness monitoring that would allow inclusion of MPA network design elements in the core monitoring recommendations?
- Are there species within the monitoring framework that may serve as sentinels of the ecological effects of climate change? Are there replacement focal species that could better serve as sentinels of climate change effects in the region?

Participating Scientists (asterisks indicate scientists selected by Sea Grant)

Elizabeth A. Babcock, Assistant Professor, Division of Marine Biology and Fisheries, Rosenstiel School of Marine and Atmospheric Science, University of Miami

Eric Bjorkstedt, Fisheries Ecology Division, NOAA Fisheries' Southwest Fisheries Science Center and Adjunct Professor, Department of Fisheries Biology, Humboldt State University

Paul Dayton, Professor of Oceanography, Scripps Institute of Oceanography, UC San Diego

Andrew DeVogelaere*[1], Research Coordinator and Sanctuary Integrated Monitoring Network Program Director, Monterey Bay National Marine Sanctuary

John Dixon, Lead Environmental Economist, The World Bank (retired)

Graham Edgar, Senior Marine Ecologist, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Australia

Steve Gittings, Science Director, NOAA Office of National Marine Sanctuaries

Glenys Jones, Planner, Performance Evaluation and Reporting, Parks and Wildlife Service, Tasmania, Australia

Bob Leeworthy, Chief Economist, Chief Economist NOAA/NOS/Office of National Marine Sanctuaries

Lisa Levin, Professor, Integrative Oceanography Division, Scripps Institution of Oceanography, UC San Diego

Phil Levin, Program Manager, Northwest Fisheries Science Center, NOAA Fisheries

Laurence McCook, Manager, Research and Monitoring, Great Barrier Reef Marine Park Authority

Michael Orbach, Professor in the Practice of Marine Affairs and Policy, Nicholas School of the Environment, Duke University

[1] This respondent could not be reached to approve the inclusion of his individual summarized comments in this report.

John Pearse*, Professor Emeritus, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz

Linwood Pendleton, Director of Ocean and Coastal Policy, Nicholas Institute for Environmental Policy Solutions, Duke University

J.P. Ray*, President, Oceanic Environmental Services,

Hugh Sweatman, Leader, Long-term Monitoring Program for the Great Barrier Reef, Australian Institute of Marine Science

Simon Thrush, Principal Scientist, National Institute of Water and Atmospheric Research, New Zealand & Department of Environmental Sciences (DIPTERIS), University of Genoa, Italy

Main Themes of Technical Comments Received

Most respondents expressed broad support for the proposed MPA monitoring framework, describing it with terms such as "comprehensive," "well thought out", "appropriate", "reasonable," and "solid document." In particular, respondents expressed broad support for:

- The underlying approach of the framework that seeks to provide useful information to resource managers at a "realistic" cost. Respondents generally viewed the framework as doing a nice job balancing budget realities with the needs for monitoring.
- The "vital signs" approach and, more generally, the framework's distinction of different levels of monitoring information (vital signs, tier 1 ecosystem assessment, and tier 2 ecosystem assessment).
- Use of both ecological and consumptive/non-consumptive use metrics in the framework.
- The particular ecosystem features selected. Respondents also generally appreciated the approach to effectiveness monitoring, although several acknowledged the challenges in doing effectiveness monitoring.

While most respondents expressed broad support for the proposed framework, many also identified concerns with specific elements of the framework. Common concerns expressed included the following:

- A desire to see the framework in the context of the full monitoring plan to more carefully analyze its potential effectiveness.
- Uncertainty that the data gathered will be sufficient to determine whether oceanic changes are due to MPAs or other factors.
- Suggestion that strengthening of the socio-economic and governance portions of the plan would be useful and necessary.
- A desire for additional clarity regarding why particular attributes and indicators had been selected; or why components had been placed in "vital signs" as opposed to "tier 1 ecosystem assessments" or "tier 2 ecosystem assessments".
-
- A desire to prioritize certain attributes or indicators that might be more useful for understanding system changes.
- Concern that some of the metrics may not match well with the spatial and temporal scales of detectable responses to MPA implementation.

Additionally, many of the respondents provided input regarding the proposed vital signs and ecosystem attributes and indicators. These details will be considered by the MPA Monitoring Enterprise in the development of the monitoring plan.

Broad Themes and Highlights from Individual Respondents

Elizabeth A. Babcock, Assistant Professor, Division of Marine Biology and Fisheries, Rosenstiel School of Marine and Atmospheric Science, University of Miami

View on overall approach: Dr. Babcock expressed mixed views on the framework. She said that the ecosystem monitoring elements of the proposed approach appear to be reasonable. However, she said that the document did not explain how or whether the framework would monitor whether the MPAs were achieving their stated objectives.

Key feedback regarding framework:

- It is difficult to evaluate the framework due to a lack of detailed explanation for why it was structured as it was. Better rationale should be provided to clarify why particular ecosystem features were selected for vital sign monitoring, especially if the framework is intended to monitor MPA effectiveness rather than just ecosystem health.
- The selected vital signs appear to be reasonable for ecosystem monitoring.
- The approach of breaking down the ecosystem monitoring into higher and lower priority tiers appears to be reasonable.
- The attributes and indicators selected should be informative of the ecosystems selected (i.e., they do provide indications of ecosystem health), but may not be sufficient to determine whether MPA goals/objectives are being met.
- Indicator species alone cannot replace biodiversity measurements. Recommends biodiversity surveys for the monitoring program.

Eric Bjorkstedt, Fisheries Ecology Division, NOAA Fisheries' Southwest Fisheries Science Center and Adjunct Professor, Department of Fisheries Biology, Humboldt State University

View on overall approach: Dr. Bjorkstedt was broadly supportive of the proposed framework, which reflected "careful thought to many of the relevant issues surrounding ecosystem assessment and MPA monitoring." He supported the inclusion of the socioeconomic metrics with the ecological metrics as part of comprehensive evaluation of MPAs.

Key feedback regarding framework:

- Some of the metrics selected seem likely to match poorly to the spatial scale of detectable responses to MPA implementation—as opposed, for example, to climate trends and ongoing responses to changes in fishery management—and are likely to be too noisy to yield useful insights in a reasonable time frame.
- Given the various guidelines that influence the design of MPA networks, there may be relatively limited scope to evaluate some of the "implementation" or "effectiveness" questions, and some of these may be very difficult to answer.
- Forcing data collectors to distinguish between tier 1 and tier 2 and between vital sign species and other species means that they will have to ignore other data before their eyes or in hand.
- Designation of tier 1, tier 2, and vital sign species must include non-fished species to assist with understanding oceanographic and climate effects, and where possible integrative measures (e.g., proportion dwarf rockfish on deep reefs) are likely to be useful.

Paul Dayton, Professor of Oceanography, Scripps Institute of Oceanography, UC San Diego

View on overall approach: Dr. Dayton was very supportive of the proposed approach. He said that the proposed framework does an excellent job of balancing reality (i.e., the need for cost effectiveness) with the needs for monitoring. He viewed the proposed ecosystem approach to be appropriate (i.e., maximizing what we know and

incorporating an open-ended program). He viewed the overall approach to be appropriately focused more on understanding the relationships rather than identifying the species or defining the patterns. He expressed strong support for the vital signs approach.

Key feedback regarding framework:

- The subdivision into seven habitats is appropriate.
- It is prescient of the authors to separate the two tiers in the ecosystem assessment approach, as this involves many unknowns. The current break points seem fine given current knowledge, but some may well change. The monitoring program needs to be able to adapt accordingly.

John A. Dixon, Lead Environmental Economist, The World Bank (retired).

View on overall approach: Dr. Dixon offered a mixed view of the framework. On the one hand, he viewed it as very complicated, likely difficult to fund, and difficult to explain to policy makers and the public. On the other hand, he viewed the ecosystem divisions and idea of having vital signs and tier 1 and 2 indicators as a potentially productive approach. He supported the effort to provide useful information at realistic costs.

Key feedback regarding framework:

- The sheer number of indicators in the framework seems overwhelming. The framework would benefit from some weighting of the different indicators.
- It may be difficult to interpret the data collected. What can you say if some vital signs go up and others go down?
- The monitoring framework is complicated by the varying temporal scales of the ecosystem indicators.
- Indicators of both consumptive and non-consumptive uses can play a more central role in monitoring policy-relevant outcomes of MPA management.

Graham Edgar, Senior Marine Ecologist, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Australia

View on overall approach: Dr. Edgar was generally positive but with a mixed view on the framework. While he was encouraged that the framework emphasizes monitoring of ecological components in the systems, he felt that the framework appeared overly compartmentalized. As a result of arbitrary boundaries imposed between monitoring components and ecosystem-types, he suggested that potentially-useful additional indicators may be overlooked.

Key feedback regarding framework:

- It appears as though the draft determines what to monitor first, then subsequently decides what questions can be answered on the basis of data collected; this approach should be reversed with priority questions identified and listed upfront.
- Photoquadrats should be used to identify boundaries for some systems and habitats, rather than applying arbitrary depth cutoffs. Using this approach might reveal changes in depth limits for species that become useful indicators for monitoring.
- The distinction between vital signs and ecosystem assessments seems somewhat artificial; he recommends recognition that monitoring processes generally fall along a continuum that extends from low unit-cost activities involving a high level of community engagement and spatial coverage to more expensive activities that require scientific engagement and high technical precision focused within relatively confined areas.
- A focus on ecological community-level indicators should generate a wider range of monitoring outcomes than a focus on individual indicator species; a community-level approach would allow for monitoring of new dominant species, such as may manifest through climate change or human-assisted invasion, and would

allow for development of community species richness indicators and the tracking of population declines of newly-threatened species.

Steve Gittings, Science Director, NOAA Office of National Marine Sanctuaries
View on overall approach: Dr. Gittings indicated general support for the approach, with some specific comments about recommended indicators.

Key feedback regarding framework:

- Those indicators that might provide early warning to allow management actions to intervene before irreparable change occurs are particularly important, and should be prioritized and flagged as such in the framework.
- The document would benefit from an increased attention to invasive species.

Glenys Jones, Planner, Performance Evaluation and Reporting, Parks and Wildlife Service, Tasmania, Australia
View on overall approach: Dr. Jones indicated strong support for the framework, describing it as an "impressive and ambitious program that promises to significantly advance knowledge and understanding of Californian MPAs." She noted that careful consideration will need to be given to prioritizing the monitoring activities to ensure the program remains well-targeted, focused and manageable.

Key feedback regarding framework:

- The attributes most likely to change under improving or worsening scenarios should be prioritized for implementation.
- Socio-economic indicators that measure the value and contribution of MPAs to California and its people; and community perceptions of anticipated and realized changes attributable to MPAs, should be included.
- A new component should be added that monitors the effectiveness of selected MPA projects/initiatives as this would provide factual feedback about performance to inform and guide adaptive management.
- General support for ecosystem assessment and vital signs approach.
- An integrated visual image monitoring component should be added which includes high quality video footage suitable for television transmission.
- Strong support for simple consistently formatted reporting outputs that are accessible to all; however should provide option for 'neutral' reporting of detected changes (i.e. neither 'good' nor 'bad' change).
- Two key focus areas for ecosystem modeling R&D are:
  - MPA design for conservation management; and
  - MPAs and fisheries management.

Bob Leeworthy, Chief Economist, NOAA/NOS/Office of National Marine Sanctuaries
View on overall approach: Dr. Leeworthy expressed general agreement with overall approach.

Key feedback regarding framework:

- Elements of the framework that raised some concern were focused on what is done in establishing baselines from which socioeconomic impacts will be judged and how effectiveness is assessed.
- The proposed tier 1 metrics for consumptive use do not fully exploit currently available information for monitoring and build the assessment capability for effectiveness.
- The differentiation between "vital signs" and "ecosystem assessment tiers 1 and 2" makes good sense.

Lisa Levin, Professor, Integrative Oceanography Division, Scripps Institution of Oceanography, UC San Diego
View on overall approach: Dr. Levin found the overall framework to be "well thought out and appropriate."

Key feedback regarding framework:

- The fundamental goals driving the selection of vital signs and the ecosystem assessment are not sufficiently clear. The expectation is that monitoring should be linked not just to structural attributes but to ecosystem functions. These functions are specific to each system and should be specified. Ecosystem health needs to be assessed in the context of these functions.
- The ecosystem divisions seem to be somewhat arbitrary (e.g., sandy beaches are considered as a separate feature, but estuaries include tidal mudflats, salt marshes, etc.). Many habitats and subsystems are lumped into estuaries; some could be broken out.
- Nearly all of the vital signs provide positive indication of ecosystem health; negative indicators are rarely included.
- The different between "status and trends" monitoring and "effectiveness" monitoring could be better clarified at the beginning.

Phil Levin, Program Manager, Northwest Fisheries Science Center, NOAA Fisheries
View on overall approach: Dr. Levin found the overall framework "very impressive" while offering several suggestions for improvement, most notably regarding the selection of indicators.

Key feedback regarding framework:

- Would be useful to have a conceptual model for each ecosystem that shows how the indicator and attributes relate to the general ecological processes.
- Recommend using more fundamental ecosystem attributes. For example, nutrient cycling would be the attribute and planktivores would be the indicator.
- Recommend using some ratios as indicators.
- Suggest adding non-economic social science into the framework.

Laurence McCook, Manager, Research and Monitoring, Great Barrier Reef Marine Park Authority
View on overall approach: Dr. McCook notes strong support for the framework, describing it as "a substantive and very strong approach."

Key feedback regarding framework:

- The distinction between ecosystem assessment tiers should prioritize ecological significance rather than technological complexity.
- Some of the hierarchical distinctions between vital signs and ecosystem assessment tiers seem to constrain rather than enhance the framework; some of the "Vital Signs" may not be cheap or simple to monitor (and may not in fact be *vital* to the system).
- It is important to weight the indicators and attributes; some are more vitally important than others.
- The links to adaptive management and policy changes due to monitoring should be made explicit, and the effectiveness of management should be explicitly monitored.

Michael Orbach, Professor in the Practice of Marine Affairs and Policy, Nicholas School of the Environment, Duke University
View on overall approach: Dr. Orbach indicated general support for the approach while expressing a desire for significantly more development of socio-economic monitoring.

Key feedback regarding framework:

- Recommend more detailed socio-economic categories, including: commercial fishing; recreational fishing; other recreational water use; commercial shipping; military; oil, gas and mining; other energy production; aquaculture; and aesthetic.
- Recommend monitoring governance as well, such as local municipal and county decisions that might affect marine use.
- Private vessel recreational fishing should be included, as should catch per unit effort.
- The shore-side components of the socio-economic system should be included.
- Attitudes and opinions of various stakeholders about the resources, their environments, and the MPA process should be monitored regularly.

John Pearse, Professor Emeritus, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz

View on overall approach: Dr. Pearse found the framework to be "comprehensive" and the modular approach (i.e., having vital signs and tier 1 and 2 ecosystem attributes/indicators) to be good and realistic given budget limitations. He supported the use of "citizen scientists" in much of the monitoring, including high school students, but recommended having a well-trained staff to assure data quality and to do analyzes. He approved of focusing on the ecosystem but acknowledged that this is difficult to do well. He found the effectiveness monitoring questions to be appropriate (though difficult to answer). He supported monitoring a smaller number of species/feature that can be clearly identified and monitored over a more superficial program that covers all possibilities.

Key feedback regarding framework:

- The framework document would benefit from more clarity; it might otherwise be confusing to the general public. In particular, more clarity is needed around distinguishing the "vital signs" metrics from the "ecosystem assessment" approach.
- Some ecosystem features are more important than others for MPA monitoring; the framework should be modified to delineate these priorities. Modules that involve potential or actual human impacts should be given top priority, especially those that can be replicated.

Linwood Pendleton, Director of Ocean and Coastal Policy, Nicholas Institute for Environmental Policy Solutions, Duke University

View on overall approach: Dr. Pendleton found the overall approach to be appropriate. Like many others, he would have preferred to see more information on analysis than was in the framework (i.e., he wanted to see the draft plan).

Key feedback regarding framework:

- Different vital signs and attributes need to be monitored at different scales (MPA, network, fishing block). The Monitoring Enterprise needs to make sure that the various geographic scales are compatible.
- There is a high degree of inter-relatedness among the vital signs, attributes, and human uses to be monitored. How will the Monitoring Enterprise ensure that the spatial and temporal scales of these vital signs and attributes will be measured in a way that permits analysis?
- Many of the vital signs and attributes are related, although it is assumed they can be analyzed independently. If the point is to understand how the MPA affected the vital sign or attribute, it will be important to understand what trends, changes, etc. are attributable directly to the MPAs and which are related to other factors that may or may not be affected by MPAs. In other words, more detail is needed on the data will be analyzed to show the effect of MPAs while controlling for all other factors. The plan should

indicate what sorts of other "explanatory monitoring variables" must be collected to make sense of the monitoring data.

J.P. Ray, President, Oceanic Environmental Services
View on overall approach: Dr. Ray offered qualified support for the framework. In light of the funding limitations, he sees this approach as a good first step. However, he noted that the limitations of this approach should be well understood by managers and policy makers. Additionally, he felt that the approach may not be comprehensive enough to identify the causes of oceanic changes.

Key feedback regarding framework:

- Because of the complexity of ocean environments, monitoring should additionally include federal waters off California and international waters both north and south.
- General support for the vital signs approach. Qualified support for the ecosystem assessment approach, as more detailed physical and chemical oceanography data would be needed to understand the monitoring data.

Hugh Sweatman, Leader, Long-term Monitoring Program for the Great Barrier Reef, Australian Institute of Marine Science
View on overall approach: Dr. Sweatman supported the framework, calling it a "thoughtful approach."

Key feedback regarding framework:

- Concerns about whether using aggregate indices such as average rockfish size will obscure changes in individual component species.
- General support for the vital signs and ecosystem assessment approaches.
- Suggest adding regular comprehensive review of relevance and effectiveness of monitoring activities.

Simon Thrush, Principal Scientist, National Institute of Water and Atmospheric Research, New Zealand & Department of Environmental Sciences (DIPTERIS), University of Genoa, Italy
View on overall approach: Dr. Thrush noted general support for the approach, while noting that the detail of the data gathering and analysis will be crucial elements to the program's success.

Key feedback regarding framework:

- Support for the vital signs and ecosystem assessments approach.
- Suggests that the links between monitoring, evaluation, and management action be made explicit, including key decision points.
- A strategy for data continuity, quality assurance, and control will be crucial.

APPENDIX C-6. NORTH CENTRAL COAST REGIONAL GOALS AND OBJECTIVES AND SITE-LEVEL OBJECTIVES

During the MPA planning process, goals and objectives for the North Central Coast regional MPA network were developed, based on the statewide goals expressed in the MLPA. In addition, site-specific objectives were developed for each individual MPA, linked to the regional goals and objectives. The following two documents detailing these goals and objectives are incorporated into this appendix:

- California Marine Life Protection Act Initiative, North Central Coast Regional Goals and Objectives (Adopted by the MLPA Blue Ribbon Task Force on February 14, 2008)
- Individual MPA Objectives, Integrated Preferred Alternative (IPA), North Central Coast Study Region (The IPA Proposal corresponds to the MPA network adopted by the Fish & Game Commission.)

California Marine Life Protection Act Initiative
North Central Coast Regional Goals and Objectives
Adopted by the MLPA Blue Ribbon Task Force on February 14, 2008

Introduction

The members of the North Central Coast Regional Stakeholder Group (NCCRSG) agree that regional goals, objectives, and design and implementation considerations are all very important in the development of an effective system of marine protected areas (MPAs) that have stakeholder support. Regional goals are statements of what the regional MPAs are ultimately trying to achieve (Pomeroy et al. 2004)[1]. The regional goals are largely taken directly from the Marine Life Protection Act (MLPA) itself. Regional objectives are more specific measurable statements of what MPAs may accomplish to attain a related goal (Pomeroy et al. 2004). The NCCRSG recognizes that MPAs are one among a suite of tools to manage marine resources.

Design considerations are additional factors that may help fulfill provisions of the MLPA related to facilitating enforcement, encouraging public involvement, and incorporating socio-economic considerations, while meeting the act's goals and guidelines. Design considerations will be applied as the location, category (reserve, park or conservation area), size and other characteristics of potential MPAs are being developed. Design considerations are cross-cutting (they apply to all MPAs) and are not necessarily measurable. MPA alternatives developed by the NCCRSG should include analysis of how the proposal addresses both regional goals and objectives and design guidelines. [2]

[1] Pomeroy R.S., J.E. Parks, and L.M. Watson. 2004. How is your MPA doing? A Guidebook of Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness. IUCN, Gland, Switzerland and Cambridge, UK. xvi + 216 p. (Accessed 17 January 2004). http://effectivempa.noaa.gov/guidebook/guidebook.html.

[2] John Kirlin Memo, August 22, 2005.

Regional Objectives

Goal 1. To protect the natural diversity and abundance[3] of marine life, and the structure, function, and integrity of marine ecosystems.

1. Protect species diversity and abundance consistent with natural fluctuations by including and maintaining areas of high native species diversity and representative habitats.
2. Include areas with diverse habitat types in close proximity to each other.
3. Protect natural size and age structure and genetic diversity of populations in representative habitats.
4. Protect natural trophic structure and food webs in representative habitats.
5. Protect ecosystem structure, function, integrity and ecological processes to facilitate recovery of natural communities from disturbances both natural and human induced.

Goal 2. To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.

1. Help protect or rebuild populations of rare, threatened, endangered, depressed, depleted, or overfished species, where identified, and the habitats and ecosystem functions upon which they rely.[4]
2. Sustain or increase reproduction by species most likely to benefit from MPAs through retention of large, mature individuals[5].
3. Sustain or increase reproduction by species most likely to benefit from MPAs through protection of breeding, foraging, rearing or nursery areas.
4. Protect selected species and the habitats on which they depend while allowing the commercial and/or recreational harvest of migratory, highly mobile, or other species

[3] *Natural diversity* is the species richness of a community or area when protected from, or not subjected to, human-induced change (drawn from Allaby 1998 and Kelleher 1992). *Natural abundance* is the total number of individuals in a population protected from, or not subjected to, human-induced change (adapted from Department 2004 and Kelleher 1992).

[4] The terms "rare," threatened," "endangered," "depressed," "depleted," and "overfished" referenced here are designations in state and federal legislation, regulations, and fishery management plans (FMPs)—e.g., California Fish and Game Code, Marine Mammal Protection Act, Magnuson Stevens Fishery Conservation and Management Act (MSA), California Nearshore FMP, Federal Groundfish FMP). Rare, e*ndangered,* and *threatened* are designations under the California Endangered Species Act. *Depleted* is a designation under the federal Marine Mammal Protection Act. *Depressed* means the condition of a marine fishery that exhibits declining fish population abundance levels below those consistent with maximum sustainable yield (California Fish and Game Code, Section 90.7). *Overfished* means a population that does not produce maximum sustainable yield on a continuing basis (MSA) and in the California Nearshore FMP and federal Groundfish FMP also means a population that falls below the threshold of 30% or 25%, successively, of the estimated unfished biomass

[5] An increase in lifetime egg production will be an important quantitative measure of an improvement of reproduction.

where appropriate through the use of state marine conservation areas and state marine parks.

Goal 3. To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbances, and to manage these uses in a manner consistent with protecting biodiversity.

1. Ensure some MPAs are close to population centers, coastal access points, and/or research and education institutions and include areas of educational, recreational, and cultural use.
2. Sustain or enhance cultural, recreational, and educational experiences by improving catch rates, high scenic value, lower congestion, or increased size or abundance of species.
3. To enhance the likelihood of scientifically valid studies, replicate appropriate MPA designations, habitats or control areas (including areas open to fishing) to the extent possible.
4. Develop collaborative scientific monitoring and research projects evaluating MPAs that link with fisheries management information needs, classroom science curricula, volunteer dive programs, and fishermen, and identify participants.

Goal 4. To protect marine natural heritage, including protection of representative and unique marine life habitats in north central California waters, for their intrinsic value.

1. Include within MPAs the following habitat types: estuaries, the intertidal zone at the Farallon Islands, and subtidal waters (including the water column and benthic habitats) around the Farallon Islands
2. Include and replicate to the extent possible [practicable], representatives of all marine habitats identified in the MLPA or the *California MLPA Master Plan for Marine Protected Areas* across a range of depths.

Goal 5. To ensure that north central California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.

1. Minimize negative socio-economic impacts and optimize positive socio-economic impacts for all users, to the extent possible, and if consistent with the Marine Life Protection Act and its goals and guidelines.
2. For all MPAs in the region involve interested parties to help; develop objectives, a long-term monitoring plan that includes standardized biological and socioeconomic monitoring protocols, and a strategy for MPA evaluation, and ensure that each MPA objective is linked to one or more regional objectives.

3. To the extent possible, effectively use scientific guidelines in the *California MLPA Master Plan for Marine Protected Areas*.

Goal 6. To ensure that the north central coast's MPAs are designed and managed, to the extent possible, as a component of a statewide network.

1. Develop a process to inform adaptive management that includes stakeholder involvement for regional review and evaluation of management effectiveness to determine if regional MPAs are an effective component of a statewide network.
2. Develop a mechanism to coordinate with future MLPA regional stakeholder groups in other regions to ensure that the statewide MPA network meets the goals of the MLPA.

Regional Design and Implementation Considerations

Design Considerations

The NCCRSG recognizes several issues that should be considered in the design and evaluation of marine protected areas. Like the "Considerations in the Design of MPAs" that appears in the *California MLPA Master Plan for Marine Protected Areas*, these considerations may apply to all MPAs and MPA proposals regardless of the specific goals and objectives for that MPA. The design considerations below will be incorporated with the goals and objectives and provided to the MLPA Master Plan Science Advisory Team, MLPA Blue Ribbon Task Force, and California Fish and Game Commission. Design considerations with long-term monitoring components will be used in developing monitoring plans and to inform the adaptive management process.

1. In evaluating the siting of MPAs, considerations shall include the needs and interests of all users.
2. Recognize relevant portions of existing state and federal fishery management areas and regulations, to the extent possible, when designing new MPAs or modifying existing ones.
3. To the extent possible, site MPAs to prevent fishing effort shifts that would result in serial depletion.
4. When crafting MPA proposals, include considerations for design found in the Nearshore Fishery Management Plan[6] and the draft Abalone Recovery and Management Plan.[7]

[6] Design considerations from Nearshore Fishery Management Plan:
1. Restrict take in any MPA [intended to meet the NFMP goals] so that the directed fishing or significant bycatch of the 19 NFMP species is prohibited.
2. Include some areas that have been productive fishing grounds for the 19 NFMP species in the past but are no longer heavily used by the fishery.
3. Include some areas known to enhance distribution or retain larvae of NFMP species
4. Consist of an area large enough to address biological characteristics such as movement patterns and home range. There is an expectation that some portion of NFMP stocks will spend the majority of their life cycle within the boundaries of the MPA.
5. Consist of areas that replicate various habitat types within each region including areas that exhibit representative productivity.

[7] Design considerations from Abalone Recovery and Management Plan:
Proposed MPA sites should satisfy at least four of the following criteria.
1. Include within MPAs suitable rocky habitat containing abundant kelp and/or foliose algae
2. Insure presence of sufficient populations to facilitate reproduction.
3. Include within MPAs suitable nursery areas, in particular crustose coralline rock habitats in shallow waters that include microhabitats of moveable rock, rock crevices, urchin spine canopy, and kelp holdfasts.
4. Include within MPAs the protected lee of major headlands that may act as collection points for water and larvae.
5. Include MPAs large enough to include large numbers of abalone and for research regarding population dynamics.
6. Include MPAs that are accessible to researchers, enforcement personnel, and others with a legitimate interest in resource protection.

5. In developing MPA proposals, consider how existing state and federal programs address the goals and objectives of the MLPA and the north central coast region as well as how these proposals may coordinate with other programs.
6. To the extent possible, site MPAs adjacent to terrestrial federal, state, county, or city parks, marine laboratories, or other "eyes on the water" to facilitate management, enforcement, and monitoring.
7. To the extent possible, site MPAs to facilitate use of volunteers to assist in monitoring and management.
8. To the extent possible, site MPAs to take advantage of existing long-term monitoring studies.
9. To the extent possible, design MPA boundaries that facilitate ease of public recognition and ease of enforcement.
10. Consider existing public coastal access points when designing MPAs.
11. MPA design should consider the benefits and drawbacks of siting MPAs near to or remote from public access.
12. Consider the potential impacts of climate change, community alteration, and distributional shifts in marine species when designing MPAs.
13. To the extent possible, preserve the diversity of recreational, educational, commercial, and cultural uses.
14. To the extent possible, optimize the design of the MPA network to facilitate monitoring and research that answers resource management questions; an example is including MPAs of different protection levels in similar habitats and depths, adjacent or in otherwise comparable locations, to state marine reserves, to evaluate the effectiveness of different protection levels in meeting regional and statewide goals.

Implementation Considerations

Implementation considerations arise after the design of MPAs as the California Department of Fish and Game and any other responsible agencies implement decisions of the California Fish and Game Commission and, if appropriate, the California Park and Recreation Commission, with funding from the Legislature or other sources.

1. Improve public outreach related to MPAs through the use of docents, improved signage, and production of an educational brochure for north central coast MPAs.
2. When appropriate, phase the implementation of north central coast MPAs to ensure their effective management, monitoring, and enforcement.
3. Ensure adequate funding for monitoring, management, and enforcement is available for implementing new MPAs.

4. Develop regional management and enforcement measures, including cooperative enforcement agreements, adaptive management, and jurisdictional maps, which can be effectively used, adopted statewide, and periodically reviewed.
5. Incorporate volunteer monitoring and/or cooperative research, where appropriate.

Individual MPA Objectives
Integrated Preferred Alternative (IPA)
North Central Coast Study Region

In the following document, Goals (G) and Objectives (O) refer to "Regional goals, objectives, and design and implementation considerations for the north central coast regional component of a statewide MPA network."

Point Arena SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Protect diverse species, unique and complex habitats (pinnacles, wash rocks, caverns, clefts, honeycomb formation, undercut & vertical rock walls, cobbles, deep sand, kelp), in an area of persistent upwelling.
- Restore declining yelloweye, canary & china rockfish populations. (G2-O1, G2-O2)
- Leave fishing open for the harbor, popular fishing and diving spots north & south of harbor, most of Manchester Beach crab grounds, shore fishing on Manchester, extensive salmon fishing areas & cultural uses near Garcia River mouth & Manchester Beach. (G3-O1)
- Improve fish productivity in SMR to benefit local rockfish fishing outside. (G3-O2)
- Provide an iconic place with MPA designation. (G3-O3)

Point Arena SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT the recreational take of salmon by trolling and the commercial take of salmon with troll fishing gear

Specific Objectives:

- Extend protection to state boundary to encompass deeper habitat & associated species in regional center of high productivity (see above). (G1-O2, G1-O3, G2-O1 and G2-O2)
- Protect nearshore reef species & habitats on which they depend while allowing commercial and/or recreational harvest of migratory, highly mobile, or other species where appropriate through the use of SMCA. (G2-O4, G5-O1)

Sea Lion Cove SMCA

Proposed Regulations: The recreational and commercial take of all marine invertebrates and marine aquatic plants is prohibited. Take of all other species is allowed

Specific Objectives:

- Contribute to the protection of vulnerable abalone populations and intertidal ecosystem.
- Create opportunities for education and enjoyment related to intertidal areas and invertebrate communities in an unusually scenic spot.

Saunders Reef SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT:
1. The recreational take of salmon by trolling
2. The commercial take of salmon with troll fishing gear, and urchin

Specific Objectives:
- Protect complex and highly productive rocky reef and kelp habitat including part of an extensive stand of bull kelp, and associated species, including nearshore finfish and multiple abalone species.
- Protect deeper sand and rock habitat in a regional center of high productivity.

Del Mar Landing SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:
- Protect community of marine species and their habitat.
- Provide greater ecosystem protection at an existing MPA originally established as an "ecological reserve."

Stewarts Point SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:
- Provide the highest protection to complex rocky habitat and kelp (including coves, wash rocks, shelves, walls, cobble and boulders), dependent communities and ecosystem functions within a preferred-size SMR.
- Include area with a relatively steep depth gradient.
- Provide opportunity for continuous land-sea protection and management of scenic area for natural heritage purposes by portion sited adjacent to Salt Point State Park.

Salt Point SMCA[1]

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT the recreational abalone and finfish

Specific Objectives:
- Enhance recreational experience via proximity to Stewarts Point and Gerstle Cove SMRs.

Gerstle Cove SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Protect intertidal habitat in an existing MPA that appears to be working for resident species, including abalone.
- Enhance biodiversity protection from existing MPA via proximity to Rocky Pt -Horseshoe Pt. SMR. (G1-O1)
- Preserve traditional site for educational and non-consumptive recreation; This SMR is a heritage site. (G3-O2)

Russian River SMRMA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT recreational hunting of waterfowl is allowed unless otherwise restricted by hunting regulations (sections 502, 550, 551 and 552)

Specific Objectives:

- Protect nursery ground habitat.
- Protect communities associated with areas of diverse estuarine habitats including open channels, mud flats, eel grass beds, etc.
- Protect estuary, steelhead, Russian River Chinook & Coho salmon, birds, mammals etc.
- Protect salmonid species subject to increased fishing impacts when estuary mouth is closed and fish are unable to transit into the ocean.

Russian River SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT:

1. The recreational take of Dungeness crab by trap, and surf smelt by hand-held dip net or beach net
2. The commercial take of Dungeness crab by trap

Specific Objectives:

- Protect Russian River Chinook and Coho salmon (Evolutionary Significant Units), at localized estuarine collection point.

Bodega Head SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Protect area of high benthic species diversity & maintain species diversity & abundance characteristic of north central coast region north of Point Reyes. (G1-O1)
- Monitor appropriate indicator species with focus on Nearshore & Deeper Nearshore Fishery Management Plan species. (G1-O5)
- Protect natural trophic structure & food webs, including prey for other fish, marine birds & marine mammals.

- Provide protection to area that contains one of most persistent & important upwelling plumes along entire California Coast & provides for significant down stream larval dispersal. (G1-O5)
- Help restore depleted species, such as near shore & deeper nearshore species. (G2-O1)
- Protect larval sources & enhance reproductive capacity of shelf species including rockfishes. (G2-O2)
- Protect area with diverse habitats & associated species including kelp forest ecosystems.
- Protect natural heritage location while minimizing socioeconomic impacts to local communities. (G5-O1)
- Protect forage base for colonies of marine mammals & sea birds as well as protect colonies from disturbance.
- Provide comparison analysis environment by providing SMR adjacent to SMCA across range of depths & fully accessible area within single reef complex in close proximity to Bodega Bay Marine Lab. (G1-O2, G3-O1)

Bodega Head SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT:

1. The recreational take of pelagic finfish by trolling, Dungeness crab by trap, and market squid by hand-held dip net
2. The commercial take of pelagic finfish with troll fishing gear or round haul net, Dungeness crab by trap, and market squid by round haul dip net

Specific Objectives:

- Minimize effect of fishing on area of high benthic species diversity characteristic of north central coast region north of Point Reyes while allowing specific recreational and commercial harvest. (G5-O1)
- Protect natural trophic structure & food webs, including prey for other fish, marine birds & marine mammals.
- Help restore depleted species, such as near shore and deeper nearshore species. (G2-O1)
- Protect larval sources & enhance reproductive capacity of shelf species including rockfishes. (G2-O2)
- Protect area with diverse habitats and associated species including kelp forest ecosystems.
- Protect natural heritage location while minimizing socioeconomic impacts to local communities. (G5-O1)
- Provide comparison analysis environment by providing SMCA adjacent to SMR across a range of depths and fully accessible area within single reef complex in close proximity of Bodega Bay Marine Lab. (G1-O2, G3-O1, G3-O3)
- Protect one of rare hard bottom reef complexes in NCCSR that extend from shore seaward to state water boundary.

Estero Americano SMRMA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT the recreational hunting of waterfowl is allowed unless otherwise restricted by hunting regulations (502, 550, 551, and 552)

Specific Objectives:

- Protect species diversity and abundance, trophic structure & food webs, natural age structure & genetic diversity in representative habitats. (G1-O1, G1-O3, G1-O4)
- Sustain or increase reproduction of species by protecting & retaining large individuals & protecting breeding, foraging, rearing & nursery areas. (G2-O2, G2-O3)
- Enhance scientific validity with similar habitat replicated in close proximity. (G3-O3)

Estero de San Anotonio SMRMA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT the recreational hunting of waterfowl is allowed unless otherwise restricted by hunting regulations (502, 550, 551, and 552)

Specific Objectives:

- Protect species diversity & abundance, trophic structure and food webs, natural age structure & genetic diversity in representative habitats. (G1-O1, G1-O3, G1-O4)
- Sustain or increase reproduction of species by protecting & retaining large individuals & protecting breeding, foraging, rearing & nursery areas. (G2-O2, G2-O3)
- Enhance scientific validity with similar habitat replicated in close proximity. (G3-O3)

Point Reyes SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Protect diverse fish, seabird & marine mammals associated with multiple habitats including exposed high energy rocky shoreline, sand & gravel beaches, offshore islets, surf grass, soft & hard substrates set against oceanic features of major headlands at receiving end of coastal upwelling system of global significance.
- Protect natural tropic & natural ecosystem structure & function with minimal human-induced changes. (G1-O4, G1-O5)
- Protect larval retention zone of regional import for many fish & invertebrate species. (G2-O2)
- Reduce disturbances to major mainland seabird colonies & elephant seal rookeries within study region. (G2-O3)
- Preserve an iconic place. (G3-O1)
- Include areas with diverse habitat types within one MPA cluster. (G1-O2)

Point Reyes SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT:

1. The recreational take of salmon by trolling, and Dungeness crab by trap
2. The commercial take of salmon with troll fishing gear, and Dungeness crab by trap

Specific Objectives:

- Extend protection offshore to state boundary for diverse fish, seabird & marine mammal species in deeper hard & soft bottom. (G1-O2, G3-O1, G5-O3)
- Protect near shore reef species & habitats on which they depend while allowing commercial and/or recreational harvest of migratory, highly mobile, or other species where appropriate through use of SMCA. (G2-O4)
- Help protect diversity of species, including fish & mammals.
- Cover diversity of bottom habitats & oceanographic/wind conditions.

Estero de Limantour SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Expands on long-term protections for complex estuarine habitats & dependent species, including eelgrass beds & mudflat ecosystems. (G1-O1, G1-O4, G1-O5, G2-O3, G4-O1)
- Provide connectivity between tributaries & tidal marshes & diverse near-shore habitats with contiguous Point Reyes SMR. (G1-O5, G2-O3, G4-O1)
- Protect significant nursery area for Dungeness crab, & numerous rockfish & flatfish species. (G2-O3)
- Protect essential habitat for Black Brandt geese & a key foraging area for shorebirds, coastal waterfowl & brown pelicans. (G2-O3)
- In designated federal wilderness area. (G1-O1, G3-O2)
- Support current NPS coho salmon & steelhead trout migration habitat restoration projects on multiple tributaries. (G2-O1)
- Protect major harbor seal pupping & haul-out sites. (G2-O3)

Drakes Estero SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT:
1. The recreational take of clams
2. The commercial aquaculture of shellfish pursuant to a valid Sate Water Bottom Lease and permit

Specific Objectives:
- Protects estuarine habitats while allowing existing aquaculture activities as well as recreational clamming to continue.

Duxbury SMCA[1]

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT the recreational finfish from shore only and the recreational take of abalone

Specific Objectives:
- Protect species while allowing traditional recreational access. (G2-O4)
- Protect an area of important marine natural heritage.

Montara SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:
- Protect area of high benthic species diversity & maintain species diversity & abundance characteristic of north central coast region north of Point Reyes. (G1-O1)
- Monitor appropriate indicator species with focus on Nearshore and Deeper Nearshore Fishery Management Plan species. (G1-O5)
- Protect natural trophic structure & food webs, including species that serve as prey for other fish, marine birds & marine mammals. (G1-O4)
- Enhance non-consumptive recreational & educational experiences by protecting intertidal ecosystems by reducing congestion & increasing size & abundance of species most likely to benefit from MPAs. (G3-O2)
- Help restore depleted species, such as near shore & deeper nearshore species. (G2-O1)
- Protect larval sources & enhance reproductive capacity of shelf species including rockfishes. (G2-O2)
- Protect area with diverse habitats and associated species including kelp forest ecosystems. (G1-O2)
- Protect natural heritage location while minimizing socioeconomic impacts to local communities. (G5-O1)
- Protect forage base for colonies of marine mammals as well as protect colonies from disturbance. (G1-O5)
- Provide comparison analysis environment by providing SMR adjacent to SMCA across range of depths.

Pillar Point SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT:

1. The recreational take of pelagic finfish by trolling, Dungeness crab by trap and squid by hand-held dip net
2. The commercial take of pelagic finfish with troll fishing gear or round haul net, Dungeness crab by trap and market squid by round haul net

Specific Objectives:

- Enhance non-consumptive recreational & educational experiences by protecting intertidal ecosystems by reducing congestion & increasing size & abundance of species most likely to benefit from MPAs. (G3-O2)
- Help restore depleted species, such as near shore & deeper nearshore species. (G2-O1)
- Protect larval sources & enhance reproductive capacity of shelf species including rockfishes. (G2-O2)
- Protect area with diverse habitats & associated species including kelp forest ecosystems. (G1-O2)
- Protect natural heritage location while minimizing socioeconomic impacts to local communities. (G5-O1)
- Provide comparison analysis environment by providing SMR adjacent to SMCA across range of depths.

North Farallon Islands SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Include a portion of unique tidal, subtidal, benthic & pelagic habitat of Farallones.
- Help protect concentrations of prey & foraging predators - fish & breeding colonies of seabirds & marine mammals - at highly productive & unique mix of habitats.
- Protect natural diversity & structure & function of unique marine ecosystem (G1-O1, G1-O5)
- Help assure continued recovery of ground fish (G2-O1)
- Enhance reproductive success of seabirds & marine mammals using islands (G2-O3)
- Increase supply of large adults & larval fish which can disperse to adjacent areas for fisheries harvest outside MPA (G3O2)
- Protects globally significant biological site. (G1-O1, G1-O2, G1-O3, G1-O4, G1-O5, G2-O1, G2-O3, G4-O1)

Southeast Farallon Island SMR

Proposed Regulations: Take of all living marine resources is prohibited

Specific Objectives:

- Allow natural ecosystem function in key portion of subregion. (G1-O5)
- Include portion of unique tidal, subtidal, benthic & pelagic habitat of Farallones. (G4-O1)

- Protect natural diversity and structure and function of unique marine ecosystem, increase rockfish larval production. (G1-O1, G2-O1, G2-O2)
- Help assure continued recovery of groundfish. (G2-O1)
- Enhance reproductive success of seabirds & marine mammals using islands. (G2-O3)
- Increase supply of large adults & larval fish which can disperse to adjacent areas for fisheries harvest outside MPA. (G3-O2)
- Protects globally significant biological site.

Southeast Farallon Island SMCA

Proposed Regulations: Take of all living marine resources is prohibited EXCEPT the recreational take of salmon by trolling and the commercial take of salmon with troll fishing gear

Specific Objectives:

- Protect benthic habitat and forage base for fish, birds and mammals at islands, while allowing salmon trolling. (G1-O2, G2-O3, G2-O4, G3-O2, G4-O1,G5-O1)
- Improve fish productivity in SMR to benefit local rockfish fishing outside MPA. (G3-O2)
- Protect nearshore reef species & habitats on which they depend while allowing commercial and/or recreational harvest of migratory, highly mobile, or other species where appropriate through use of a SMCA. (G2-O4)

[1] *Note: This area will initially be designated as an SMCA, though its regulations allow later change to SMP by the State Park and Recreation Commission.*

APPENDIX C-7. LIST OF SPECIES LIKELY TO BENEFIT FROM MARINE PROTECTED AREAS IN THE NORTH CENTRAL COAST REGION

During the MPA planning process, the North Central Coast Science Advisory Team identified a list of species 'most likely to benefit' from MPAs. This list included species likely to show a detectable change in local population as a result of MPA implementation. This list was also derived from a longer list of 'species likely to benefit' from MPAs. Both lists are provided here.

California MLPA Master Plan Science Advisory Team
List of Species Likely to Benefit from
Marine Protected Areas in the MLPA North Central Coast Study Region
(revised April 14, 2008)

The Marine Life Protection Act (MLPA) requires that species likely to benefit from marine protected areas (MPAs) be identified; identification of these species will contribute to the identification of habitat areas that will support achieving the goals of the MLPA. The draft *Marine Life Protection Act Master Plan for Marine Protected Areas (July 2006)* includes a broad list of species likely to benefit from protection within MPAs. The master plan also indicates that regional lists will be developed by the master plan science advisory team (SAT) for each study region of the California coast.

Attached to this document are the list of species likely to benefit for the MLPA North Central Coast Study Region (Alder Creek/Point Arena in Mendocino County to Pigeon Point in San Mateo County), as well as a list of the species *most likely to benefit* for the study region. These lists were adopted by the SAT on October 1, 2007, but may be modified by the SAT in the future as more information becomes available.

Species are included in the list of species likely to benefit if they meet one or more of these conditions:

- They occur in the MLPA North Central Coast Study Region.
- They are taken directly or indirectly in commercial or recreational fisheries.
- They have life history characteristics that make them more conducive to protection by MPAs, such as: sedentary behavior, long life spans, slow growth, or association with habitats that need additional spatial protection. An MPA would be expected to increase the species abundance or spawning biomass if the species is at an abnormally low abundance or abnormally low size frequency (i.e. below the range of natural fluctuations).

While this list is approximate, there are other species that may benefit or even diminish by establishing an MPA. In addition, it should be noted that many species have not yet been assessed for abundance or size frequency or their full life history requirements are not yet known.

The SAT defined the species *most likely to benefit* as those likely to show a detectable change in local population as a result of MPA implementation. Species are included in the species most likely to benefit list if they meet one or more of the following conditions:

- There is evidence for direct fishing effects on the species in question (e.g., the species is targeted by a fishery, known to be taken as bycatch in a local fishery, or fishing reduces important resources required of a species).
- The species suffers negative impacts associated with human activities other than fishing.
- A significant proportion of the species distribution occurs within habitats represented in the study region.

Table 1: Invertebrate species MOST likely to benefit from marine protected areas in the MLPA North Central Coast Study Region

abalone, red	*Haliotis rufescens*
clam, littleneck (Tomales Bay cockle)	*Protothaca staminea*
limpets	*Lottia gigantea*
mussels, native	*Mytilus californianus*
snail, turban	*Tegula funebralis*
urchin, red	*Strongylocentrotus franciscanus*

Table 2: Fish species MOST likely to benefit from marine protected areas in the MLPA North Central Coast Study Region

cabezon	*Scorpaenichthys marmoratus*
eel, wolf	*Anarrhichthys ocellatus*
flounder, starry	*Platichthys stellatus*
greenling, kelp	*Hexagrammos decagrammus*
greenling, rock	*Hexagrammos lagocephalus*
lingcod	*Ophiodon elongatus*
prickleback, monkeyface	*Cebidichthys violaceus*
prickleback, rock	*Xiphister mucosus*
ray, bat	*Myliobatis californicus*
rockfish, black	*Sebastes melanops*
rockfish, black-and-yellow	*Sebastes chrysomelas*
rockfish, blue	*Sebastes mystinus*
rockfish, bocaccio	*Sebastes paucispinis*
rockfish, brown	*Sebastes auriculatus*
rockfish, calico	*Sebastes dalli*
rockfish, China	*Sebastes nebulosus*
rockfish, copper	*Sebastes caurinus*
rockfish, flag	*Sebastes rubrivinctus*
rockfish, gopher	*Sebastes carnatus*
rockfish, grass	*Sebastes rastrelliger*
rockfish, greenspotted	*Sebastes chlorostictus*
rockfish, kelp	*Sebastes atrovirens*
rockfish, olive	*Sebastes serranoides*
rockfish, quillback	*Sebastes maliger*
rockfish, rosy	*Sebastes rosaceus*
rockfish, speckled	*Sebastes ovalis*
rockfish, squarespot	*Sebastes hopkinsi*
rockfish, starry	*Sebastes constellatus*
rockfish, treefish	*Sebastes serriceps*
rockfish, vermilion	*Sebastes miniatus*
rockfish, yelloweye	Sebastes ruberrimus

rockfish, yellowtail	Sebastes flavidus
smelt, surf	*Hypomesus pretiosus*
surfperch, barred	*Amphistichus argenteus*
surfperch, black	*Emibiotoca jacksoni*
surfperch, calico	*Amphistichus koelzi*
surfperch, pile	*Damalichthys vacca*
surfperch, rainbow	*Hypsurus caryi*
surfperch, redtail	*Amphistichus rhodoterus*
surfperch, rubberlip	*Phacochilus toxotes*
surfperch, shiner	*Cymatogaster aggregata*
surfperch, striped	*Embiotoca lateralis*
surfperch, walleye	*Hyperprosopon argenteum*
surfperch, white	*Phanerodon furcatus*

Table 3: Bird and Mammal species MOST likely to benefit from marine protected areas in the MLPA North Central Coast Study Region

brant	*Branta bernicla*
cormorant, Brandt's	*Phalacrocorax penicillatus*
cormorant, double-crested	*Phalacrocorax auritus*
cormorant, pelagic	*Phalacrocorax pelagicus*
grebe, Western/Clark's	*Aechmophorus occidentalis, clarkii*
guillemot, pigeon	*Cepphus columba*
murre, common	*Uria aalge*
murrelet, marbled	*Brachyramphus marmoratus*
oystercatcher, black	*Haematopus bachmani*
plover, snowy	*Charadrius alexandrinus*
porpoise, harbor	*Phocoena phocena*
sandpiper, western	*Calidris mauri*
scaup, lesser	*Aythya affinis*
scoter, surf	*Melanitta perspicillata*
sea lion, Steller	*Eumetopias jubatus*
sea otter, southern	*Enhydra lutris*
seal, harbor	*Phoca vitulina*
surfbird	*Aphriza virgata*
willet	*Catoptrophorus semipalmatus*

APPENDIX C-8. LEVELS OF PROTECTION ASSIGNED TO INDIVIDUAL MPAS AND THE ACTIVITIES ASSOCIATED WITH EACH LEVEL OF PROTECTION IN THE MLPA NORTH CENTRAL COAST STUDY REGION.

	Level of Protection	MPA Types	Activities associated with this protection level
	Very high	SMR	No take
	High	SMCA	In water depth > 50m: pelagic finfish[1] by hook and line (salmon by troll only); coastal pelagic finfish[2] by seine
	Moderate-high	SMCA	In water depth < 50m: pelagic finfish[1] by hook and line (salmon by troll only); coastal pelagic finfish[2] by seine; Dungeness crab (traps/pots), squid (pelagic seine)
	Moderate	SMCA SMP	salmon (non-troll H&L); abalone (diving); halibut, white seabass, shore-based finfish, croaker, and flatfishes (H&L); smelt (H&L and hand/dip nets); clams (hand harvest); giant kelp (hand harvest)
	Moderate-low	SMCA SMP	Urchin (diving); lingcod, cabezon, greenling, rockfish, and other reef fish (H&L); surfperches (H&L)
	Low	SMCA SMP	bull kelp and mussels (any method); all trawling; giant kelp (mechanical harvest); mariculture (existing methods)

[1] Pelagic finfish: northern anchovy (*Engraulis mordax*), barracudas (*Sphyraena* spp.), billfishes* (family Istiophoridae), dolphinfish (*Coryphaena hippurus*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), salmon (*Oncorhynchus* spp.), Pacific sardine (*Sardinops sagax*), blue shark (*Prionace glauca*), salmon shark (*Lamna ditropis*), shortfin mako shark (*Isurus oxyrinchus*), thresher sharks (*Alopias* spp.), swordfish (*Xiphias gladius*), tunas (family Scombridae), and yellowtail (*Seriola lalandi*). *Marlin is not allowed for commercial take.

[2] Coastal pelagic finfish: northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), and Pacific sardine (*Sardinops sagax*).