Advance Materials for Public Workshops, Round 2
Draft South Coast MPA Monitoring Metrics

Santa Barbara (November 8), Culver City (November 10), Carlsbad (November 15)

Introduction & Purpose of this Document

The MPA Monitoring Enterprise, in collaboration with the Department of Fish and Game (DFG), is currently developing a draft South Coast MPA Monitoring Plan. At a first round of monitoring planning public workshops held in the South Coast region in July 2010, participants identified priorities for MPA monitoring, including ecological components of ocean ecosystems, human activities, and MPA design and management questions. The input received during these workshops, together with subsequent consultations with scientists and monitoring experts, has informed the development of initial draft approaches and metrics for monitoring South Coast MPAs.

At a second round of public workshops, the Monitoring Enterprise will present these initial draft monitoring approaches and metrics. Our objectives are to facilitate questions and discussion of the draft approaches and to seek written comments on the draft metrics, at and/or following the workshops. The deadline for submission of written comments on the draft metrics is **November 27, 2010**.

This document describes the draft South Coast monitoring metrics that will be the primary focus of discussion at the workshops. It is hoped that workshop participants will review this document before the workshops, and refer to it during the workshops and while preparing any written comments on the draft metrics.

Following these workshops, the MPA Monitoring Enterprise will use the input received to further refine the monitoring metrics, which will be incorporated into a draft South Coast MPA Monitoring Plan. The draft plan will be subject to agency review and released for public comment, likely in early 2011. The revised plan will then be submitted to the California Fish & Game Commission for consideration, likely in Spring 2011.

About the draft South Coast MPA Monitoring Metrics

The Monitoring Enterprise has developed a framework for monitoring that will meet Marine Life Protection Act (MLPA) requirements. This framework adopts an ecosystem-based approach that encompasses habitats, marine life populations, diversity and abundance, and human activities, including consumptive and non-consumptive uses of marine resources and ecosystems. This will enable assessment of the performance of the South Coast regional MPA network against the full range of MLPA goals.

Ten Ecosystem Features have been identified for the South Coast region that collectively represent and encompass South Coast ecosystems, including humans, and provide the overarching structure for MPA monitoring. These are:

- Consumptive Uses
- Non-consumptive Uses
- Kelp and Shallow (0 – 30m) Rock Ecosystems
- Mid-depth (30 – 100m) Rock Ecosystems
- Deep Ecosystems including Canyons (> 100m)
- Rocky Intertidal Ecosystems
- Soft-bottom Subtidal (0 – 100m) Ecosystems
- Wetland and Estuarine Ecosystems

- Soft-bottom Intertidal Ecosystems, including Beaches
- Nearshore Pelagic Ecosystems (in state waters > 30m)

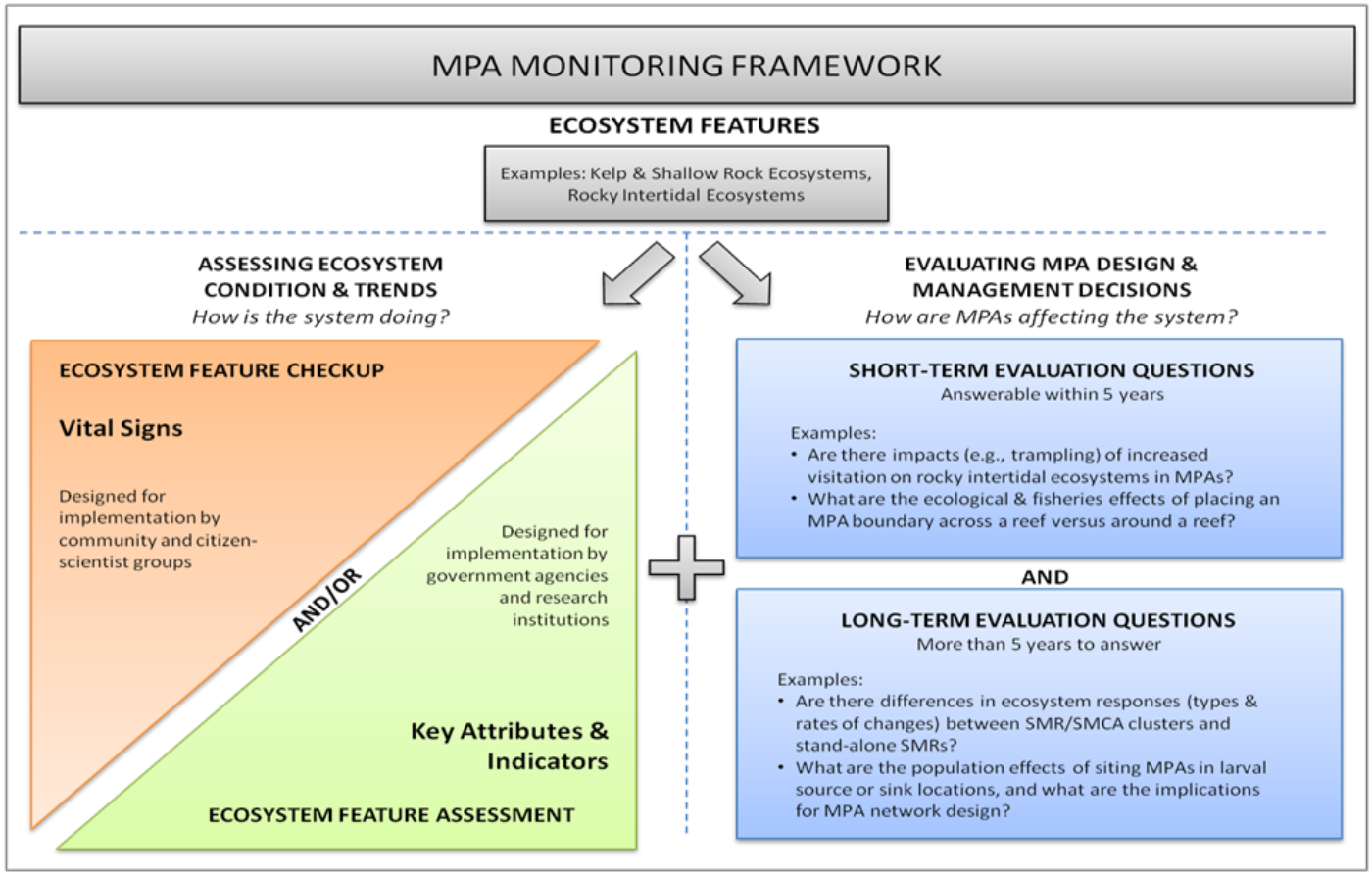
The Ecosystem Features provide the top level of the monitoring framework, which will include two core monitoring elements: 1) assessing ecosystem conditions and trends, and; 2) evaluating MPA design and management decisions (see MPA monitoring framework diagram on page 1). Assessment of ecosystem condition and trends will be used to track the state of marine ecosystems, including human activities, in the South Coast region, and how they change over time inside and outside the MPAs. Evaluations of specific MPA design and management decisions, such as MPA size and spacing, will examine the effects of these decisions on Ecosystem Features or Ecosystem Feature components. Collectively, the two core monitoring elements will provide information to assess progress in achieving MLPA goals, and facilitate future adaptive management decisions.

The remainder of this document provides a more detailed explanation of each of the two core monitoring elements and presents draft monitoring metrics for each.

Table of Contents

A. MPA Monitoring Framework 1
B. Assessing Ecosystem Condition & Trends 2
Kelp & Shallow (0-30m) Rock Ecosystems 3
Mid-depth (30-100m) Rock Ecosystems 7
Deep (>100m) Ecosystems, including canyons 10
Rocky intertidal Ecosystems 12
Soft-bottom subtidal (0-100m) Ecosystems 15
Estuarine & Wetland Ecosystems 18
Soft-Bottom intertidal & Beach Ecosystems 21
Nearshore pelagic ecosystems 24
Consumptive uses 27
Non-consumptive Uses 30
C. Evaluating MPA Design & Management Decisions 32
Short-term MPA Design & Management Evaluations 32
Long-term MPA Design & Management Evaluations 33
Size & Shape 34
Spacing 34
Habitat representation 35
Placement & Siting 35
Levels of protection 36

A. MPA MONITORING FRAMEWORK



Schematic diagram of the South Coast MPA Monitoring Framework showing the two principal monitoring elements: 1) assessing ecosystem condition and trends, and; 2) evaluating MPA design and 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 ten Ecosystem Features, which collectively represent and encompass the South 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.

B. ASSESSING ECOSYSTEM CONDITION & TRENDS

The MPA monitoring framework includes two core elements: 1) assessing ecosystem condition and trends and; 2) evaluating design and management decisions (see framework diagram, page 1). This section covers the first core element (shown on the left-hand side of the framework diagram): Assessing Ecosystem Condition and Trends. These assessments will be used to track the condition of marine ecosystems, including human activities, in the South Coast region – their status and how they change over time, inside and outside the MPAs.

The framework for Assessing Ecosystem Condition and Trends is implemented by monitoring the South Coast Ecosystem Features. It is important to note that this framework is not designed to measure everything that could possibly be measured in each Ecosystem Feature; rather, its goal is to efficiently "take the pulse" of these systems.

There are two approaches or options for taking the pulse of Ecosystem Features: Ecosystem Feature Checkups and Ecosystem Feature Assessments. Either or both of Ecosystem Feature Checkups and Ecosystem Feature Assessments can be used to track the condition of Ecosystem Features, depending on available partners and other resources, and other considerations.

Ecosystem Feature Checkups are designed to be carried out by community and citizen-scientist groups and thus use simplified sampling protocols and methods. The metrics for Checkups are referred to as Vital Signs, and they collectively provide a coarse-grained evaluation of Ecosystem Feature condition.

Ecosystem Feature Assessments are more detailed and technically demanding than Checkups and thus are likely to be implemented by government agencies and research institutions. Metrics for Assessments are divided into two levels: Key Attributes, which are important aspects of the structure or functioning of the Ecosystem Feature, and Indicators or Focal Species that provide insight into the condition of each Key Attribute. The Indicators or Focal Species are used together to assess the Key Attribute, and the Key Attributes are used together to assess the Ecosystem Feature.

The draft metrics (Vital Signs, and Key Attributes and Indicators or Focal Species) include species identified as priorities during the first round of public workshops, those with important ecological roles, 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 with fished species.

In addition to the draft metrics for monitoring via Checkups or Assessments, we also identify contextual information for each Ecosystem Feature. This information will facilitate the interpretation of monitoring results and includes, for example, information such as sea surface temperature, ocean currents and indicators of water quality.

The following tables present the Vital Signs, Key Attributes and Indicators/Focal Species, and contextual information for each Ecosystem Feature. Rationales for the selection of Key Attributes and Indicators/Focal Species are provided. Because Vital Signs are drawn from the list of Indicators, the rationales for Vital Signs can be found in the Attribute and Indicator tables. The Monitoring Enterprise is inviting comments on these draft metrics.

ECOSYSTEM FEATURE: KELP & SHALLOW (0-30M) ROCK ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Sheephead abundance & size frequency ➢ Red sea urchin abundance & size frequency ➢ Spiny lobster abundance & size frequency ➢ Kelp bass abundance & size frequency ➢ Rockfish abundance & size frequency ➢ Pink abalone abundance & size frequency ➢ Green abalone abundance & size frequency ➢ Red abalone abundance & size frequency

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal species	Indicator description & rationale
Biogenic Habitat: Macroalgae	• Canopy-forming kelp provides structure for numerous species and is a key foraging and nursery habitat for fish and invertebrates • Macroalgal abundance is an indicator of primary production	Giant kelp (*Macrocystis pyrifera*) areal extent of surface canopy	• *M. pyrifera* is the dominant canopy-forming species • Areal extent is a measure of amount of habitat provided
Strong Ecological Interactors	• Includes species that have been demonstrated to play important roles in structuring this ecosystem • Changes in the density of these species is predicted to have significant impacts on system functioning • Includes harvested and unharvested species	Sheephead (*Semicossyphus pulcher*) density & size structure	• Individuals change sex from female to male and large males are often fishery targets • Is an important predator of urchins and thus plays an important role in kelp forest dynamics • Important in commercial and recreational fishery
		Red sea urchin (*Strongylocentrotus franciscanus*) density & size structure	• Key herbivore that has a strong effect on giant kelp abundance • Important commercial fishery

		Spiny lobster (*Panulirus interruptus*) density & size structure	• Has a broad diet and is an important predator of urchins • Important species in commercial and recreational fisheries • Initial results from the Channel Islands suggest that this species will respond to MPA designation
		Sea stars (*Pisaster* spp., *Pycnopodia helianthoides*) density	• These predators can exert strong top-down control on community structure • Diet is primarily mollusks and crustaceans
		Sea otter (*Enhydra lutris*) abundance	• Keystone predator that can have strong top-down impacts on kelp communities through predation on urchins and abalone • Historically found throughout the South Coast, currently only found at San Nicolas Island
Trophic structure: Predatory fishes	• Presence of predatory fish indicates a functioning food web at multiple lower levels • Can play key ecological roles by moderating food web structure through top-down control • Response to protection may vary among species	Kelp bass (*Paralabrax clathratus*) density & size structure	• Feed primarily on small fishes and invertebrates • Larvae spend approximately 30 days in the plankton before settling • An important target of the recreational fishery in the South Coast
		Olive rockfish(*Sebastes serranoides*) density & size structure	• Live up to 25 years • Do not move long distances as adults • Were historically an important target of a recreational fishery, however populations have declined in the past few decades
		Kelp rockfish (*Sebastes atrovirens*) density & size structure	• Strong association with giant kelp • Prey on crustaceans and small fishes • Targeted by the sport fishing and live-fish fisheries
		Lingcod (*Ophiodon elongatus*) density & size structure	• Feeds primarily on demersal fish, mollusks and crustaceans • Strongly site-attached as adults, potentially increasing the magnitude of an MPA response

		Giant sea bass (*Stereolepis gigas*)	• Slow-growing and mature relatively late • Feed primarily on demersal fishes and crustaceans • Populations are currently well below historic levels
Trophic structure: Predatory invertebrates	• Presence of predatory invertebrates indicates a functioning food web at multiple lower levels • Includes commercially and recreationally harvested species	Rock crabs (*Cancer* spp.) density & size structure	• Important predators and scavengers in rocky habitats • Moderately mobile and so may respond to implementation of MPAs • An important commercial fishery
		Kellet's whelk(*Kelletia kelletii*) density & size structure	• An important benthic predator on herbivorous snails • Subject of a growing fishery in the South Coast region
Trophic structure: Planktivorous fishes	• These fishes indicate a functioning system in which nutrients are captured via an influx of plankton	Blacksmith (*Chromis punctipinnis*) density & size structure	• Abundant planktivore in South Coast kelp forests • Not sought after in commercial or recreational fisheries
		Senorita (*Oxyjulis californica*) density & size structure	• Abundant planktivore in South Coast kelp forests • Greater abundances observed outside MPAs in the Channel Islands 5 years post-designation • Not sought after in commercial or recreational fisheries
		Blue rockfish *(Sebastes mystinus*) density & size structure	• Populations have declined in the South Coast in recent decades; fishing pressure and changing ocean conditions are thought to have contributed to this decline • May give birth twice in a breeding season potentially leading to rapid MPA responses
Trophic structure: Herbivorous invertebrates	• Play important ecological roles as consumers of plants and algae (live and drift)	Pink abalone (*Haliotis corrugata*) density & size structure	• Historically the target of heavy fishing pressure • Populations are currently depleted, such that there is low reproductive success
		Green abalone (*Haliotis fulgens*)	• Historically the target of heavy fishing

	density & size structure	pressure • Populations are currently depleted, such that there is low reproductive success
	Red abalone (*Haliotis rufescens*) density & size structure	• Historically the target of heavy fishing pressure • Populations are currently depleted, such that there is low reproductive success

DRAFT OPTIONAL ADD-ONS FOR ECOSYSTEM ASSESSEMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Biogenic habitat	Giant kelp (*Macrocystis pyrifera*) stipe density
	Sub-canopy & turf algae cover
	Surfgrass (*Phyllospadix* spp.) cover
	Sessile invertebrate cover
Trophic structure: Herbivorous fishes	Density & size structure of focal species: Opaleye (*Girella nigricans*) Halfmoon (*Medialuna californiensis*)
Trophic structure: Unfished fishes	Painted greenling (*Oxylebius pictus*)
Species diversity	Species richness (invertebrates & fish)
	Species diversity (functional groups of fish & invertebrates

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results:

Sea surface temperature, depth of the thermocline, nutrients, turbidity, sedimentation, pH, salinity, chlorophyll, physical structure of the reef (e.g. rock type, rugosity)

ECOSYSTEM FEATURE: MID-DEPTH (30-100M) ROCK ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Rock crab abundance & size frequency ➢ Rockfish abundance & size frequency ➢ Lingcod abundance & size frequency ➢ Ocean whitefish abundance & size frequency ➢ White abalone abundance & size frequency

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Biogenic Habitat: Sessile invertebrates	• Provides habitat for a diverse suite of species	Structure forming invertebrate cover and height	• Provide structure and topographical relief • Many species are slow-growing, long-lived and fragile and may thus indicate an undisturbed environment
Trophic Structure: Predatory invertebrates	• Predatory invertebrates indicate the presence of a functioning food web	Rock crab (*Cancer* spp.) density	• Benthic predators and scavengers • Important prey for fish and other invertebrates • Moderately mobile and so may respond to implementation of MPAs • Taken in a commercial fishery
		Sheep (spider) crab (*Loxorhynchus grandis*) density	• Largest California crab and a key benthic predator and scavenger
Trophic Structure: Predatory fishes	• Play important roles at multiple trophic levels • Indicator of the presence of a functioning food web • Indicators are likely to exhibit varying responses to protection	Bocaccio (*Sebastes paucispinis*) density & size structure	• Prey upon fishes, including young rockfish • Long-lived (up to 50 yrs) and relatively fast-growing • Currently designated as “over-fished” and thus may respond positively to implementation of MPAs

		Vermilion rockfish (*Sebastes miniatus*) density & size structure	• Primarily piscivorous • Long-lived (up to 60 years) and slow-growing • Relatively sedentary as adults, potentially increasing responsiveness to MPA designation • Greater abundance observed inside MPAs in the Channel Islands 5 years post-designation
		Lingcod (*Ophiodon elongatus*) density & size structure	• Feed primarily on demersal fishes and invertebrates • Relatively sedentary, potentially increasing responsiveness to MPA designation • Taken in both commercial and recreational fisheries • Greater abundance observed inside MPAs in the Channel Islands 5 years post-designation
		Ocean whitefish (*Caulolatilus princeps*) density & size structure	• Feed primarily on small crustaceans, squid and fish • Taken primarily in the recreational fishery; commercial fishery is small • Greater abundance observed inside MPAs in the Channel Islands 5 years post-designation
		Rockfish (*Sebastes* spp.) size structure	• Numerically dominant fish in this ecosystem • Taken in both commercial and recreational fisheries • Larger individuals may have disproportionally higher reproductive output
Trophic Structure: Detritivores	• Indicate the capture of nutrients and productivity from sources internal and external to the system	Urchin (Echinidae, multiple species) density & size structure	• Mobile grazers that feed on live and drift algae
		White abalone (*Haliotis sorenseni*) density & size structure	• Mobile grazers that primarily feed on drift algae • Listed as critically endangered • Populations are not expected to recover quickly due to chronic reproductive failure as a result of low adult density (i.e. Allee effect)
Community Structure: Dwarf rockfish	• Dwarf rockfish populations were historically constrained by	Total dwarf rockfish abundance (multiple species)	• Trends in abundance may indicate shifts in community structure

	predation by large adult rockfish and by competition with juveniles of larger species • Fishing has disproportionately affected larger, slow-growing species resulting in increases of dwarf rockfish populations	

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Biogenic Habitat	Cover of focal species: Purple hydrocoral (*Stylaster californicus*) Elk kelp (*Pelagophycus porra*)
Species diversity	Species richness (invertebrates & fish)

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results:

Substrate relief, rock type, proximity to shallow reef, oxygen, currents, depth of thermocline, internal wave energy

ECOSYSTEM FEATURE: DEEP (>100M) ECOSYSTEMS, INCLUDING CANYONS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Rockfish (*Sebastes* spp.) abundance & size frequency ➢ Flatfish abundance & size frequency ➢ Sea urchin (multiple species) abundance ➢ Spot prawn abundance and size frequency

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Biogenic Habitat: Sessile invertebrates	• Provide habitat for a diverse suite of species	Structure-forming invertebrate cover and height	• Provide structure and topographical relief • Many species are slow-growing, long-lived and fragile and may thus indicate an undisturbed environment
Trophic Structure: Predatory fishes	• Indicates the presence of a functioning food web • Indicator species are likely to vary in response to local protection	Cowcod (*Sebastes levis*) density & size structure	• Diet is primarily fishes, octopus and squid • Currently designated as "overfished" • Long-lived and late maturing, so MPA response may be slow
		Bocaccio (*Sebastes paucispinis*) density & size structure	• Prey upon other fishes, including young rockfish • Long-lived, and relatively fast growing • Currently designated as "overfished" and thus may respond positively to implementation of MPAs
		Bank rockfish (*Sebastes rufus*) density & size structure	• Long-lived and slow-growing • Populations have declined since the 1990s • May respond positively to implementation of MPAs, but response is likely to be slow
		Sablefish (*Anoplopoma fimbria*) density & size structure	• Diet includes crustaceans and small fishes • Long-lived, fast growing and highly mobile • Targeted primarily by commercial fisheries

Trophic Structure: Detrivores	• Indicate the capture of nutrients and productivity from sources internal and external to the system	Sea urchin (Echinoidea, multiple species) abundance	• Feed on drift algae and other detrius • Provide structural relief in soft-sediment areas that can be used as prey refuges for small invertebrates and fish
		Hagfish (*Eptatretus stoudii*) abundance	• Important detritivores in deep ecosystems, feeding primarily on dead fish and mammals • Target of a growing fishery
		Spot prawns (*Pandalus platyceros*) abundance & size structure, sex ratio	• Feed on other crustaceans and mollusks as well as fish carcasses • Change sex as grow, shifts in sex/size structure may indicate response to MPAs • Target of commercial fishery
Community Structure: Dwarf rockfish	• Dwarf rockfish populations were historically constrained by predation by large adult rockfish and by competition with juveniles. Fishing has disproportionately affected larger species resulting in increases in dwarf rockfish populations	Total dwarf rockfish abundance (multiple species)	• Trends in abundance may indicate shifts in community structure

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

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

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results: Rugosity, cold-water seeps, O_2 minimum zone, currents, trawling history

ECOSYSTEM FEATURE: ROCKY INTERTIDAL ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Mussel bed area ➢ Rockweed cover ➢ Ochre sea star abundance & size frequency ➢ Black oystercatcher abundance ➢ Black abalone abundance & size frequency ➢ Green abalone abundance & size frequency ➢ Purple sea urchin abundance & size frequency ➢ Owl limpet abundance & size frequency ➢ Pinniped abundance (harbor seal, California sea lion, northern elephant seal)

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Biogenic Habitat	• Provides refuge from predators and exposure to desiccating conditions • Plants and algal species are indicators of primary production in the system • Species may be sensitive to human disturbance, such as trampling	Mussel (*Mytilus* spp.) percent cover	• Mussel beds provide habitat for many invertebrate species • Preyed on by sea stars, whelks and birds • Cover and density may be reduced by trampling
		Feather boa kelp *(Egregia menziesii*) percent cover	• Provides shelter for other algal and invertebrate species • Preferred food of some invertebrate grazers
		Rockweed (*Silvetia compressa*) percent cover	• Canopy provides habitat and shelter for mobile invertebrates • Cover and density may be reduced by trampling
		Surfgrass (*Phyllospadix* spp.) percent cover	• Provides shelter and nursery habitat for fishes and invertebrates • Important primary producer

			• Impacted by trampling, sewage and oil
Trophic Structure: Predators	• Presence indicates a functioning multi-level food web • May regulate community structure through top-down control	Sea star (*Pisaster ochraceus*) density & size	• Keystone species that strongly influences community structure by preferentially feeding on mussels
		Black oystercatcher (*Haematopus bachmani*) abundance	• A characteristic predatory bird species on rocky shores • Presence is linked to availability of prey (primarily mussels and limpets) • Breed on undisturbed, rocky open ocean shores
Trophic Structure: Herbivorous invertebrates	• Play key roles in structuring intertidal communities by maintaining bare rock that can facilitate settlement of sessile organisms • An important link in intertidal food webs	Black abalone (*Haliotis cracherodii*) density & size structure	• Feed primarily on drift algae • Populations are currently depressed due to overharvesting and disease • Recently listed as endangered by the federal government
		Green abalone (*Haliotis fulgens*) density & size structure	• Found in warmer waters in Southern California • Occur from the low intertidal to shallow subtidal • Feed on drift algae, preferring fleshy reds
		Purple sea urchin (*Strongylocentrotus purpuratus*) density & size structure	• Important grazer that feeds on drift algae and kelp • Play a role as a bioeroder by boring holes in rocks
		Owl limpet (*Lottia gigantea*) density & size structure	• Maintain territories on rocks by grazing or bulldozing other competitors

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Biogenic habitat	Cover of focal groups Turf algae Foliose red algae

	Fucoid algae
Trophic structure: Predators	Piscivorous bird richness and abundance
	Shorebird richness and abundance
Species diversity	Species richness (algae & invertebrates)
	Species diversity (functional groups of fish & invertebrates

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results:

Wave exposure, natural disturbance, climate, geology, human disturbance

ECOSYSTEM FEATURE: SOFT-BOTTOM SUBTIDAL (0-100M) ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Eelgrass areal extent ➢ Yellow rock crab abundance & size frequency ➢ California halibut abundance & size frequency ➢ Surfperch (multiple species) abundance & size frequency ➢ Flatfish abundance & size frequency

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attributes	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Biogenic Habitat	• Plays an important role by providing structure and habitat	Eelgrass (*Zostera* spp.) areal extent	• Provides important foraging and nursery areas • Physical disturbance can lead to declines in abundance
		Sand dollar (*Dendraster excentricus*) bed extent	• Stabilizes the substrate and provide structure for a diverse community of organisms
Trophic Structure: Benthic infauna	• Provide important linkages in subtidal food webs	Functional diversity of benthic infauna (feeding guilds)	• Changes in functional diversity occur in response to decreased disturbance or changes in sediment quality
Trophic Structure: Mobile invertebrates	• Play a variety of roles in the ecosystem including as predators, scavengers and bioturbators	Yellow rock crab (*Cancer anthonyi*) density & size structure	• Function both as predators and scavengers, eating a wide variety of invertebrates • Preyed on by fishes, including rockfishes, as well as by octopus and sea stars • Targeted both recreationally and commercially
		Sea star (*Astropecten* spp.) density & size structure	• Feed primarily on gastropods and sea pansies
		Ridgeback prawn (*Sicyonia ingentis*) density & size structure	• Abundant detritivore • Population size appears to be positively correlated with warm-water events, as seen

			during El Niños • Targeted by a commercial fishery
		Sea cucumber (*Parastichopus* spp.) density & size structure	• Feed on detritus and small organisms in sand and mud • Important bioturbators, altering the structure of the top layer of sediment • Harvested commercially
Trophic Structure: Predatory fish	• Play important roles in structuring the community • Indicate the presence of multiple, functioning trophic levels	California halibut (*Paralichthys californicus*) density & size structure	• Adults are piscivorous • Use shallow waters of the open coast as nursery grounds • Taken by both recreational and commercial fisheries
		Sanddab (*Citharichthys* spp.) density & size structure	• Feed near or on the bottom on a variety of prey; adults feed primarily on euphausiids and squid • Preyed upon by larger fishes, diving birds and marine mammals • Taken by both recreational and commercial fisheries
		Barred sand bass (*Paralabrax nebulifer*) density & size structure	• Prey includes crabs, octopus, squid and small fishes • Juveniles are often associated with eelgrass beds • Taken exclusively by recreational fishery
		Surfperch abundance (Embiotocidae, multiple species) density & size structure	• Diets consist of crustaceans, molluscs and polychaete worms • Important prey for fish and birds • Live-bearers that lack a pelagic larval stage • Taken in the recreational fishery

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Biogenic Habitat	Elk kelp (*Pelagophycus porra*) cover
Productivity: Subsidies	Squid egg (*Loligo opalescens*) cover
Trophic Structure: Predatory fish	Density & size structure of focal species: Bat ray (*Myliobatis californica*) Leopard shark (*Triakis semifasciata*) Angel shark (*Squatina californica*)
Species Diversity	Species richness (invertebrates & fishes)
	Species diversity (functional groups of fish & invertebrates

DRAFT CONTEXTUAL INFORMATION

This information will facilitate the interpretation of monitoring results:

Levels of disturbance, wave regime, grain size, location of adjoining habitats, shell mounds, depth of photic zone, current velocity, water quality

ECOSYSTEM FEATURE: ESTUARINE & WETLAND ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Eelgrass areal extent ➢ Ghost and mud shrimp abundance ➢ Pacific gaper and chione clam abundance & size frequency ➢ Marine bird diversity & abundance ➢ Halibut abundance & size frequency ➢ Arthropod biomass ➢ Harbor seal abundance (colony size)

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Biogenic Habitat	• Plays critical ecological role as nursery habitat • Important habitat for foraging	Areal extent of eelgrass (*Zostera marina*)	• Abundance has been shown to influence fish assemblages • Poor water quality, high turbidity, and physical disturbance lead to declines
Trophic Structure: Benthic infauna	• Includes bioturbators, filter-feeders and tube-builders • Key component of estuarine food web • Provide important habitat modification effects	Mud shrimp (*Upogebia* spp.) abundance	• Important bioturbators, creating branched burrows that create habitat for other species • Important prey for some fishes and birds • Abundance is negatively affected by trampling associated with hand harvest, thus is likely to benefit from establishment of MPAs
		Ghost shrimp (*Callianassa* spp.) abundance	• Important bioturbators, creating branched burrows that create habitat for other species • Important prey for some fishes and birds • Abundance is negatively affected by trampling associated with hand harvest, thus is likely to benefit from establishment of MPAs

		Pacific gaper clam (*Tresus nuttalli*) density & size structure	• Popular recreationally targeted species throughout California • Lives in burrows up to 1m deep • Collected for food and as bait
		Chione clam (*Chiones* spp.) density & size structure	• Preyed on by bat rays, crabs and whelks • Primarily a recreationally targeted species
Trophic Structure: Predatory birds	• Responsive to changing prey abundance • Sensitive to habitat modification (e.g. loss of foraging habitat or decreased water quality)	Total abundance & diversity of piscivorous birds & shorebirds	• Spend significant time foraging in estuarine habitats • Populations may increase in areas with reduced disturbance • Increases in abundance may results from increased fish populations
Trophic Structure: Predatory fishes	• Indicate the presence and functioning of multiple lower trophic levels • Abundances may increase in areas under MPA designation with decreased disturbance and take, and increased prey populations	Leopard shark (*Triakis semifasciata*) density and size structure	• Opportunistic feeder on crustaceans, mollusks, and some species of fish • Abundance in estuaries can vary seasonally • Taken recreationally, and to a lesser extent, commercially
		Bat ray (*Myliobatis californica*) density and size structure	• Feed primarily on mollusks and crustaceans • Known to return to the same bays and sloughs to give birth and mate • Taken recreationally, and to a lesser extent, commercially
		California halibut (*Paralichthys californicus*) density and size structure	• Estuaries provide important nursery habitat for juvenile halibut
Trophic Structure: Resident fishes	• Serve as important energy linkages in food web • Increases may be expected in direct response to reduced fishing and indirect responses to increased prey availability and reduced habitat disturbance	Shiner surfperch (*Cymatogaster aggregata*) density and size structure	• Diet consists of small crustaceans and other invertebrates • Prey for larger fish as well as harbor seals and birds • Harvested recreationally
		Spotted sand bass (*Paralabrax maculatofasciatus*) density and size structure	• Feed primarily on crustaceans and small fishes • Range is restricted to shallow bays and estuaries in Southern California • Recreationally targeted species, with pressure increasing in recent years

Productivity	• Arthropods are an important source of food in this ecosystem and provide an important link between terrestrial and marine ecosystems	Arthropod biomass	• Measures of arthropod biomass can indicate food availability for birds and other organisms that forage in estuaries and wetlands • Increases in arthropod biomass are related to system productivity

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Biogenic Habitat	Areal extent of common pickleweed (*Salicornia virginica*)
	Habitat diversity
Trophic structure: Benthic infauna	Abundance & foraging rates of shorebirds
Trophic structure	Parasite diversity
Species diversity	Species richness (invertebrates & fish)
	Species diversity (functional groups of fish & invertebrates

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results:

Tidal regime, estuary or wetland size and morphology, freshwater inputs, water temperature, human activities (e.g., breaching, flood and mosquito control), water quality (e.g., dissolved O_2, salinity, chlorophyll, turbidity, sediment load, contaminants)

ECOSYSTEM FEATURE: SOFT-BOTTOM INTERTIDAL & BEACH ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Sand crab abundance ➢ Pismo clam abundance & size frequency ➢ Beach wrack composition and abundance ➢ Surfperch abundance (multiple species) ➢ Grunion nest density and number of runs ➢ Shore bird richness & abundance ➢ Pinniped abundance (harbor seal, California sea lion, northern elephant seal)

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Trophic Structure: Suspension feeders	• Convert phytoplankton to biomass and thus make energy available to higher trophic levels	Sand crab (*Emerita analoga*) density & size structure	• Population sizes are closely related to the productivity of inshore waters • Prey for many fishes and birds • Collected for use as bait by fishermen
		Pismo clam (*Tivela stultorum*) density & size structure	• Found in the intertidal zone on flat beaches but can also be found in the shallow subtidal • Predators include sharks, bat rays, sea otters and moon snails • Larvae are thought to be benthic associated, suggesting local recruitment • Taken in the recreational fishery
		Bean clams (*Donax gouldii*) density & size structure	• Common bivalve on sandy beaches • Can form dense aggregations • Abundance can vary widely from year to year

Productivity: Beach wrack	• Macroalgal wrack is an important source of nutrients to beach ecosystems • The presence of wrack is indicative of linkages between nearshore and intertidal ecosystems	Wrack composition (e.g. kelps, foliose reds) and abundance	• Wrack is an essential food source for amphipods and isopods, which themselves are an important food source for fishes and birds
Productivity: Surf zone fish assemblage	• Exhibit a range of life history characteristics • Subject to different levels of recreational and commercial fishing	Surfperch abundance and size structure(Embiotocidae, multiple species)	• Diets consist of crustaceans, molluscs and polychaete worms • Are important prey for fish and birds • Bear live young and lack a pelagic larval stage • Targeted by recreational fishery
		Grunion (*Leuresthes tenuis*) nest density, number of runs	• Endemic to California • Spawning occurs on beaches • Nests are negatively impacted by activities such as beach grooming and nourishment
Trophic Structure: Predatory birds	• Soft-bottom intertidal environments are important foraging habitat for migratory and resident bird species	Total abundance of shorebirds	• Shorebird abundance indicates the availability of prey • Abundance may increase in with decreased disturbance
		Shorebird species richness	• Increased richness of shorebirds is predicted to occur in response to increased abundance and diversity of prey species

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Productivity	Wrack invertebrate diversity and biomass
Predators: Shorebirds	Shorebird feeding (capture) rate
Species diversity	Species richness (invertebrates & fish)
	Species diversity (functional groups of fish & invertebrates

DRAFT CONTEXTUAL INFORMATION

This information will facilitate the interpretation of monitoring results: Wave regime, slope, grain size and sorting, width of sandy area, erosion/deposition cycles, nourishment, grooming, coastal development, other human activities, contaminants

ECOSYSTEM FEATURE: NEARSHORE PELAGIC ECOSYSTEMS

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Semi-pelagic/pelagic rockfish average & maximum size ➢ Brandt's cormorant abundance ➢ Pelagic cormorant abundance ➢ Sooty shearwater abundance ➢ Cassin's auklet breeding success

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

Draft Key Attribute	Key Attribute rationale	Draft Indicators/Focal Species	Indicator description & rationale
Trophic Structure: Predatory fishes	• Increased abundance of these higher level predators indicates the presence and functioning of multiple lower trophic levels	Widow rockfish (*Sebastes entomelas*) density & size structure	• Feed on small fishes, crustaceans and gelatinous zooplankton • Semi-pelagic/pelagic fish often found in schools in midwater • Federally designated as overfished
		Shortbelly rockfish (*Sebastes jordani*) density & size structure	• Semi-pelagic/pelagic fish often found in dense aggregations in midwater • Planktivorous, primarily on euphausiids • Young-of-the-year are prey for birds, piscivorous fish and marine mammals • Currently not commercially targeted
		Yellowtail (*Seriola lalandi*) density & size structure	• Opportunistic foragers, feeding on fish, squid and crustaceans • Population size may vary in response to oceanographic conditions, increasing when warmer water is present • Taken in commercial and recreational fisheries

		Pacific barracuda (*Sphyraena argentea*) density & size structure	• Found schooling in the nearshore epipelagic • Feed on fishes such as anchovy, sardine and Pacific mackerel • Taken primarily in the recreational fishery
		Pacific mackerel (*Scomber japonicas*) density & size structure	• Exhibit seasonal migration with increased numbers inshore from July to November • Feed on small fishes, euphausiids and squid • Important commercial and recreational species
Trophic Structure: Predatory birds	• Important predators in pelagic ecosystems • Forage in areas ranging from shallow estuarine and nearshore waters to deeper pelagic habitats • Populations fluctuate with oceanographic and climatic changes • May benefit from reduced disturbance of nesting sites	Brandt's cormorant (*Phalacrocorax penicillatus*) abundance (colony size) and fledgling rate	• Feed primarily on small fishes • Typically nest on broad cliff ledges or the tops of headlands
		Pelagic cormorant (*Phalacrocorax pelagicus*) abundance (colony size) and fledgling rate	• Forage in bays, estuaries and close to shore along the coast • Feed primarily on small fishes and crustaceans • Breed on small, offshore islands and rocky cliffs with deep water at the base
		Sooty shearwater (*Puffinus griseus*) abundance (colony size) and fledgling rate	• Migratory species for which California is an important foraging area • Feed on fishes, squid and euphausiids
		Cassin's auklet (*Ptychoramphus aleuticus*) abundance (colony size) and fledgling rate	• Nest in small burrows on islands • Feed primarily on euphausiids and small fishes • Often forage at oceanographic fronts where prey are concentrated
Trophic Structure: Forage base	• Species provide food and nutrients to higher trophic levels	Forage fish biomass (sardines, anchovies, other schooling bait fish)	• Important prey for fishes, mammals and birds • Population sizes may fluctuate with oceanic conditions
		Market squid (*Loligo opalescens*) biomass	• Important prey for fishes, mammals and birds • Important commercial fishery

DRAFT OPTIONAL ADD-ONS TO ECOSYSTEM ASSESSMENT

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

Draft Key Attribute	Draft Indicators/Focal Species
Productivity: Ichthyoplankton	Total ichthyoplankton abundance
	Total abundance of rockfish (*Sebastes* spp.) larvae
	Ratio of fished species to unfished species
Trophic structure	Total jellyfish abundance
Trophic structure: predators	Size and persistence of bird feeding aggregations

DRAFT CONTEXTUAL INFORMATION

This information will be used to facilitate interpretation of monitoring results:

Sea surface temperature, fronts, upwelling, salinity, currents

ECOSYSTEM FEATURE: CONSUMPTIVE USES

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

Draft Vital Signs
➢ Landings (weight & value) of key species (nearshore finfish, spiny lobster, red urchin & market squid) per fishing block & port for the commercial fishery ➢ Landings (number & length frequency) of key species (rockfish, kelp bass, barred sand bass, white seabass & Pacific barracuda) per fishing block & port by CPFVs ➢ Catch per unit effort (CPUE) of key species (as above) per fishing block & port by CPFVs ➢ Number of lobster captured per fishing trip and location by recreational fishers

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

DRAFT CONSUMPTIVE USES TO BE MONITORED

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

Draft Consumptive Uses to be Monitored	**Uses to be Monitored rationale**
Commercial Fishing: Nearshore rockfish (*Sebastes* spp.) Spiny lobster (*Panulirus interruptus*) California halibut (*Paralichthys californicus*) Red sea urchin (*Strongylocentrotus franciscanus*) Market squid (*Loligo opalescens*) Crab (*Cancer* spp., *Loxorhynchus grandis*)	• Commercial fishing generates significant direct and indirect revenue from secondary services and facilities – playing an important role in coastal communities • Selected species are important components of commercial fisheries in the South Coast and play important ecological roles • Trends in commercial fishing in response to MPA designation will be closely linked to broader economic, regulatory and ecological changes in the region
Recreational Fishing – Commercial passenger fishing vessels (CPFVs) including dive charters: Nearshore rockfish (*Sebastes* spp.) Kelp bass (*Paralabrax clathratus*) Barred sand bass (*Paralabrax nebulifer*) Spiny lobster (*Panulirus interruptus*) California scorpionfish (*Scorpaena guttata*)	• CPFVs – also called party boats – are popular within the region • Fishing is primarily conducted using hook-and-line gear • Selected species are commonly taken by CPFVs
Recreational Fishing - Private Vessels (including kayak angling)	• Fishing from private vessels, including kayaks, is a popular recreational activity

Nearshore rockfish (*Sebastes* spp.) Kelp bass (*Paralabrax clathratus*) Barred sand bass (*Paralabrax nebulifer*) Spiny lobster (*Panulirus interruptus*) California halibut (*Paralichthys californicus*)	in the South Coast region • Selected species are those that are commonly taken and may play important ecological roles in the system.
Recreational Fishing – Shore-based Surfperches (Embiotocidae, multiple species) Croakers (Scianidae, multiple species) Silversides (Antherinopsidae, multiple species)	• Shore-based fishing is a popular form of recreational fishing in the South Coast region • Includes all land-based fishing access including beaches, rocky shores and man-made structures

DRAFT 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, Knowledge, Attitudes and Perception (KAP) surveys may be most usefully conducted once every five or more years. Indicators for each consumptive use are:

Draft Indicators	Indicator rationale
1. Number of people or vessels engaged in the activity	• Data is cost efficient to obtain although it is likely to be more informative over longer time scales • Highly dependent on other factors: e.g. market forces, additional fisheries regulations, permit restrictions, etc.
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	• Tracking the number of fishing trips at a variety of spatial scales provides spatially explicit data that can be used to document shifts in fishing activity • Landings of key species include weight of landings per trip and vessel, and fish size; information that can provide informative links to ecological changes in fish stocks • CPUE is an integrative measure of level and quality of activity that can be linked to ecological changes
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 expenditure (recreational fisheries)	• Economic or quality values can be used to assess relative costs and benefits of MPA implementation to the consumptive use participants. • These values are used in analyses that can estimate the effects of the MPAs versus other environmental changes occurring at the same time, such as changes in market demand or fuel costs.
4. Knowledge, Attitudes and Perceptions (KAP) of participants a. Motivation b. Satisfaction	• Surveys contribute additional information to explain patterns in activity level and increase our understanding of the role of the MPAs in observed changes. • KAP surveys can include a broader sector of the public, e.g. those living inland

DRAFT OPTIONAL CONSUMPTIVE USES TO BE MONITORED

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

Draft Consumptive Uses to be Monitored
Recreational Fishing - spearfishing White seabass (*Atractoscion nobilis*) Yellowtail (*Seriola lalandi*) Sheephead (*Semicossyphus pulcher*) Kelp bass (*Paralabrax clathratus*)
Recreational Fishing – Clamming Pacific gaper clam (*Tresus nuttalli*) Pismo clam (*Tivela stultorum*) Chione clam (*Chiones* spp.)
Scientific collecting (indicators to be developed)

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results:

Economic metrics (e.g. fuel prices, market demand, market prices, regional economic indicators), environmental condition metrics (e.g. weather conditions measured via the number of available fishing days), regulatory changes (e.g. changes in fishing season length)

ECOSYSTEM FEATURE: NON-CONSUMPTIVE USES

DRAFT METRICS FOR ECOSYSTEM FEATURE CHECKUP

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

DRAFT METRICS FOR ECOSYSTEM FEATURE ASSESSMENT

DRAFT NON-CONSUMPTIVE USES TO BE MONITORED

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

Draft Non-consumptive Uses to be Monitored	Rationales
Scuba diving	• Recreational non-consumptive diving is popular in the region • Increased quality of recreational diving opportunities may be linked to ecological changes in response to MPA designation • Diving produces direct and indirect revenue from businesses, services and facilities in the region
Recreational beach use	• Beaches in the South Coast region are heavily used for a variety of recreational activities • These activities provide opportunity to explore relationships between human visitation and ecological impacts, such as habitat modification
Tidepooling	• Tidepool visitation appeals to a broad demographic • This activity provides opportunity to explore relationships between human visitation and ecological impacts, such as trampling
Wildlife viewing - kayaking	• The region contains many popular kayaking locations in the nearshore environment • This activity provides opportunity to explore relationships between human visitation and ecological impacts, such as potential wildlife disturbance

DRAFT 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, Knowledge, Attitudes and Perceptions (KAP) surveys are typically conducted once every five or more years. Indicators for Non-consumptive Uses are:

Draft Indicators	Indicator rationale
1. Level of activity – number & location of trips (spatial use & intensity)	• Includes number of trips per individual and total number of individuals • Geographic comparisons of trips to MPA and non-MPA locations must also take into account other factors e.g. areas historically popular for recreational activities, ease of access, and seasonality effects
2. Knowledge, Attitudes and Perceptions (KAP) of participants a. Motivation – including MPAs b. Satisfaction – e.g., travel distance, travel & activity costs, likelihood of return	• Surveys contribute additional information to explain patterns in activity level and increase our understanding of the role of the MPAs in observed changes. • Full KAP surveys can include a broader sector of the public including those living inland

DRAFT 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.

Draft Non-consumptive Uses to be Monitored
Wildlife viewing – boating Wildlife viewing – shore-based Educational use

DRAFT CONTEXTUAL INFORMATION

This information will facilitate interpretation of MPA monitoring results:

Economic metrics (e.g. fuel prices, trip costs(such as the price of wildlife viewing boat trips), regional economic indicators), environmental condition metrics (e.g. weather condition measured as the number of dry days or amount of rainfall)

C. EVALUATING MPA DESIGN & MANAGEMENT DECISIONS

As noted above, the MPA monitoring framework includes two core monitoring elements: 1) assessing ecosystem condition and trends; and 2) evaluating design and management decisions (see framework diagram, page 1). This section covers the second core monitoring element (seen on the right-hand side of the framework diagram): Evaluating MPA Design & Management Decisions.

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. Monitoring to meet MLPA requirements includes evaluation of select MPA design and management decisions to inform future management decisions and thereby facilitate adaptive management.

To guide the implementation of this monitoring element, evaluations of MPA design and management decisions are categorized into two groups: short-term evaluations, which are expected to generate conclusive information in four years or less (i.e., within one of the five-year MPA review periods recommended in the MLPA Master Plan); and long-term evaluations, which are expected to take more than four years to answer.

The draft evaluation questions in this document have arisen both through the South Coast MPA planning process (as reported in various MLPA Initiative documents) and through the South Coast monitoring planning process to date. During the MPA planning process for the South Coast, stakeholders developed MPA network proposals, implementing guidelines relating to the siting, size, and boundary placement of proposed MPAs, as well as the human activities allowed in each MPA. As recorded in MLPA Initiative documents, many potential evaluation questions arose through this process.

The following pages present an initial list of draft evaluation questions that may be included in the draft South Coast MPA Monitoring Plan. The Monitoring Enterprise is inviting comment on these evaluation questions.

DRAFT 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 one of the five-year MPA review cycles. Five-year reviews of MPAs are recommended by the MLPA Master Plan to fulfill the MLPA requirement for adaptive MPA management. These questions tend to focus on specific design or management decisions, and the responses of select ecological or socioeconomic components of Ecosystem Features to those decisions.

Following is a draft list of short-term evaluation questions. These are being proposed for inclusion in the South Coast MPA Monitoring Plan as an initial inventory of questions from which specific questions to be addressed may be selected at the time of monitoring implementation. Note: these are <u>not</u> listed in order of priority.

1. Are there impacts (e.g., increased disturbance) of visitation on marine mammal haul-outs, and nesting seabirds and shorebirds in estuaries and on beaches in MPAs and special closures?
2. Are there impacts (e.g., trampling, displacement of flora and fauna) of visitation on rocky intertidal ecosystems in MPAs?
3. What are the economic effects (e.g., fuel costs, time spent at sea) of MPA placement, specifically distance from ports and location relative to fishing grounds, and what are the implications for siting MPAs to minimize adverse economic impacts and to prevent serial depletion?

4. How frequent are MPA boundary-crossings by targeted species and does the frequency of boundary crossings differ between MPAs that encompass a reef and those that split a reef? What changes have occurred in the fisheries (e.g., fishing effort, catch) conducted on the portions of reefs left open to fishing?
5. Does locating an MPA close to a boat ramp or other access point affect the level of enforcement and/or compliance with MPA regulations?
6. How do allowed uses of SMCAs influence the distribution and intensity of fishing effort? Do SMCAs that allow take of multiple species or use of multiple gear types have disproportionately high fishing intensity?
7. What impact does anchoring have on purple corals and other biogenic habitats?
8. During the MPA planning process, the South Coast Science Advisory Team (SCSAT) recommended that MPAs proposed to protect communities associated with giant kelp (*Macrocystis pyrifera*) be located in areas of persistent kelp. However, a stretch of the mainland coast, between Palos Verdes and San Elijo, does not contain persistent kelp beds. In this area, the SCSAT recommended that MPAs be designed to encompass potential kelp habitat as represented by the maximum kelp measure, and made recommendations about the amount of this habitat that needs to be included in proposed MPAs designed to protect kelp forest habitat.[1] Are the kelp forest communities contained within 2.04 linear miles of maximum kelp equivalent, in terms of assemblage composition, to those found within 1.14 linear miles of persistent kelp?
9. During the MPA design process, the SCSAT developed science guidelines for individual and MPA network design, including recommending that all key habitats be included in replicate MPAs.[2] Are the identified key habitats represented and replicated in the implemented array of MPAs? Is kelp habitat accurately represented by the "maximum kelp" designation?
10. During the MPA planning process, there was discussion about experimentally removing urchins from some rocky reefs. Does urchin removal impact the amount of kelp (e.g., aerial extent, stipe density)?
11. Do sediment plumes from beach nourishment or dredging activities negatively impact the growth of seagrasses and/or kelp in nearby MPAs?
12. What are the impacts (e.g., reduced foraging rates, increased disturbance, improved nesting habitat) of beach grooming on shorebirds in MPAs?
13. Are there differences in the number of shorebirds nesting and foraging on beaches in MPAs that are nourished and those that are not?

DRAFT 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 five-year MPA review cycles recommended in the MLPA Master Plan. These questions tend to focus 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 nature of the South Coast environment. Because of their complex nature, many of these questions may be best addressed through research partnerships.

To identify approaches that can inform future 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: 1) the guidance on MPA Network Design as developed by the MLPA Science Advisory Team and outlined in the MLPA Master Plan;[3] 2) the science guidance developed during the South Coast MPA planning process as recorded in

[1] California MLPA Initiative, Science Question Received at the August 3, 2009 Meeting of the MLPA South Coast Regional Stakeholder Group, Revised September 3, 2009.
[2] *Draft Methods Used to Evaluate MPA Proposals in the MLPA South Coast Study Region*, MLPA Initiative, May 4 2009, p.64-68
[3] *California Marine Life Protection Act Master Plan for Marine Protected Areas*, Revised Draft, Jan. 2008, p. 34-41.

various MLPA Initiative documents; and 3) consultations with stakeholders to date during the development of the draft South Coast MPA Monitoring Plan. These questions highlight topics within each category and are not in order of priority.

SIZE & SHAPE

Based on scientific information on movement patterns of various species, the MLPA Master Plan for MPAs 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".[4] In applying this guidance to the South Coast region, the SCSAT recommended that each individual MPA cover an alongshore span of at least 3-6 miles, with a total minimum size of 9 square miles.[5]

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 SCSAT adopted this recommendation.

Draft evaluation questions, not listed in order of priority:

1. Are there differences in ecosystem responses (e.g., types and rates of changes observed) among MPAs of different sizes? In particular, are there thresholds or discontinuities in the way in which ecosystems respond that are a function of MPA size, and what are the implications for network design?
2. What is the relationship between the alongshore span of an MPA and the protection afforded to organisms with different home range sizes, movement patterns and pelagic larval durations?
3. How are the MPAs used by species that inhabit shallow nearshore habitats when young and move to deeper habitats as adults, and what are the implications for the offshore extent of MPAs?
4. If fishing occurs along the boundaries of MPAs, what are the effects on species and communities inside MPAs of different sizes?
5. 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?

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. While the MPA spacing guidelines primarily focus on larval dispersal distances, the distances between MPAs can also interact with the movements of adult organisms, for example during along-shore migrations. The MLPASAT recommended spacing MPAs approximately 31-62 miles apart to be within the larval dispersal ranges of important bottom-dwelling fish and invertebrate groups. The SCSAT adopted this guideline for MPAs on the mainland of the South Coast Region, and recommended that guidelines other than spacing (e.g. bioregions, habitat representation, habitat replication, and MPA size) be applied to the design of MPAs at the Channel Islands.[6]

Draft evaluation questions, not listed in order of priority:

[4] Ibid. p. 37.
[5] 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. (*Draft Methods Used to Evaluate MPA Proposals in the MLPA South Coast Study Region*, MLPA Initiative, May 4 2009.)
[6] Ibid, p. 77.

1. Does inter-MPA distance affect patterns of larval supply and recruitment in MPAs?
2. What are the effects of different inter-MPA distances on connectivity between MPAs, either through larval exchange or movement of adults?

HABITAT REPRESENTATION

In addition to direction concerning MPA size and spacing, the science guidelines 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. The SCSAT adopted these recommendations with the addition of two habitats unique to the South Coast Region.[7] In addition, the SCSAT identified five bioregions in the South Coast (North Mainland, South Mainland, West Channel Islands, Mid-Channel Islands, and East Channel Islands), and recommended that each habitat type be protected in at least one MPA in each of the bioregions 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 species-habitat relationships to assess the extent to which the identified habitat types are associated with different species, life stages, or biological communities.

Draft evaluation questions, not listed in order of priority:

1. 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?
2. Do MPAs enclosing multiple habitat types harbor higher species abundances or more diverse communities than those that encompass only a single habitat type through the effects of increased habitat structural complexity?
3. Are there differences in ecosystem responses (e.g., types and rates of changes observed) between MPAs in which habitats are contiguous and those with similar but patchily distributed habitats?
4. Is “spillover” of fishery species affected by habitat continuity across MPA boundaries, and what are the implications for designing MPAs to achieve ecosystem protection and potential benefits to fisheries?

PLACEMENT & SITING

In designing proposed MPA networks for the South Coast Region, stakeholders considered where MPAs were located relative to access points, terrestrial parks, boat launch facilities, marine research laboratories and educational institutions. Stakeholders also considered how siting MPAs could enhance or reduce network connectivity.

Draft evaluation questions, not listed in order of priority:

1. What are the population effects of siting MPAs in larval source or sink locations, and what are the implications for MPA network design? In particular, to what extent are mainland MPAs a source of larvae and recruits to Channel Island MPAs?
2. What are the effects on visitation and associated recreational opportunities of siting MPAs adjacent to public versus private land?

[7] Two habitats unique the SCR as identified by the SCSAT are oil seeps and shallow hydrothermal vents (Ibid, p. 57).

LEVELS OF PROTECTION

The proposed South Coast regional MPA networks include 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 extractive activities, depending on the site. To guide the MPA planning process, the SCSAT defined 'Levels of Protection', reflecting scientific judgments of the relative effects of allowing specific harvest activities within MPAs.[8] Each proposed 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 activities that alter habitat, such as mechanical giant kelp harvest and mussel and scallop extraction, were categorized as "Low" protection. As the same level of protection may be applied to MPAs that allow different fishing activities at different sites, SMRs are 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, not listed in order of priority:

1. What are the ecosystem responses (e.g., types and rates of changes observed) within SMRs and how do these differ from such responses within SMCAs?
2. Do SMR/SMCA clusters provide greater protection than stand-alone SMRs, for example through a "buffer" effect?
3. 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)?
4. Are there differences in ecosystem responses (e.g., types and rates of changes) between MPAs that do and do not allow take of pelagic species?
5. What is the impact of urchin and giant kelp harvest on lobster-urchin-sheephead-kelp dynamics?
6. Are there differences in ecosystem responses (e.g., types and rates of changes) between MPAs that do and do not contain habitat restoration activities?

[8] *Draft Methods Used to Evaluate MPA Proposals in the MLPA South Coast Study Region*, MLPA Initiative, May 4 2009, p. 15-32