California Marine Life Protection Act Initiative
Draft Methods Used to Evaluate Marine Protected Area Proposals in the MLPA South Coast Study Region
Chapters 4 and 5 – Habitat Representation and Replication
Revised September 25, 2009

4. Habitat Representation Analyses (Goals 1 and 4)

Status of this chapter: The SAT has approved of the habitats and evaluation methods in this chapter.

Identification of Key and Unique Habitats for the MLPA South Coast Study Region

The Marine Life Protection Act (MLPA) provides guidance that marine protected areas (MPAs) should encompass a variety of marine habitat types and communities, across a range of depths and environmental conditions. This chapter identifies the key and unique habitats in the South Coast Study Region, as required by the MLPA. The methods for evaluating MPA proposals with respect to representation of key and unique habitats are described in detail later in the chapter.

Habitats Identified in the MLPA and the *Master Plan*

Subsequent to provisions in the MLPA, the *Master Plan* further refines the list of "key" habitats (listed below). The SAT recognizes estuaries as a critical California coastal habitat; consequently, estuaries were added to the list of key habitats in the *Master Plan*. The *Master Plan* further subdivides habitats identified in the MLPA by substrate type or depth, identifying the following key habitats: sand beach, rocky intertidal, estuary, shallow sand, deep sand, shallow rock, deep rock, kelp, shallow canyon, and deep canyon. Because changes in species composition occur across depth zones, even over the same substratum, the SAT has subsequently refined the habitat definitions to include five depth zones (intertidal, intertidal to 30 meters (m), 30 m to 100 m, 100 m to 200 m, and deeper than 200 m). Key habitat types provide benefits by harboring a particular set of species or life stages, having special physical characteristics, or being used in ways that differ from other habitats. The SAT also recommends the representation in MPAs of oceanographic features that represent specific pelagic habitats, such as upwelling centers, estuary waters, river plumes, fronts, and retention zones.

Key habitats in the South Coast Region

The set of habitats described in the MLPA and *Master Plan* can be expanded or reduced by the SAT to reflect representative habitats for each study region. In addition to the habitat types delineated in the MLPA, the SAT notes that key habitat types such as rocky reefs, intertidal zones, and kelp forests are actually broad categories that include several types of habitat and that special consideration in design planning should be given to habitats that are uniquely productive (e.g. upwelling centers or kelp forests) or aggregative (e.g. fronts) or those that sustain distinct use patterns. All of the key habitats except sea mounts occur in the South

Coast Study Region within state waters, although some, such as pinnacles, are not well mapped.

Considering guidance from the MLPA and *Master Plan*, the SAT has identified the following "key" marine habitats in the South Coast Study Region (m = meters):

- rocky shore
- sandy beach
- surfgrass
- coastal marsh
- tidal flats
- estuarine waters
- eelgrass
- kelp
- rocky reef 0-30m
- rocky reef 30-100m
- rocky reef 100-200m
- rocky reef >200m
- soft bottom 0-30m
- soft bottom 30-100m
- soft bottom 100-200m
- soft bottom >200m
- submarine canyons
- pinnacles
- upwelling centers
- retention zones
- river plumes
- fronts

Although underwater pinnacle and estuary habitats are considered to be key habitats, the SAT notes that Farnsworth Bank and San Diego Bay have unique characteristics that should be considered for protection by the SCRSG. Farnsworth Bank is a unique underwater pinnacle in 15 to 91 m (50 to 300 ft) of water off the seaward coast of Santa Catalina Island that supports rare dense growths of the purple hydrocoral (*Stylaster californica,* previously known as *Allopora californica*). Farnsworth Bank is currently a State Marine Conservation Area explicitly to prohibit take of purple coral. San Diego Bay is a large and ecologically important unique bay/estuary complex in the South Coast Study Region. Most of these key habitats are mapped in the *Draft Regional Profile of the South Coast Study Region*[1]

Kelp Forests and Seagrass Beds in the South Coast

Kelp forests and seagrass beds are biogenic key habitats in the study region which require additional comment. Kelp forest communities are known to be among the most productive and biologically rich habitats in the region. The dominant kelp species and their associated communities differ across bioregions, with substratum type, and with depth. For example, the elk kelp (*Pelagophycus porra*) grows over a narrow depth range (30 to 90 m) on coarse sediment-laden habitats (e.g. the leeward side of Santa Catalina Island) as well as rocky substrata (e.g Point Loma) and has a limited geographical distribution (Abbot and Hollenberg 1976). Giant kelp (*Macrocystis pyrifera*), the major species of most southern California kelp forests, is more widely distributed in the state and the study region where it grows over a broader depth range (6 to 80 m) and occurs on substrata ranging from hard to soft rock to coarse sand (Abbott & Hollenberg 1976). Seagrasses are flowering plants that form important habitat in shallow waters for a variety of marine organisms. The most common type of

[1] The South Coast Regional Profile can be found at (http://www.dfg.ca.gov/mlpa/index.asp)

seagrass along the open coast is surfgrass (*Phyllospadix* spp.), which forms beds that fringe rocky coastline areas at the zero tide level down to several meters below the zero-tide level. Surfgrass serves as an important habitat for a variety of life stages of fish and invertebrates, including the California spiny lobster (Engle 1979) as well as algae (Stewart & Myers 1980). The most common type of seagrass in estuaries and sheltered coastal bays is eelgrass (*Zostera marina*), which also occurs along the open coast in the Channel Islands (Coyer et al 2008). A second species of eelgrass (*Zostera pacifica*) occurs along the open coast in southern California, on both the channel islands and the mainland[5]. The long leaves and dense, matted root systems of eelgrass beds help prevent erosion and maintain stability in nearshore areas by slowing down water flow; this consequently enhances sediment accumulation and faunal recruitment. Eelgrass beds also provide refuge, foraging, breeding, or nursery areas for invertebrates, fish, and birds (Hoffman 1986).

Pelagic Habitats in the South Coast Study Region

There are several key pelagic habitats, defined by water properties and water motion, that require additional comment:

(i) Estuary waters: Sheltered waters within semi-enclosed bays (e.g. San Diego Bay), seasonally closed lagoons (e.g. San Dieguito Lagoon), and harbors (e.g. Dana Point Harbor) are typically shallow and warm with low salinities after winter rains and relatively high turbidity and suspended particulate material year-round.

(ii) Upwelling centers: In areas where cold sub-thermocline water breaks the surface, it supplies nutrients to near-surface primary production. This upward flux of cold water includes upwelling, internal waves and vertical mixing across the thermocline. A plume of cold water flows away from the center, with increasing temperature and phytoplankton content. Recurrent upwelling sites ~~are demarcated on the map, including~~ include the major upwelling center at Point Conception and smaller, less persistent sites at Point Dume, Palos Verdes, and Point Loma.

(iii) Retention zones: Warm and stratified waters are found in areas where there is an absence of upwelling and where there is some topographic shelter. Depending on nutrient supply and “age” of the water, the warm surface layer may be rich in phytoplankton (e.g. Santa Barbara Channel) or the phytoplankton maximum may be found sub-surface, on the thermocline (e.g. La Jolla Bay).

(iv) River plumes. During periods of river flow, plumes represent waters with low salinity, low stratification, and a high load of terrigeneous material (both biogenic and contaminants). While plumes occur infrequently in southern California, primary locations are listed in the water quality chapter, e.g. Santa Clara River plume off Ventura.

(v) Fronts. At the boundary between waters of different density (warm vs cool, salty vs less salty), there is a surface convergence that collects plankton, forming the foundation of rich feeding areas for fish, birds and mammals. Plume fronts are transient, while upwelling fronts are more persistent, as in the western Santa Barbara Channel.

Pelagic habitats, created by water movement, are necessarily fluid and difficult to demarcate with fixed boundaries. Furthermore, processes like upwelling and terrestrial runoff occur as events in response to winds or rainfall, so features are impermanent, although they may be recurrent. Thus, while it is important to recognize these habitats, they are difficult to map and evaluate for habitat representation and replication. For the purpose of evaluation, only estuary waters, ~~upwelling centers and retention zones~~ are mapped, ~~since they are strongly associated with topography, such as bays or headlands~~. ~~However, the extent of these features can only be estimated and their variability cannot be shown on the maps.~~ These Pelagic habitats overlay benthic habitats and should be a secondary consideration in MPA siting.

Unique Habitats in the South Coast Study Region

Goal 4 of the MLPA aims to protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value. In addition to the key habitats and habitat features discussed previously, two unique or rare habitat types occur in the South Coast Study Region and should be considered for inclusion in MPAs. These are *oil seeps* and *shallow hydrothermal vents.* The SAT will evaluate representation, but not replication of these two unique habitats, so consideration should be given for their inclusion in MPAs. Benthic communities and environmental conditions around oil seeps and shallow hydrothermal vents differ from those in surrounding areas. Natural oil seeps are not rare in the SCSR, though they occur nowhere else in state waters. The largest concentration of oil seeps occurs in the Santa Barbara Channel area (Wilkinson 1971). Shallow hydrogen sulfide vents appear to be restricted to White Point on the Palos Verdes Peninsula. These vents occur from the intertidal to shallow subtidal depths (0-10m) and support H_2S-oxidizing bacterial mats and have different localized water chemistry and temperature (Daley et al 1993). Recent research has found that the hydrothermal vent macroinvertebrate community at White Point is a subset of the surrounding fauna and is limited to species able to withstand stressful environments (Malwani & Kim 2008). The microbial biomass produced through sulfur oxidation around the vents is morphologically similar to deep hydrothermal vents and is an energy source based on chemosynthesis rather than photosynthesis (Dailey & Anderson 1991). Currently, little to no research has been conducted on the effects of extractive or non-extractive human activities on shallow hydrothermal vents or oil seep communities.

Summary of Guidelines and Evaluation Methods: Habitat Representation

The *Master Plan* guidelines with respect to habitat protection are as follows:

1. “For an objective of protecting the diversity of species that live in different habitats and those that move among different habitats over their lifetime, every ‘key’ marine habitat should be represented in the MPA network.”
2. “’Key’ marine habitats (defined above) should be replicated in multiple marine protected areas (MPAs) across large environmental and geographic gradients to protect the greater diversity of species and communities that occur across such gradients, and to protect species from local year-to-year fluctuations in larval production and recruitment.”

Guidance in the MLPA closely mirrors these guidelines in the *Master Plan* with one key difference: the MLPA specifically indicates that marine reserves (SMRs) are an important component of habitat protection.

To assess how the key and unique habitats defined here are represented across a range of environmental conditions, the SAT has identified five distinct bioregions within the MLPA South Coast Study Region (see Chapter 2). Because the key habitats within these bioregions support different marine life communities, the SAT recommends that MPA proposals represent key habitats across all five bioregions.

In evaluating habitat representation the SAT considers:

- the quality of habitat maps,
- the availability of habitats across the entire study region,
- the availability of habitats within the five bioregions defined by the SAT,
- the percentage of available habitat protected in MPAs across all six levels of protection, and
- the distribution of habitat protection across the five bioregions in the MLPA South Coast Study Region.

Several of the key and unique habitats named above have limited distribution in the study region or are poorly mapped (see below for more detailed discussion of habitat map quality). In consideration of data limitations, the SAT conducts a full evaluation of habitat representation (including area and percent of habitat protected) only for habitats that are adequately mapped. For habitats that are not comprehensively mapped, the SAT conducts one of the following simplified evaluations of habitat representation: 1) presence/absence of the habitat in an MPA proposal, or 2) the percent of known habitat point-locations protected.

The SAT is currently discussing projects that affect habitat quality such as habitat restoration and artificial reefs and considering if or how these should be included in habitat representation analyses.

Consideration of Habitat Map Quality

The quality of habitat mapping influences the way in which habitat representation can be assessed. For habitats that are comprehensively mapped, it is possible to accurately assess both the amount of habitat encompassed by a proposed MPA and the percent of available habitat protected. Unfortunately, many of the habitat maps are subject to one or more of the following limitations: 1) mapping is not of consistent quality across the entire study region, 2) mapped data does not allow assessment of the extent of habitat protected (aerial or linear extent), or 3) mapping does not accurately reflect presence or absence of habitats.

Table 4-1 Habitat mapping quality. This table summarizes the limitations of habitat maps and recommendations for use of habitat data in habitat evaluations.

Habitat	Source	Reviewed By	Review Summary	Recommended Use
Key Habitats				
rocky shore	NOAA Environmental Sensitivity Index (ESI) shoreline - 1993	Staff, P. Raimondi	provides a reasonable assessment of rocky shore presence but not accurate on a small scale	appropriate for assessing length and percent protected
sandy beach	NOAA ESI shoreline - 1993	Staff, P. Raimondi	provides a reasonable assessment of sandy beach presence but not accurate on a small scale	appropriate for assessing length and percent protected
surfgrass	Minerals Management Service (MMS) 1980-1982	Staff, D. Pondella, S. Murray	1) data is old but still fairly accurate 2) multiple categories of abundance were collapsed into simple presence/ absence	appropriate for assessing length and percent protected
coastal marsh	NOAA Coastal Change Assessment Program (CCAP)	Staff, R. Ambrose	1) may under-estimate the extent of marsh in some areas 2) no major gaps in coverage	appropriate for assessing area and percent protected
tidal flats	NOAA ESI shoreline - 1993	Staff	old ESI shoreline layer does not reflect current shoreline well in dynamic estuarine environments	will not provide an accurate assessment of tidal flat protection
estuaries	US Fish and Wildlife Service National Wetland Survey, NOAA ESI (2004)	Staff, R. Ambrose	Multiple data sources were used in combination with local knowledge and aerial photography to expand or contract estuarine boundaries to encompass all tidally influenced inland waterways	appropriate for assessing area and percent protected
eelgrass - estuarine	Merkel and Associates 2009	Staff, R. Ambrose	1) recent mapping accurately captures the aerial extent of eelgrass in most estuaries in the southern California bight	appropriate for assessing area and percent protected

Habitat	Source	Reviewed By	Review Summary	Recommended Use
eelgrass – open coast	Engle and Miller 2005, Jessie Altstatt, Santa Barbara Channel Keepers	Staff, R. Ambrose	1) open coast eelgrass has not been comprehensively mapped across the study region 2) a combination of data sources were used to generate a simple point file of known open coast eelgrass locations	appropriate for assessing the number of known locations protected only
kelp – giant kelp	DFG aerial surveys (from 1989, 1999, and 2002-06)	Staff	Aerial surveys used to generate two separate estimates of kelp bed length: 1) "maximum kelp" = locations with kelp present at least 1 of 7 years 2) "persistent kelp" = locations with kelp present at least 3 of 7 years	appropriate for assessing length and percent protected the two alternate measures differ in the likelihood of kelp presence from year to year
kelp – elk kelp	K. Miller, J. Engle, P. Dayton, E. Parnell, DFG ROV data	Staff, S. Murray, P. Dayton	available maps are not a comprehensive survey of the entire bight but do encompass all known locations of elk kelp beds	appropriate for assessing the number of known locations protected only
rocky reef 0-30m	CSUMB Seafloor mapping, DFG aerial kelp surveys, Bight '08 report	Staff	1) Multibeam sonar mapping does not typically extend in shallower than 20 m 2) a variety of information sources were used to inform a linear proxy line for nearshore (0-30m substrates)	appropriate for assessing length and percent protected
rocky reef 30-100m	CSUMB Seafloor mapping	Staff	high resolution data, but contains some notable gaps	appropriate for assessing area and percent protected
rocky reef 100-200m	CSUMB Seafloor mapping	Staff	high resolution data, but contains some notable gaps	appropriate for assessing area and percent protected
rocky reef >200m	CSUMB Seafloor mapping	Staff	high resolution data, but contains some notable gaps	appropriate for assessing area and percent protected

Habitat	Source	Reviewed By	Review Summary	Recommended Use
soft bottom 0-30m	CSUMB Seafloor mapping	Staff	1) Multibeam sonar mapping does not typically extend in shallower than 20 m 2) a variety of information sources were used to inform a linear proxy line for nearshore (0-30m substrates)	appropriate for assessing length and percent protected
soft bottom 30-100m	CSUMB Seafloor mapping	Staff	high resolution data, but contains some notable gaps	appropriate for assessing area and percent protected
soft bottom 100-200m	CSUMB Seafloor mapping	Staff	high resolution data, but contains some notable gaps	appropriate for assessing area and percent protected
soft bottom >200m	CSUMB Seafloor mapping	Staff	high resolution data, but contains some notable gaps	appropriate for assessing area and percent protected
submarine canyons	G. Green	Staff	Areas designated as canyons closely mirror bathymetry from other sources but layer is inconsistent in extent	appropriate for assessing the number of locations protected only
pinnacles	unmapped			
upwelling centers	unmapped			
retention areas	unmapped			
river plumes	unmapped			
oceanographic fronts	unmapped			
Unique Habitats				
oil seeps	USGS	Staff	mapping of point locations may be comprehensive but does not indicate relatives size	appropriate for assessing the number of known locations protected only
shallow hydrothermal vents	A. Melwani	Staff	only a single location known and mapped	appropriate for assessing the number of known locations protected only

Habitats with linear measurements include sandy or gravel beaches, rocky intertidal, coastal marsh, tidal flats, and surfgrass. Habitats with area measurements include estuaries, coastal marsh, eelgrass, kelp, and hard and soft bottom at depths of 0-30 m, 30-100 m, 100-200 m, and greater than 200 m. Due to a lack of nearshore substrate data, shallow hard- and soft-bottom habitats were also estimated as linear measurements by determining the type of habitat present along a 20 meter depth contour.

Kelp Evaluation Methods

Because kelp forest communities vary markedly by depth, the SAT determined that the most important consideration in protection of a kelp forest community is that the MPA extends across the depth range of the kelp forest. Simply stated, a narrow band of kelp along a steep shore is likely to encompass as much biological richness as a broader kelp bed along a gently sloping shore, provided that the two extend along a similar length of shoreline. To ensure that both steep and gently sloping kelp beds are considered equally in habitat representation and replication analyses, the SAT used the alongshore length of the offshore edge of the kelp bed as the measure of kelp habitat.[2] This approach assumes that the proposed MPA extends from the inshore to offshore margins of the bed as directed by the habitat replication guidelines.

The abundance and distribution of giant kelp in the South Coast Study Region fluctuates from year to year due to a variety of factors including oceanographic conditions, storm activity, fluctuations in associated species assemblages, and anthropogenic influences (further ecological information regarding giant kelp can be found in section 3.1.5 of the *Regional Profile of the MLPA South Coast Study Region*). These fluctuations present a unique challenge for evaluating protection of kelp and associated kelp forest species within MPA proposals. For this reason, the SAT has developed two complimentary methods for assessing the amount of kelp forest habitat present within an MPA.

Kelp measures were developed based on data from an extensive number of surveys conducted in the SCSR. Data delineating the distribution of giant kelp have been gathered by the DFG with aerial surveys using a Digital Multispectral Video (DMSV) sensor. These overflight data have been gathered statewide on an annual basis since 2002 during the fall and early winter when kelp abundance is highest. Additional statewide kelp abundance data were gathered by DFG during 1989 and 1999. For the MLPA SCSR process, seven total years of statewide data are available from DFG: 1989, 1999, 2002, 2003, 2004, 2005, and 2006. In some cases, the DFG kelp dataset incorporates data from organizations using a comparable methodology to create a statewide dataset. For instance, kelp data for San Diego and Orange

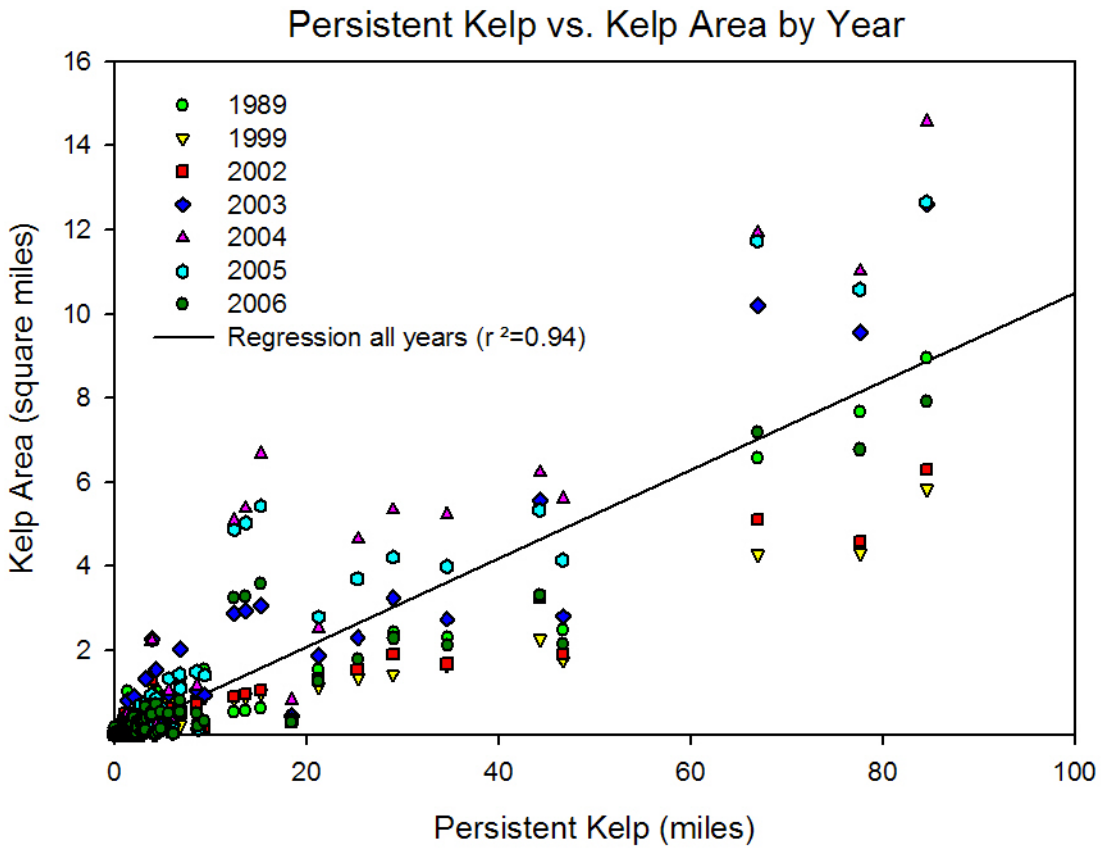
[2] Analysis of the relationship between the linear measure of kelp persistence and kelp area in each the seven years of kelp surveys shows a robust relationship between the linear and area measures (see Figure 4-1). This analysis also shows the variability of kelp area from year to year and indicates that the seven years of aerial kelp surveys span a range of conditions: 1999 and 2002, were characterized by warm water conditions and relatively low kelp cover, whereas 2003-05 were characterized by cooler waters and more expansive kelp cover, and 1989 and 2006 show intermediate kelp cover.

County gathered by MBC Applied Environmental Science for the Region Nine Kelp Survey Consortium are incorporated into the DFG dataset. It is also important to recognize that many available studies of kelp forests focus on a relatively small geographic area or do not comprehensively map the spatial extent of kelp growth. The kelp data gathered by DFG differ from other available data in that they fully cover the MLPA SCSR using a consistent methodology for delineating the aerial extent of giant kelp forests.

Because the abundance and distribution of kelp varies from year to year, measures of kelp used in SAT habitat analyses must provide a means to assess both the amount of *potential* kelp habitat within an MPA, as well as areas where there is a reasonable likelihood that kelp habitat will be present in any given year. The maximum extent of kelp (i.e. the total cumulative area over which kelp was present at least once in the seven sample years) within the seven years of available overflight data was used to assess the availability of nearshore rocky reef or potential kelp habitat but not considered by the SAT to provide a robust measurement of kelp habitat. This estimate was derived from a composite kelp coverage map (that overlaid all available data years). The linear extent of potential kelp habitats was drawn along the outer edge of all kelp beds and roughly parallel to shore. This linear measure of kelp shall hereafter be referred to as "maximum kelp." The maximum extent of kelp was further used to inform nearshore substrate proxy line (see April 23, 2009 memorandum *Use of Substrate Data in the MLPA Initiative Process* for further details, available online at: http://www.dfg.ca.gov/mlpa/pdfs/agenda_042809a8.pdf).

In order to differentiate areas that are *likely* to contain kelp habitat from those with sporadic kelp cover, the SAT analyzed the overlap between the seven available years of kelp canopy aerial surveys. Locations where kelp was recorded in 3 or more of the 7 survey years were identified as areas with a reasonable likelihood of kelp presence in any given year. The linear extent of these more persistent kelp beds was estimated using a line drawn around the outer edge of all areas where kelp occurred at least 3 of 7 years and roughly parallel to shore. This linear measure of likely kelp was termed "persistent kelp" or "kelp persistence."

Figure 4-1 Persistent Kelp versus Kelp Area By Year



Comparison of the linear measure of kelp persistence and the area of kelp canopy observed in each of the 7 years of aerial surveys indicates a robust relationship between the two measures of kelp. Aerial measures of kelp within a given year tend to be distributed either above or below the regression line, indicating that inter-annual variability in environmental conditions that occur Bight-wide are the source of much of the variation in kelp canopy cover in a given location.

~~Although aerial measurements of kelp were available from DFG surveys, a linear proxy of kelp extent was used for all habitat analyses. Because kelp forest communities vary markedly by depth, the SAT determined that the most important consideration in protection of a kelp forest community is that the MPA extends across depth range of the kelp forest. Simply stated, a narrow band of kelp along a steep shore is likely to encompass as much biological richness as a broader kelp bed along a gently sloping shore, provided that the two extend along a similar length of shoreline. To ensure that both steep and gently sloping kelp beds are considered equally in habitat representation and replication analyses, the SAT used kelp bed length as the measure of kelp habitat. Kelp bed length was measured with a line drawn along the outside of the kelp bed, roughly parallel to the shore and derived from the composite aerial extent of kelp in the years 1989, 1999, and 2003 through 2006.~~

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5. Habitat Replication Analyses (Goals 1, 2, 3, 4 and 6)

Status of this chapter: The SAT has approved of the evaluation methods in this chapter.

The MLPA's Guidelines Regarding Habitat Replication Analyses

The *Master Plan* guidelines with respect to habitat replication are as follows:

1. "Key" marine habitats (defined above in Chapter 4.0) should be replicated in multiple marine protected areas (MPAs) across large environmental and geographic gradients to protect the greater diversity of species and communities that occur across such gradients, and to protect species from local year-to-year fluctuations in larval production and recruitment.

2. For an objective of providing analytical power for management comparisons and to buffer against catastrophic loss of an MPA, at least three to five replicate MPAs should be designed for each habitat type within a biogeographical region [Point Conception to U.S./Mexico border].

Replication of habitats in MPAs addresses goals 1, 2, 3, 4 and 6 of the Marine Life Protection Act (MLPA) as well as other requirements and guidance in the act, including habitat replication within state marine reserves (SMRs). Evaluations of habitat replication include the number of replicates in SMRs, and also the replication of habitats in state marine conservation areas and state marine parks at the various levels of protection.

Guidance in the *Master Plan* requires that habitat be replicated in three to five MPAs in the biogeographic region. However, spacing guidelines (see Chapter 7.0) may require greater replication of habitats. Benefits of MPAs are largely dependent on the habitat contained in them. An MPA that does not contain appropriate habitat for an ecosystem or particular species (e.g. kelp forest) provides insufficient benefits to that ecosystem or species.

In evaluating habitat replication, the SAT considers:

- The overall size of each MPA or cluster of MPAs (contiguous MPAs with different allowed uses) at the three highest levels of protection, and
- the extent of each habitat contained within the MPA or MPA cluster.

Only MPA clusters above the minimum size (nine square miles[3]) were considered for habitat replication (with the exception of estuarine habitats). The SAT considered an MPA to include a specific habitat if the MPA encompassed a critical amount of the habitat. This critical amount

[3] Unless otherwise noted, all distance measurements are measured in statute miles and all area measurements are measured in square statute miles. Depths are reported in meters (m).

was defined as an area sufficient to encompass 90% of the species known to use the habitat in sufficient abundance to be ecologically represented in the habitat. (see Figure 5-1.)

To determine the estimated amount of habitat needed, the SAT examined biological survey data from a variety of habitat types present in the study region. Only datasets that had the following features were used: (1) sampling allowed for estimation of species richness, (2) sampling was spatially explicit (the location, depth and area were known), (3) sufficient replication to allow for robust resampling, (4) asymptotic like area by richness curves), (5) absence of meaningful design bias, such as would exist if only certain taxa were targeted. Using a resampling procedure and accumulation functions (including Michaelis-Menten) the SAT then estimated the amount of habitat area needed to encompass 90% of the species likely to occur in each habitat (see Figure 5-1).

Figure 5-1 Estimated Proportion of Species per Amount of Habitat for Rocky Habitats

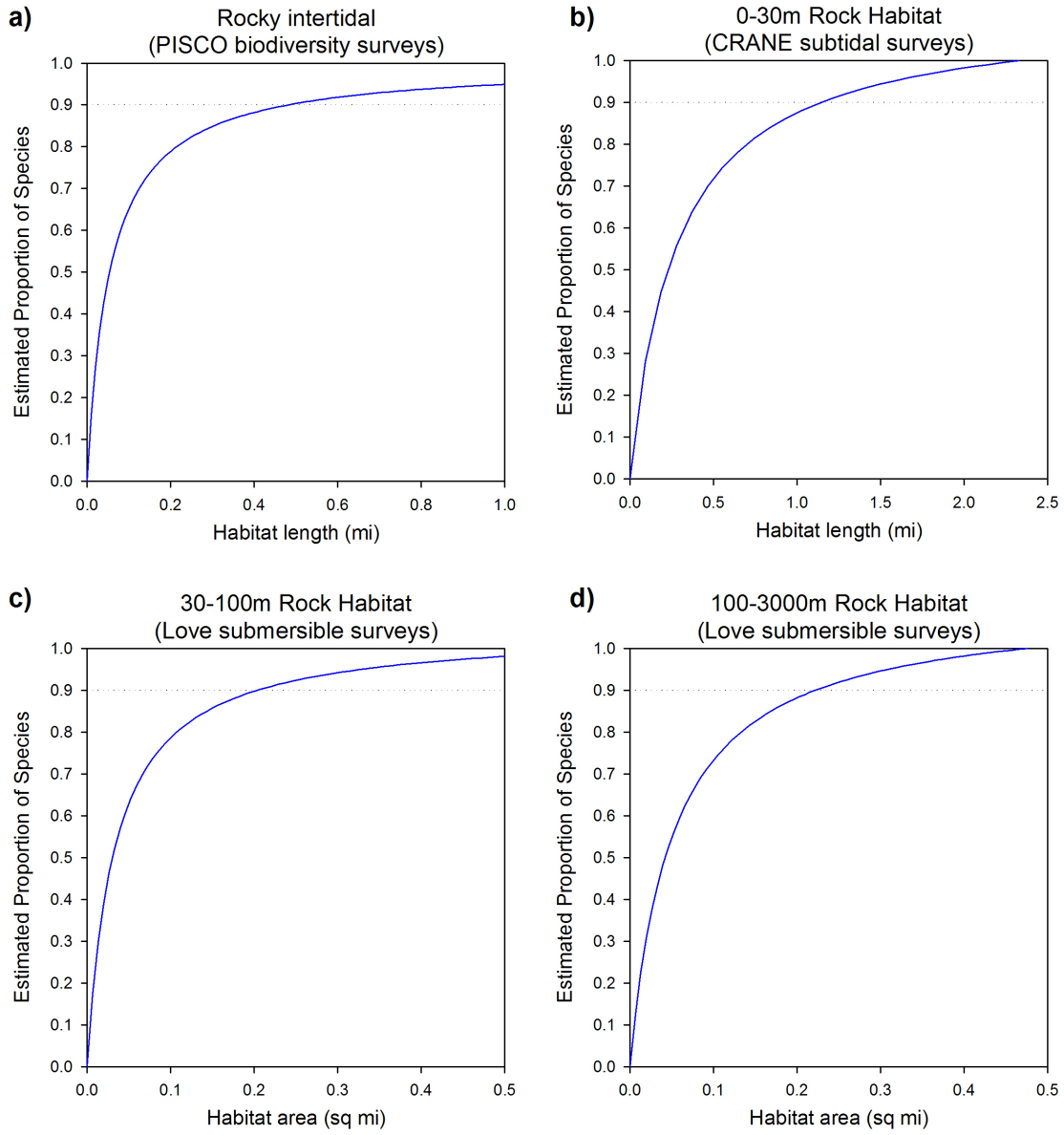


Table 5-1 Amount of Habitat in an MPA Necessary to Encompass 90% of Local Biodiversity

Habitat	Representation needed to encompass 90% of biodiversity	Data Source
Rocky Intertidal	~0.48 linear miles	PISCO Biodiversity
Surfgrass	~0.48 linear miles	PISCO Biodiversity (see below)
Shallow Rocky Reefs/Kelp Forests (0-30 m)	~1.14 linear miles	CRANE Subtidal Surveys (see discussion below)
Deep Rocky Reefs (30-100 m)	~0.20 square miles	Love Surveys
Deep Rocky Reefs (100-3000 m)	~0.22 square miles	Love Surveys
Sandy Beaches *	~1.14 linear miles	See below
Soft-Bottom Habitat (0-30 m)	~1.14 linear miles	See below
Soft-Bottom Habitat (30-100 m)	~2.24 square miles	SCCWRP (BIGHT '98 & '03)
Soft-Bottom Habitat (100-200 m)	~1.10 square miles	SCCWRP (BIGHT '98 & '03)
Soft-Bottom Habitat (>200 m)	~0.46 square miles	SCCWRP (BIGHT '98 & '03)
All Soft-Bottom Habitat (>0 meters)	***~8 square miles***	***Preferred option - see below***
Estuarine Habitats	0.12 square miles (77 acres)	SONGS sampling

* Sandy beaches are often linked to shallow soft-bottom areas, therefore linear extent for sandy beaches is tied to linear extent of soft-bottom habitat, see below for further explanation.

Surfgrass: Surfgrass occurs in shallow and intertidal rocky habitats along the coast of the study region. Few organisms live exclusively in surfgrass habitat but many intertidal and shallow rock species benefit from its presence. The SAT assessed the percent biodiversity using the area/biodiversity relationship from the rocky intertidal.

Kelp: The SAT's size recommendation for individual habitats, including kelp habitat, is based on the area or spatial extent of habitat necessary to support 90% of available biodiversity. To assess the minimum length of a kelp bed needed to encompass 90% of kelp forest biodiversity, the SAT analyzed kelp forest community surveys conducted by CRANE and determined that the minimum linear extent was 1.14 miles. Although all CRANE surveys are ostensibly conducted in kelp forest communities, scrutiny of the survey data indicated that 72%

of transects had kelp present at the time of the survey. Thus, the communities surveyed by CRANE represent kelp forest communities in an environment with a 72% likelihood of kelp. By comparison, an analysis of kelp distribution indicates that capturing a given quantity of the "persistent kelp" linear measure in an MPA yields a 54% likelihood that an equal or greater amount of kelp will be present in the MPA in any given year (see Figure 5-2). Aerial kelp surveys may slightly underestimate the extent of kelp habitat because they only detect kelp plants that are large enough to create a surface canopy. Thus, a 54% likelihood of surface canopy may be closer to the 72% likelihood represented by the CRANE surveys. Based on this assessment, the SAT determined that the biodiversity curve derived from the CRANE surveys (1.14 miles to encompass 90% of biodiversity) was most appropriately applied to the "persistent kelp" measure.

For kelp forest, shallow soft-bottom, and shallow rocky habitats, protection of habitat must extend from shore to the 30 meter contour.

Estuarine Habitats: As noted above, estuaries are not included in the general rule that replication of habitat needs to be within an MPA cluster that is at least nine square miles. This is because estuarine habitats very often are not adjacent to coastal rocky habitats and a requirement for co-location could greatly restrict the location of MPA clusters.

The SAT recommends that wherever possible, a mixture of estuarine sub-habitats be protected in close proximity to one another to allow for the movement of species among sub-habitats. Additionally, protection of areas close to the mouth of an estuary is likely to have great benefit for species that use both estuarine and open-coast habitats. As for all other habitats shown above, the minimum area for estuarine reserves were based upon biological surveys and yielded the estimated amount of area needed to encompass 90% of the biodiversity in an estuarine system. The analysis showed that 77 acres is sufficient area to capture 90% of the species across the three main estuarine sub-habitats: eelgrass, tidal flats, and coastal marsh. In order for estuarine habitats to be considered present, a minimum of 77 acres of estuarine habitats must be included within an MPA. For the three sub-habitats to be considered present, a minimum of 25 acres of each must be included within an MPA.

There were several representative habitat types for which survey data was either unavailable or there was insufficient replication to use the methodology discussed above. The presence of these habitats in a given MPA was assessed as follows:

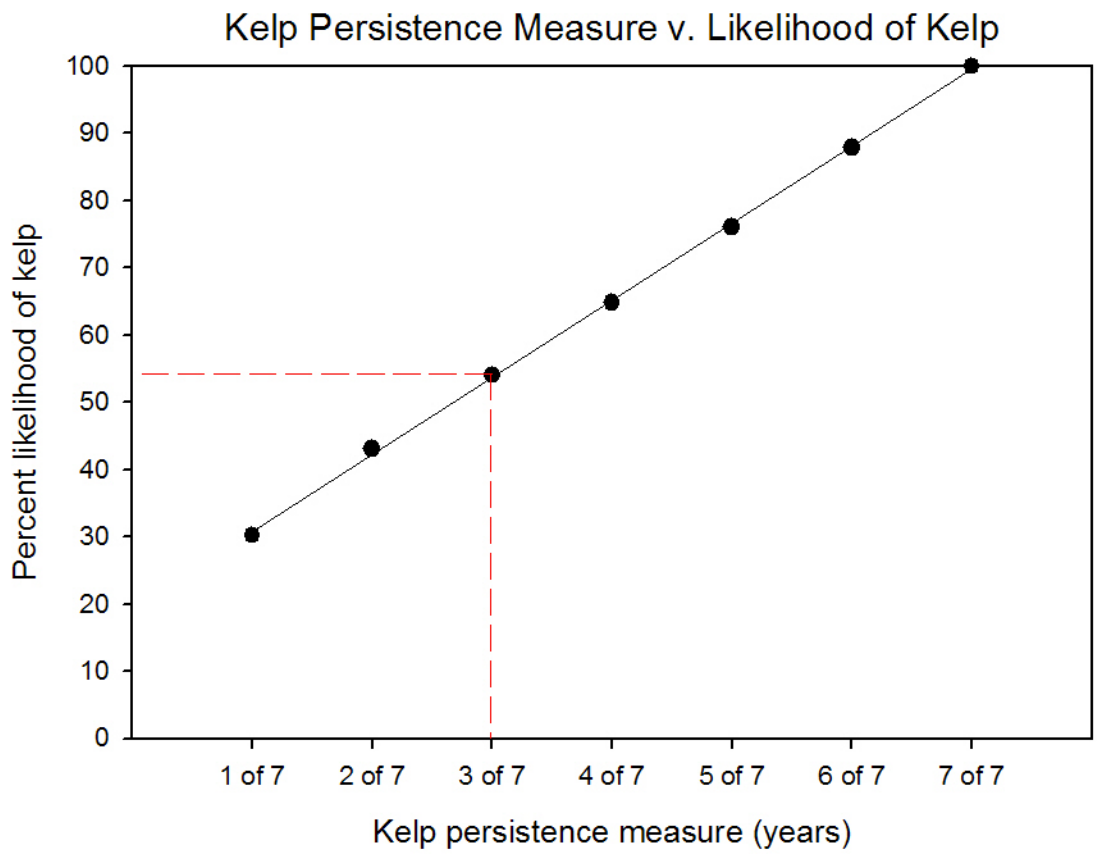
Soft bottom (0-30 meters): The species that are unique to this habitat mainly inhabit the surf zone; therefore the linear extent of shallow soft bottom was used to assess the presence of this habitat. The distribution and movement patterns of species in the surf zone is likely similar to that of species on shallow rocky reefs; therefore the percentage of biodiversity was assessed using the area/biodiversity relationship derived from 0-30m rocky reefs (1.14 linear mile = 90% biodiversity). To be considered present this habitat must also extend to the 30 meter contour.

Sandy beaches: No data were available to make a scientific assessment of the relationship between beach length and biodiversity. Because sandy beaches are usually inshore from shallow soft-bottom areas, and to make area delineation logistically feasible, the SAT linked the required linear extent of sandy beaches to soft-bottom habitats (0-30 meter). Hence, the

SAT considered sandy beach habitat present if a given MPA included at least 1.14 miles of sandy beach.

All soft-bottom habitat (>0 meters): – A value of approximately eight square miles that includes all subtidal soft bottom habitat is preferred. This value comes from examination of two sets of National Marine Fisheries Service (NMFS) trawl data that yield a value of approximately eight square miles using the methodology discussed above. The NMFS samples come from areas just outside the region and are much larger than the Southern California Coastal Water Research Project (SCCWRP) samples (>10 times as large). Also the NMFS trawls were used for the MLPA North Central Coast Study Region evaluations which yielded a value of nine square miles of sandy habitat for that region. Hence, to integrate both the SCCWRP data and the results of analysis using NMFS data, we present a minimum and preferred size for sandy habitats. It is important to note that using the preferred size does not discard the values generated by the SCCWRP analysis; instead the two results should be used together. That is, the preferred size for soft bottom subtidal habitats is eight square miles including a shore length of at least 1.14 linear miles (for the 0-30 meter depth), and 2.24, 1.1 and 0.46 square miles of habitat in the 30-100, 100-200 and >200 meter zones, respectively.

Figure 5-2 Kelp Persistence Measure versus Likelihood of Kelp



The relationship between the threshold persistence used to define kelp beds and the likelihood that kelp will be present in any given year. The measure of kelp chosen by the SAT defines all areas with kelp present at least 3 out of 7 years as "persistent" which corresponds to a 54% likelihood that kelp will be present in any given year.