California Marine Life Protection Act Initiative

Draft Methods Used to Evaluate
Marine Protected Area Proposals
in the
MLPA North Coast Study Region

Chapters 4 & 5

Habitat Representation Analyses

And

Habitat Replication Analyses

Revised June 27, 2010

4. Habitat Representation and Analyses (Goals 1 and 4)

Status of this chapter: The SAT approved this chapter on May 12, 2010. Changes from the May 12, 2010 version are in underline and strikeout.

Identification of Key and Unique Habitats for the MLPA North 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 North 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 for MPAs

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 MLPA North Coast Study 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 MLPA North 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 MLPA North Coast Study Region (m = meters, * = mapping data limitations, † = habitat is rare within the study region):

- 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*

Several of the key habitats indicated above with an asterisk (*) are subject to mapping limitations that may restrict habitat evaluations. Further detail on the methods used to evaluate inclusion of these habitats in MPA proposals is provided below. Other key habitats indicated with a dagger symbol (†) are rare or unevenly distributed within the study region, and thus may be difficult to replicate within MPAs.

Pelagic Habitats

Several pelagic habitats are included in the list of key habitats for the MLPA North Coast Study Region: namely upwelling centers, retention zones, river plumes, and oceanographic fronts. These pelagic habitats, are created by water movement, and 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. The SAT habitat workgroup has developed maps of the major upwelling centers and river plumes in the NCSR that will be available in MarineMap and can be used to inform MPA design, but will not be used in any MPA evaluation at this time. It is important to note that areas outside of the mapped upwelling centers may experience episodic upwelling events, but the mapped upwelling centers demarcate the areas of most persistent upwelling. Maps of river plumes demarcate the zones for the 5 largest rivers in the north coast that are likely to be influenced by river-borne sediments and freshwater during periods of peak flow. These mapped river plume zones are scaled to the peak river flow, while the mouths of smaller rivers and streams within the study region are represented as ~~points~~ a 1-mile buffer around river mouths to indicate potential river plumes of ~~unknown~~ limited spatial extent.

The SAT recommends that MPAs should be distributed across pelagic habitats (i.e. inside and outside of upwelling centers), but due to the dynamic nature of these pelagic habitats and the fact that they overlay mapped benthic habitats, their inclusion should be a secondary consideration in MPA siting.

Upwelling centers: The upwelling habitat layer identifies areas where water properties are those of recently upwelled waters: colder, clearer, higher in nutrients, low pH, and lower in phytoplankton as compared to coastal waters elsewhere in the study region. These areas include the major upwelling centers at Cape Blanco, Cape Mendocino, and Point Arena and adjacent waters, mostly the upwelling plumes downstream of the centers. The shape of this layer is based on satellite sea-surface temperature data, combined with knowledge of the processes and patterns of upwelling from oceanographic studies (e.g., Largier et al 1993) and professional insight on nearshore circulation. This entire region is characterized by upwelling, thus areas outside the demarcated upwelling zones may also experience recently upwelled waters at times. However, in general waters outside of the demarcated upwelling centers are warmer, lower in nutrients and higher in phytoplankton

concentrations with reduced offshore flow at the surface. While water may be detained in these other areas, there are no true retention zones in this region.

River Plumes: The plume habitat layer identifies areas that are subject to strong land runoff effects following winter rainfall events. This includes low-salinity, high levels of suspended particles, high sedimentation, and low light (and potential exposure to land-derived contaminants). The plume zones associated with the 5 rivers with maximum winter flows are mapped, whereas the smaller plumes associated with rivers with lower flow are marked by a small buffer around their origin. After heavy rain, these smaller plumes may also be distinctly visible but their extent is less (smaller than MPA size) and they persist for shorter periods. The extent of the mapped plumes of the Smith, Klamath, Mad, Eel, and Mattole Rivers is based on one day of flow at the 90-percentile level (a flow that is exceeded 36.5 days a year) and understanding of plume behavior is primarily drawn from a study of the Eel River plume (Geyer et al 2000). The extent and shape of plumes is influenced by shoreline topography (e.g., effect of Pt St George on Klamath River plume), however, plume zones are primarily north of river mouths as alongshore currents and winds are northward during periods of strong runoff. Furthermore, if plumes persist into periods of northerly (upwelling favorable) winds, they tend to be separated from the shore due to the upwelling effect. The plume shapes demarcated in the layer indicate a typical plume zone, with individual plume events exhibiting variations on this theme (i.e. sometimes larger, or smaller, or more southerly, or more northerly).

Rocky Intertidal Habitats

Rocky intertidal habitats in the North Coast Study Region occur both on the mainland and on numerous offshore rocks, sea stacks and small islands. These offshore rocks are especially abundant in the study region and are formed through the erosive action of waves that buffet the shore and whittle away the coastal cliffs, leaving isolated stands of the most resistant rock. Offshore rocks vary in size from just a few square yards to several acres and may occur as far as several miles from the mainland coast. Due to their relative isolation from human disturbance, offshore rocks provide important breeding and resting sites for a wide variety of seabirds and marine mammals. Offshore rocks also support a variety of marine algae and invertebrates, especially those adapted to a high-energy wave environment. Offshore rocks may also contribute to the availability of shallow water rocky reef habitat (0-30m depth) in the study region. To adequately represent the habitat contribution of offshore rocks, both the intertidal length and the nearshore subtidal habitat (especially for those rocks that occur in depths greater than 30 meters) must be considered. For the purpose of evaluating MPA proposals, the shoreline length of offshore rocks will be considered as a subset of rocky shores. However, the shoreline length of offshore rocks will only be assessed for those rocks that are sufficiently large to be accurately mapped (greater than 1000 square meters area) and rocks of any size that occur sufficiently far from shore to be non-contiguous with the existing mapped intertidal shoreline habitat (greater than 100m from shore). In evaluating habitat representation, the SAT will assess representation of mainland rocky shores and offshore rocks separately. In evaluating habitat replication and spacing the shoreline length of offshore rocks and mainland rocky intertidal will be combined. ~~For mapped offshore rocks that occur in depths greater than 30 meters, the SAT has developed a nearshore substrate proxy line to allow easy integration with the measurements used for nearshore substrate along the mainland coast.~~

Subtidal Rocky Reef and Soft Bottom Habitats

Substrate across the majority of the north coast study region has been mapped using high resolution multi-beam sonar techniques. This dataset, developed by the California Seafloor Mapping Program, represents a substantial advance in our ability to identify the location and extent of subtidal rocky reef and soft bottom habitats. Unfortunately, most areas shallower than 10 meters depth (33 feet) remain unmapped due to safety and logistical considerations associated with data collection in those

areas. Throughout the north coast, 99% of the area deeper than 30m depth and 72% of the area shallower than 30m depth is mapped and classified as rocky reef or soft bottom habitat. In order to best accommodate nearshore mapping gaps and reflect the strong depth-dependence of marine communities within the 0-30m depth zone, the SAT has developed a linear measure of substrate in the 0-30m zone called the 0-30m proxy line. This proxy line reflects the best readily available information about substrate within the 0-30m zone, including the areas mapped using multibeam sonar techniques and information from the shoreline [NOAA's Environmental Sensitivity Index (ESI) shoreline] and offshore rock [California Coastal National Monument] datasets. Because marine community composition and the relative abundance of species varies strongly with depth in nearshore areas, nearshore habitats that span the full range of depths from 0-30m are most likely to encompass the full range of biodiversity associated with these habitats. In this respect, a reef or soft bottom area that falls steeply from shore to 30m depth, would likely support a similar level of biodiversity as a gradually sloping reef that spans the 0-30m depth zone over a much larger area. Due to the depth-dependence of nearshore communities, the linear proxy for nearshore rocky reef and soft bottom habitats is scaled to the proportion of soft and hard bottom habitats within the 0-30m depth zone.

As developed, the nearshore proxy line is a line drawn roughly parallel to shore at 12-15m depth. This line is divided into short segments 1/10th of a minute of latitude north-south, and the estimated proportion of hard and soft bottom in the 0-30m zone is associated with each segment. To estimate the proportion of hard and soft bottom in each 1/10th minute segment, the mapped proportion is combined with an estimate from the unmapped areas. The latter value is calculated as the average of offshore and onshore borders of the unmapped areas. For example, if the shoreline is 100% rock and the offshore margin is 50% rock, the unmapped zone between the two would be approximated as 75% rock. This estimate of substrate in the unmapped zone is then scaled to area, and combined with the mapped substrate to generate an overall estimate of rock and sand in the 0-30m zone.

Rivers and estuaries

The study region contains a number of large rivers and smaller streams that provide important spawning habitat for anadromous fish species. The lower reaches of these streams provide estuarine nursery habitat for a variety of marine fishes and are contained within the North Coast Study Region. Many rivers along the north coast have dynamic mouths characterized by shifting sand bar and beach habitat such that the location of the river's outflow may change from year to year. The dynamic beaches and sand bars provide important haul-out sites for marine mammals and nesting sites for shorebirds including the endangered snowy plover. In cases where MPAs are located on the open coast near the outflows of these dynamic rivers, the SAT recommends that MPAs encompass the full range of historical river outflow locations to ensure that connectivity between the MPA and adjacent estuarine habitat is not lost to future shifts in the river mouth location.

Several of the rivers in Mendocino County are characterized by narrow channels surrounded by the steep Mendocino Range and extensive zones of tidal and marine influence. Due to their steep sides, these drowned river valleys do not contain extensive areas of coastal marsh, tidal flats, or eelgrass, however, they provide estuarine habitats in close association with one another and support a variety of marine life. The drowned river valleys in the North Coast Study Region include the estuarine portions of the following rivers:

- Noyo River
- Big River
- Albion River
- Navarro River

Humboldt Bay is the largest estuary in the north coast study region and second-largest estuary in California, after San Francisco Bay. This large and rich habitat supports a wide variety of fish and invertebrate species and serves as a nursery area for open coast species including, English sole, Pacific herring, lingcod, Dungeness crab, rock crabs, some surfperches, and some rockfishes (Barnhart et al. 1992). Approximately 40% of the known eelgrass in California occurs in Humboldt Bay (Schlosser et al. 2009). Large, dense beds occur throughout all of South Bay, Central Bay, and North Bay. South Bay beds are more dense, contain greater biomass compared to the rest of the bay and South Bay eelgrass beds have been recognized as one of the most important locations of eelgrass growth on the U.S. west coast (Phillips 1984). Due to the richness of marine life supported by Humboldt Bay, the SAT recommends that MPA arrays for the North Coast include representation the full variety of habitats contained within it.

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 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 state 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 two distinct bioregions within the MLPA North 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 both 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 two 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 two bioregions in the MLPA North 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 will conduct simplified evaluations of habitat representation.

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	Review Summary	Recommended Method of Habitat Assessment
rocky shore	NOAA Environmental Sensitivity Index (ESI) shoreline - 1994	Shoreline types are comprehensively and consistently mapped across the state. resolution may be insufficient to resolve intermixed habitats (e.g. beaches interspersed with rocky outcrops) in some areas.	Appropriate for assessing both the length and proportion of habitat included in MPA proposals.
offshore rocks	California Coastal National Monument (CCNM)	Offshore rocks are comprehensively mapped across the state, but rocks that occur further offshore are not well mapped. There are some inconsistencies in the size and location of mapped rocks as compared to satellite imagery. Larger rocks also mapped in the ESI shoreline file were removed from this dataset to avoid duplication.	A subset of the offshore rocks layer filtered to avoid redundancy with existing mapped intertidal areas may be used for assessing the length and proportion of habitat included in MPA proposals, but the accuracy of these estimates may vary by area.
sandy beach	NOAA ESI shoreline - 1994	Shoreline types are comprehensively and consistently mapped across the state. resolution may be insufficient to resolve intermixed habitats (e.g. beaches interspersed with rocky outcrops) in some areas.	Appropriate for assessing both the length and proportion of habitat included in MPA proposals.
surfgrass	*no current data available in digital format*		
coastal marsh	NOAA Coastal Change Assessment Program (CCAP) 2007	Coastal marsh areas are comprehensively and consistently mapped across the state using remote sensing data.	Appropriate for assessing both the area and proportion of habitat included in MPA proposals.

Habitat	Source	Review Summary	Recommended Method of Habitat Assessment
tidal flats	NOAA ESI shoreline - 1994	Shoreline types are comprehensively and consistently mapped across the state, however dynamic estuarine shorelines are not accurately represented in this older dataset. May not provide accurate or consistent assessment of tidal flat habitat availability.	May be used for assessing the length and proportion of habitat included in MPA proposals, but the accuracy of these estimates may vary by location.
estuaries	National Wetlands Inventory (NWI), The Nature Conservancy (TNC), satellite imagery, expert opinion	A combination of data sources and expert opinion have allowed staff to comprehensively map all tidally influenced enclosed water bodies in the study region, including man-made harbors.	Appropriate for assessing both the area and proportion of habitat included in MPA proposals.
eelgrass	PSMFC, SeaGrant, local studies and reports	Eelgrass is not comprehensively mapped across the study region, and high resolution mapping appropriate for assessing area is only available for Humboldt bay. Staff have confirmed eelgrass presence/ absence for all major estuaries in the study region.	Appropriate for assessing area in Humboldt Bay only. Additionally, presence/ absence data will allow assessment of the proportion of known eelgrass locations protected.
kelp	DFG aerial surveys (from 1989, 1999, 2002-05, and 2008)	Bull kelp, the dominant canopy-forming species in the region, does not form extensive surface canopies, thus the extent of kelp is not well documented by overflight surveys. Multiple years of overflight data allow assessment of locations that are likely to support kelp forests.	A linear measure of kelp derived from the composite of survey data years is appropriate for assessing length and proportion of habitat included in MPA proposals, but may contain some inaccuracies.
rocky reef 0-30m	CSUMB Seafloor mapping, DFG aerial kelp surveys	High resolution mapping of the substrate does not include most areas shallower than 10m depth. Combination of this data with kelp canopy and shoreline type information allows assessment of locations that are likely to contain rocky reef across a substantial portion of the 0-30m depth range.	A linear measure of nearshore rocky reef derived from multiple information sources is appropriate for assessing length and proportion of habitat included in MPA proposals.
rocky reef in the 30-100m, 100-200m, and >200m depth zones	CSUMB Seafloor mapping	High resolution mapping of the substrate is comprehensive and consistent across the study region.	Appropriate for assessing both the area and proportion of habitat included in MPA proposals.
soft bottom 0-30m	CSUMB Seafloor mapping	High resolution mapping of the substrate does not include most areas shallower than 10m depth. Combination of this data with shoreline type information allows assessment of locations that are likely to contain soft bottom across a substantial portion of the 0-30m depth range.	A linear measure of nearshore soft bottom derived from multiple information sources is appropriate for assessing length and proportion of habitat included in MPA proposals.

Habitat	Source	Review Summary	Recommended Method of Habitat Assessment
soft bottom in the 30-100m, 100-200m, and >200m depth zones	CSUMB Seafloor mapping	High resolution mapping of the substrate is comprehensive and consistent across the study region.	Appropriate for assessing both the area and proportion of habitat included in MPA proposals.
submarine canyons	G. Green	Mapping of canyons is comprehensive across the state, but area measurements may not be consistent.	May be used for assessing the area and proportion of habitat included in MPA proposals, but the accuracy of these estimates may vary by location.
pinnacles	*unmapped*		
upwelling centers	J. Largier	Major upwelling centers are comprehensively mapped across the study region, but mapping of this dynamic habitat does not reflect the complexity of temporal and spatial variation.	May be used for informational purposes, but not appropriate for assessing area or percentage of habitat protected.
retention areas	*currently unmapped*		
river plumes	J. Largier	Major and minor river plumes are mapped across the study region, but mapping of this dynamic habitat does not reflect the complexity of temporal and spatial variation.	May be used for informational purposes, but not appropriate for assessing area or percentage of habitat protected.
oceanographic fronts	*currently unmapped*		

Works Cited in Chapter 4

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Largier, J. L., B. A. Magnell and C. D. Winant, 1993. Subtidal circulation over the northern California shelf. Journal of Geophysical Research, 98(C10), 18147-18179.

Schlosser, S., and A. Eicher. 2007. Humboldt Bay Cooperative Eelgrass Summary Report April 2004 to November 2007. National Fish and Wildlife Foundation Report. UC Sea Grant Extension Program, Eureka.

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

Status of this chapter: Pending approval by the SAT.

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 [e.g., Point Conception to Oregon].

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). Replication of habitats contributes to achievement of the MLPA goals in the following ways: 1) by ensuring that protected habitats are distributed across environmental and geographic gradients to protect the full diversity of marine life in California's waters, and 2) by distributing protection across multiple areas to reduce the likelihood that a single catastrophic event or localized disturbance will disrupt MPA function state-wide. 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 habitats be replicated in three to five MPAs in the biogeographic region. However, spacing guidelines (see Chapter 7.0) may require greater replication of habitats. The SAT also recommends that key marine habitats be replicated in at least one MPA in each of the two bioregions (see Chapter 2.0) contained within the NCSR. This guidance only applies to habitats that occur in both bioregions in sufficient abundance for replication to be feasible. Because the divide between northern and southern bioregions in the North Coast Study Region is not a strong ecological break, but rather a gradual transition zone between areas with different habitat distributions and ecological assemblages, MPAs that fall on this divide could reasonably be assigned to either of the two bioregions. In cases where an MPA falls on the bioregional divide, the SAT will divide habitat replicates across the two bioregions (1/2 replicate in each) to indicate that these habitat replicates occur in the transitional zone and could reasonably be assigned to either bioregion.

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[1]) 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 was defined as an area or length sufficient to encompass 90% of the species that occur in the habitat in sufficient abundance to be ecologically represented (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 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).

[1] 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).

Figure 5-1. Estimated Proportion of Species per Amount of Habitat

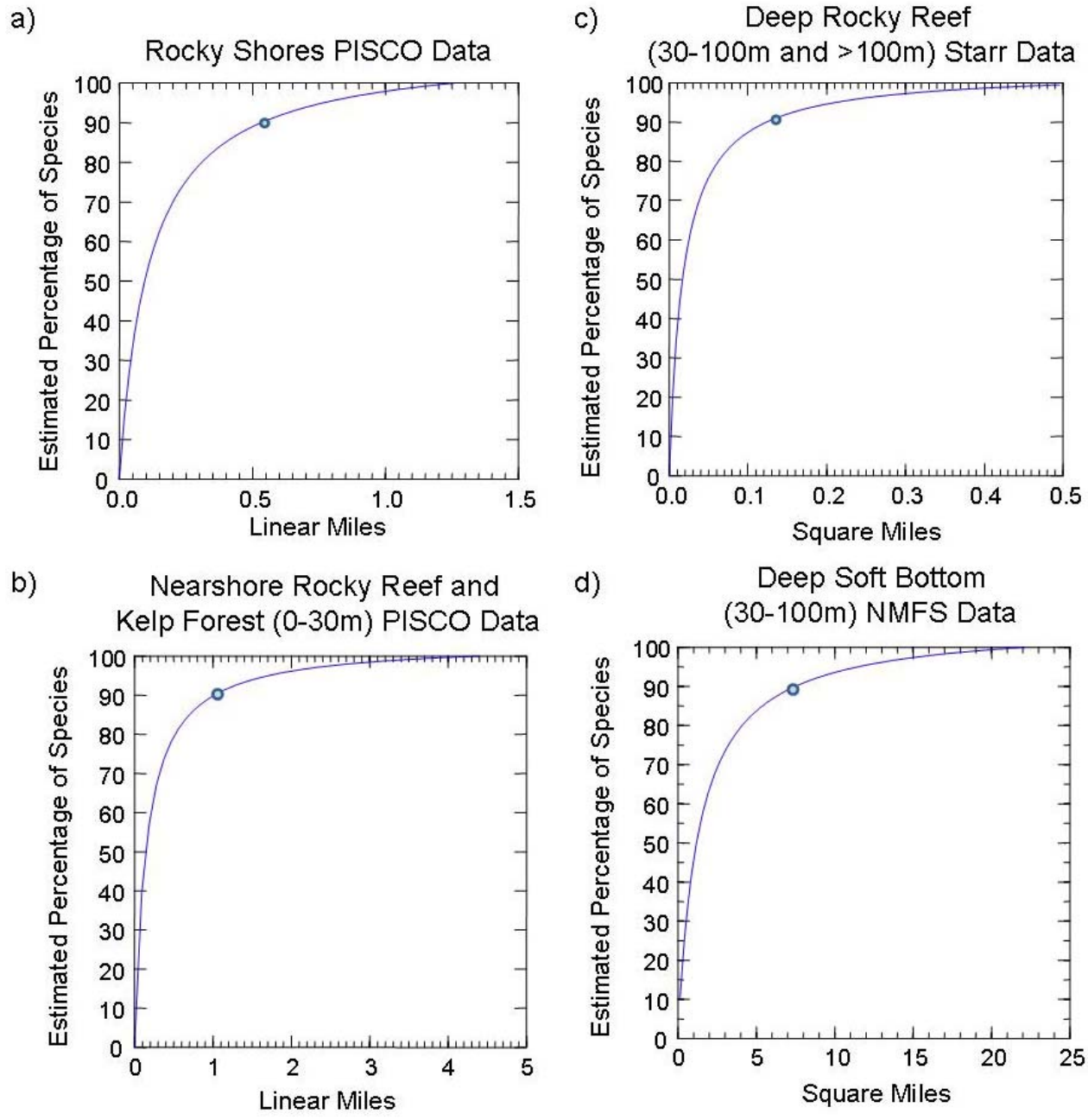

Table 5-1. Amount of habitat in an MPA necessary to encompass 90% of local biodiversity

Habitat	Amount of habitat needed to encompass 90% of biodiversity	Data Source
Rocky shores and offshore rocks	0.55 linear miles	PISCO Biodiversity
Nearshore rocky reefs and kelp forest (0-30 m)	1.1 linear miles *including the full 0-30m depth zone*	PISCO Subtidal
Rocky reef 30-100 m	0.13 square miles	Starr Surveys
Rocky reef 100-3000 m	0.13 square miles	Starr Surveys
Beaches	1.1 linear miles	*See below*
~~Soft bottom 0-3000 m~~ [a] ~~*(includes replicates of 0-30m, 30-100m and >100m soft bottom)*~~	~~10 square miles total mapped soft bottom~~ ~~Distributed across depth zones including at least:~~ ~~1.1 mi 0-30m~~ ~~5 sq mi 30-100m~~ ~~1 sq mi >100m~~	~~NMFS trawl surveys, 1977-2007~~
Soft bottom 0-100 m [a] *(includes replicates of 0-30m and 30-100m soft bottom)*	7 square miles total mapped soft bottom Distributed across depth zones including at least: 1.1 mi 0-30m 5 sq mi 30-100m	NMFS trawl surveys 1997-2007
Soft bottom 30-3000m [a] *(includes replicates of 30-100m and 100-3000m soft bottom)*	7 square miles total mapped soft bottom Distributed across depth zones including at least: 5 sq mi 30-100m 1 sq mi >100m	NMFS trawl surveys 1997-2007
Soft bottom 0-30 m *when not combined with other depth zones*	1.1 linear miles *including the full 0-30m depth zone*	*See below*
Soft bottom 30-100 m *when not combined with other depth zones*	7 square miles	NMFS trawl surveys 1997-2007
~~Soft bottom >100 m~~ ~~*when not combined with other depth zones*~~	~~17 square miles~~	~~NMFS trawl surveys 1997-2007~~
Estuarine Habitats [b]	0.12 square miles (77 acres) total estuarine area Distributed across estuarine habitats including at least: 0.04 sq mi coastal marsh (25 acres) 0.04 sq mi eelgrass (25 acres)	SONGs sampling

[a] *Trawl survey data indicate that large amounts of soft bottom habitat are required to encompass 90% of biodiversity if each depth zone is replicated independently. Since soft bottom associated species tend to utilize multiple depth zones, the SAT recommends that soft bottom habitats across multiple depth zones are included in the same MPA or MPA cluster.*

[b] *Estuarine habitat replication thresholds are based upon data from small coastal estuaries in the south and central coast regions and may not be applicable to the large estuarine areas in Humboldt Bay.*

Rocky Shores: Rocky shores in the north coast study region include the mainland shoreline and numerous offshore rocks, sea stacks, and small islands that have been mapped by the California Coastal National Monument. The combined length of rocky intertidal habitat occurring on the

mainland and offshore rocks (filtered to reduce redundancy) are combined for the purposes of evaluating replication.

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. There is currently no data available in digital format for the distribution or extent of surfgrass in the north coast study region. The SAT will therefore not evaluate surfgrass explicitly, and rather evaluate rocky intertidal habitat as potential surfgrass habitat.

Nearshore habitats (0-30m): Nearshore habitats in the 0-30m depth zone include kelp forests, 0-30m soft bottom, and 0-30m rocky reef. These habitats are evaluated using a linear proxy that approximates the coastline length of these habitats and assumes that protection extends across the entire 0-30m depth zone. To achieve replication of nearshore habitats, an MPA must encompass the entire 0-30m depth zone.

Kelp: The aerial images used by CDFG to estimate kelp coverage do not reliably capture presence of the dominant kelp species in the north coast study region, bull kelp (*Nereocystis luetkeana*). Therefore, kelp coverage estimates for the region are low and indicate large gaps between kelp patches. Kelp occurs over shallow rocky substrate (0-30 m), so adequate protection of shallow rock habitat should ensure protection of kelp even where it does not appear on the maps. In places where kelp does appear on CDFG maps, the SAT guideline for replication is the same as that for shallow rocky reef, 1.1 miles.

Beaches and 0-30m soft bottom: No data were available to make a scientific assessment of the relationship between shoreline length and biodiversity for beaches or 0-30m soft bottom habitats. Most species that live exclusively in nearshore sandy habitats are associated with the surf zone, thus linking the two habitats. In the absence of surf zone community surveys, the SAT used the species-area relationship derived from nearshore rocky reefs as a proxy. Hence, the SAT considers beach and 0-30 m soft bottom habitats present if an MPA includes at least 1.1 miles these habitats.

Soft-bottom habitats: Trawl survey data from soft bottom habitats indicate that if each soft bottom depth zone were protected individually (i.e. one depth zone per MPA) large areas would be required to ensure protection of representative biodiversity. In some cases these areas greatly exceed the minimum size guidelines for MPAs. Soft bottom associated species, however, tend to utilize multiple depth zones, thus there is substantial overlap in the species composition of adjacent depth zones, although the relative abundance of these species may vary with depth. For example, 53% of the species found in surveys from >100m depths are also found in surveys from the 30-100m depth zone. Results from the trawl surveys indicate that the most efficient way to protect the full range of biodiversity associated with soft bottom habitats in the NCSR is to protect soft bottom habitats across the full range of depths within a contiguous area of protection (i.e. one MPA or MPA cluster).

~~**Soft bottom 0-3000 m:** In order to protect 90% of the biodiversity associated with all depth zones of soft bottom habitat, the SAT recommends that an MPA include a total of 10 sq mi of mapped soft bottom habitat with at least 1.1 linear miles of 0-30m soft bottom, 5 square miles of 30-100m soft bottom, and 1 square mile of >100m soft bottom. The total area of 10 sq mi was derived from NMFS trawl data and the distribution of depth zones derived from the distribution of depth zones in the NCSR.~~

Soft bottom 0-100 m: In some sections of the NCSR, the study region does not include areas deeper than 100m. In these areas where >100m soft bottom habitats are not available, the SAT recommends that an MPA include a total of 7 square miles of mapped soft bottom habitat, including at least 1.1 miles of 0-30m soft bottom and 5 square miles of 30-100m soft bottom. The total area of

7 sq mi was derived from NMFS trawl data and the distribution of depth zones derived from the distribution of depth zones in the NCSR.

Soft bottom 30-3000 m: In some sections of the NCSR, it may be desirable to target deepwater features for protection with MPAs that do not include nearshore or shoreline habitats. In these areas, the SAT recommends that an MPA include a total of 7 square miles of mapped soft bottom habitat, including at least 5 square miles of 30-100m soft bottom and at least 1 square mile of >100m soft bottom. The total area of 7 sq mi was derived from NMFS trawl data and the distribution of depth zones derived from the distribution of depth zones in the NCSR.

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 habitat size guidelines for estuarine replication presented in the table above are based upon data from small coastal estuaries in the south and central coast regions and may not be applicable to the large estuarine areas in Humboldt Bay. In the absence of specific habitat size guidelines for Humboldt Bay, the SAT recommends that proposals consider proportional representation of the three estuarine sub-habitats in MPAs both within the bay and across the study region.

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. Estuarine sub habitats include eelgrass[2], tidal flats, and coastal marsh. 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.

[2] Mapped eelgrass in the north coast study region is available for Humboldt Bay only. The SAT will evaluate eelgrass area for Humboldt Bay and conduct an eelgrass presence/absence analysis for all other locations in the study region.