California Marine Life Protection Act Initiative

Methods Used to Evaluate Draft MPA Proposals in the North Central Coast Study Region (DRAFT)

January 7, 2008 revised draft

Contents

EXECUTIVE SUMMARY

This document provides details of the methods used to evaluate draft MPA proposals generated by members of the MLPA North Central Coast Regional Stakeholder Group (NCCRSG) and draft MPA proposals generated external to the NCCRSG. The proposals are being developed through an iterative process to "reexamine and redesign California's MPA system to increase its coherence and its effectiveness at protecting the states marine life habitat, and ecosystems", as mandated by California's Marine Life Protection Act (MLPA) [MLPA Section 2853]. Evaluations of proposals are conducted relative to MLPA goals, scientific guidelines, and California Department of Fish and Game (CDFG) feasibility criteria. Potential impacts to commercial and recreational consumptive users are also evaluated.

The MLPA Master Plan Science Advisory Team (SAT),and MLPA Initiative staff evaluate draft MPA proposals for the north central coast study region relative to the science guidelines found in the *California MLPA Master Plan for Marine Protected Areas* (Master Plan) and MLPA goals (goals 1, 2, 3, 4 and 6). The SAT developed the methods to evaluate the potential of the draft proposals to fulfill scientific and ecologically-oriented goals of the MLPA (i.e., goals 1, 2, 3 and 6). MLPA Initiative staff developed the methods used to evaluate the MLPA goal pertaining to improved recreational, educational, and study opportunities (i.e., goal 3). The feasibility criteria established by CDFG for its evaluation are contained in a separate document. All evaluations and analysis are forwarded to the MLPA Blue Ribbon Task Force (BRTF) for its consideration in providing policy guidance to the NCCRSG and California Fish and Game Commission.

This executive summary provides an overview of the elements of the SAT's and Initiative staff's evaluation relative to MLPA goals (Table 1). The full document, *Methods Used to Evaluate Draft MPA Proposals in the North Central Coast Study Region,* provides rationale and greater detail for how the guidelines were developed and made operational in the evaluation process. The full document follows the executive summary.

Table 1. MLPA goals and the evaluation elements relating to each goal

MLPA Goal	SAT Evaluation of Scientific Elements
1. To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.	Habitat representation and protection levels
2. To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.	Size and spacing guidelines; protection levels; and protection to forage, breeding and rearing areas
3. To improve recreational, educational, and study opportunities provided by marine ecosystems that are subjected to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.	Habitat replication; accessibility; impacts to fisheries
4. To protect marine natural heritage, including protection of representative and unique marine life habitats in California.	Habitat representation, replication, and protection levels

5. To ensure that California's MPAs have clearly defined objectives, effective management measures and adequate enforcement and are based on sound scientific guidelines.	No SAT evaluation specific to Goal 5
6. To ensure that the states' MPAs are designed and managed, to the extent possible, as a network.	Size and spacing guidelines

Protection Levels (Goals 1, 2, 4 and 6)

The Marine Life Protection Act (MLPA) identifies three types of marine protected areas (MPA): state marine reserve (SMR), state marine conservation area (SMCA), and state marine park (SMP). There is great variation in the type and magnitude of activities that may be permitted within these MPAs (particularly within SMPs and SMCAs), which influences the degree of protection conferred by these designations. Categorizing MPAs by their relative level of protection simplifies comparisons of the overall conservation value of MPAs within and among MPA proposals and ensures that proposals fulfill the goals of the MLPA.

The MPA types and activities associated with each protection level are presented in Table 2. The SAT assigns to each MPA one of six protection levels, from low to high, depending on the allowed activities proposed.

In assigning MPA protection levels the SAT considers:

- The specificity that proposals provide about allowed uses (e.g. specific fishing methods)
- The depth in which allowed uses could occur (For example, salmon trolling in different depth zones could confer different levels of protection)

MPAs that the SAT determines to have a protection level of moderate-high, high, or very high, were then considered as part of the size and spacing analysis (see below).

Table 2. Level of protection and the activities associated with the levels of protection

	Level of Protection	MPA Types	Activities associated with this protection level
	Very high	SMR	No take
	High	SMCA	salmon (troll H&L in water with bottom depth greater than 50m), sardine, anchovy, and herring (pelagic seine)
	Mod-high	SMCA	salmon (troll H&L in water with bottom depth less than 50m), Dungeness crab (traps/pots), squid (pelagic seine)
	Moderate	SMCA SMP	salmon (non-troll H&L), abalone (diving), halibut, white seabass, shore-based finfish and flatfishes (H&L), clams (hand harvest), giant kelp (hand harvest)
	Low-mod	SMCA SMP	Urchin (diving), lingcod, cabezon, greenling, rockfish, and other reef fish (H&L), surfperches (H&L)
	Low	SMCA SMP	bull kelp and mussels (any method), all trawling, giant kelp (mechanical harvest)

Habitat Representation Analyses (Goals 1 and 4)

California marine habitats are categorized by the MLPA and have been further subdivided by the SAT based on depth categories of 0-30 m, 30-100 m, 100-200 m, and greater than 200 m.

In evaluating habitat representation the SAT considers:

- A habitat to be "present" within an MPA if that MPA contains enough habitat to capture 90% of the local biodiversity (this differs by habitat, see Table 3).
- The degree of habitat representation proposed within each of the 3 defined SAT subregions in the MLPA North Central Coast Study Region (North, South, and Farallons).
- In the north central coast region, habitats deeper than 100m are generally not available and therefore do not need to be represented.

Table 3. The 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	**~0.5 linear miles**	**PISCO Biodiversity**
Shallow Rocky Reefs/Kelp Forests (0-30 M)	**~1 linear miles**	**PISCO Subtidal**
Deep Rocky Reefs (30-100 M)	**~0.1 square miles**	**Starr surveys**
Sandy Habitat (30-100 M)	**~10 square miles**	**NMFS triennial trawl surveys 1977-2007**
Sandy Habitat (0-30 M)	**~1 linear miles**	**Based on shallow rocky reefs**
Sandy Beaches	**~ 1 linear mile**	

Habitat Replication (Goals 3 and 4)

Habitat replication is required by the MLPA Master Plan. The SAT evaluates habitat replication in two ways:

- For Goal 3, habitat replication *within the study region* is summarized. The analysis also provides information on the potential for MPAs to contribute to regional monitoring efforts.
- For Goal 4, habitat replication is expressed *within the biogeographical region (Point Conception to Oregon)* relative to the MLPA Master Plan guidelines of 3-5 replicates per biogeographic region. For the analysis, habitats replicated in the north central coast proposals are summarized with those implemented in the central coast study region.

- Proposals that follow the size and spacing guidelines (see below) automatically result in some habitat replication within the region.

Size and Spacing Analyses (Goals 2 and 6)

Size and spacing guidelines were developed to provide for the persistence of important bottom-dwelling fish and invertebrate groups within MPAs and their dispersal among MPAs and to promote connectivity in the network (Goals 2 and 6).

In evaluating the size of MPAs, the SAT considers:

- Whether MPAs cover an alongshore span of at least 3-6 miles (preferably 6-12 miles) to protect the neighborhood size of adult species, as recommended in science guidelines of the Master Plan
- Whether MPAs extend offshore to deep waters, as recommended in the Master Plan science guidelines. The SAT has determined that MPAs that extend to the state water boundary, three miles offshore, best meet this guidance.

The SAT makes operational the Master Plan guidance above by using a minimum size threshold of 9 square miles (3 miles alongshore and 3 miles offshore) to evaluate MPAs with regard to goals 2 and 6 of the MLPA. (No MPA that is smaller than 9 square miles could meet both the alongshore and onshore-offshore size guidelines mentioned above.)

In evaluating the spacing of MPAs, the SAT considers:

- Whether an MPA has sufficient habitat present (see Table 3 above), is of sufficient size (minimum cluster size of 9 square miles), and has at least moderate-high protection level to count toward the spacing analysis.
- Adjacent MPAs together as a "cluster."
- Whether similar habitats within MPAs are spaced within 31-62 miles of one another, as recommended in the Master Plan science guidelines. The SAT has made operational this guidance by considering the distance between MPAs that contain each of the key habitats. The spacing analysis is done separately for each habitat.

The spacing analysis is conducted separately for each habitat and with a focus on MPAs at three different levels of protection: at least "moderate-high" protection; at least "high" protection; and, finally, only MPAs with "very high" levels of protection. For example, in the "high" level of protection spacing analysis, only MPAs of at least "high" level of protection are considered (i.e. MPAs with "high" and "very high" levels of protection).

Protection of Foraging, Breeding and Rearing Areas (Goal 2)

MPAs can protect birds and mammals by protecting their forage base and by reducing human disturbance to roosting sites, haul-outs, breeding colonies, and rookeries. To evaluate the protection afforded by proposed MPAs to birds and mammals the SAT:

- Identifies proposed MPAs or special closures that contribute to protection of birds and mammals.
- Identifies focal species likely to benefit from MPAs and for which data are available.
- Analyzes the proportion (of total numbers of individuals) of breeding bird/mammal at colonies and rookeries potentially benefiting by proposed MPAs.
- Analyzes the proportion of nearby foraging areas protected by MPAs, defined by evaluating protection of buffered areas around colonies.

Recreational, Education and Study Opportunities (Goal 3)

MLPA Initiative staff evaluate the potential recreational, educational, and study opportunities provided by each MPA proposal in terms of the MPAs' overall accessibility, proximity to educational institutions, inclusion of existing monitoring sites, and consideration of replication in design.

In evaluating the draft proposals Initiative staff considers:

- Access points within and near MPAs, including proximity to boat launches and ports. Proximity to MPAs that allow many uses versus MPAs that allow few uses may have different effects on different users.
- Inclusion of existing monitoring sites and close proximity to research institutions, which may increase study opportunities.
- Replication of habitats within MPAs, which may contribute to increasing research opportunities.

Social Considerations: Recreational and Commercial Fishery Impacts

While fishery impacts are not the focus of the MLPA, they may be considered in designing MPA networks. The evaluation of maximum potential recreational and commercial fishery impacts utilizes region-specific data collected by MLPA contractor, Ecotrust, on areas of importance. Potential impacts to the abalone fishery are based on landings data from CDFG.

To evaluate recreational and commercial fishery impacts, MLPA Initiative staff and contractors:

- Organize impact analyses by port and/or fishery and summarize the impacts by total area or value affected within the study region or in total fishing grounds[1].
- Evaluate the impact of proposed MPAs to abalone index sites and abalone landings

[1] Impact analyses represent a "worst case" scenario where fisherman cannot fish in a different location.

1.0 OVERVIEW

This document provides details of the methods used to evaluate draft MPA proposals generated by members of the North Central Coast Regional Stakeholder Group (NCCRSG) and draft MPA proposals generated external to the NCCRSG. The proposals are being developed through an iterative process to "reexamine and redesign California's MPA system to increase its coherence and its effectiveness at protecting the states marine life habitat, and ecosystems", as mandated by California's Marine Life Protection Act (MLPA) [MLPA Section 2853]. Evaluations of proposals are conducted relative to MLPA goals, scientific guidelines, and California Department of Fish and Game feasibility criteria. Potential impacts to commercial and recreational consumptive users are also evaluated.

2.0 MLPA GOALS AND EVALUATION ELEMENTS

The MLPA Master Plan Science Advisory Team (SAT) and MLPA Initiative staff evaluate draft MPA proposals for the north central coast study region relative to the science guidelines found in the *California MLPA Master Plan for Marine Protected Areas* (Master Plan) and MLPA goals (goals 1, 2, 3, 4 and 6). The SAT developed the methods to evaluate the potential of the draft proposals to fulfill scientific and ecologically-oriented goals of the MLPA (i.e. goals 1, 2, 3 and 6). MLPA Initiative staff developed the methods used to evaluate the MLPA goal pertaining to improved recreational, educational, and study opportunities (i.e., goal 3). The feasibility criteria established by the California Department of Fish and Game (CDFG) for its evaluation are contained in a separate document. All evaluations and analysis are forwarded to the MLPA Blue Ribbon Task Force (BRTF) for its consideration in providing policy guidance to the NCCRSG and California Fish and Game Commission. Table 1 provides an overview of the elements of the evaluation relative to MLPA goals.

Table 1. MLPA goals and the evaluation elements relating to each goal

MLPA Goal	SAT Evaluation of Scientific Elements
1. To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.	Habitat representation and protection levels
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3.0 PROTECTION LEVELS (GOALS 1, 2, 4 AND 6)

Summary of Guidelines: Level of Protection

In assigning MPA protection levels the SAT considers:

- The specificity that proposals provide about allowed uses (e.g. specific fishing methods)
- The depth in which allowed uses could occur (For example, salmon trolling in different depth zones could confer different levels of protection)

Why categorize MPAs by protection levels?
The Marine Life Protection Act (MLPA) identifies three types of marine protected areas (MPA): state marine reserve (SMR), state marine conservation area (SMCA), and state marine park (SMP). There is great variation in the type and magnitude of activities that may be permitted within these MPAs, in particular SMPs and SMCAs. This variety purposely provides designers of MPA proposals with flexibility in designing MPAs that either individually or collectively fulfill the various goals and objectives specified in the MLPA. However, this flexibility can result in a wide range of anticipated protections afforded by any individual MPA or collection of MPAs. In particular, SMCAs allow for many possible combinations of recreational and commercial extractive activities. Therefore, MPA proposals with similar numbers and sizes of SMCAs may in fact differ markedly in the type, degree, and distribution of protection throughout the study region. Thus, the purpose of categorizing MPAs by their relative level of protection is to simplify comparisons of the overall conservation value of MPAs within and among proposed MPA arrays.

Marine Protected Area (MPA) Designations
State marine reserves (SMR) provide the greatest level of protection to species and to ecosystems by prohibiting take of any kind (with the exception of scientific take for research, restoration, or monitoring). The high level of protection created by an SMR is based on the assumption that no other appreciable level of take or alteration of the ecosystem is allowed. In particular, SMRs provide the greatest likelihood of achieving MLPA goals 1, 2, and 4.

State marine parks (SMP) are designed to provide recreational opportunities and therefore can allow some or all types of recreational take of a wide variety of fish and invertebrate species by various means (e.g., hook and line, spear fishing). Because of the variety of species that potentially can be taken and the potential magnitude of recreational fishing pressure, SMPs that allow recreational fishing provide lower protection and conservation value relative to other, more restrictive MPAs (e.g., SMRs and some SMCAs). Although SMPs have lower value for achieving MLPA goals 1 and 2, they may assist in achieving other MLPA goals.

State marine conservation areas (SMCA) potentially have the most variable levels of protection and conservation of the three MPA designations because they may allow any combination of commercial and recreational fishing, as well as other extractive activities (e.g., kelp harvest).

Assigning Levels of Protection

The SAT determines what level of protection is afforded in an MPA that allows a specific activity by examining the impacts that the activity is likely to have on the ecosystems encompassed by the MPA. Those impacts fall into two main categories: (1) direct impacts of the activity, and (2) indirect impacts of the activity on community structure and ecosystem dynamics. In the case of fishing, direct impacts may include habitat disturbance and associated catch of non-target species caused by the fishing gear or method. Indirect impacts may include any change in the ecosystem caused by removal of target and non-target species. In general, removal of species that play an integral role in the food web or perform a key ecosystem function (e.g. biogenic structure) are considered to have impacts on species interactions throughout the ecosystem.

The SAT took several factors into consideration when determining the indirect ecosystem impacts of each type of harvest: 1) target-species interactions with resident species that are likely to be protected by MPAs, and 2) target-species mobility. Ultimately, the question that assisted in the determination was: "would there be a difference between ecosystems within an MPA that prohibits take of this species versus an area outside of the MPA where take is allowed?" For highly mobile species such as salmon, sardines, and anchovies, prohibiting take within an MPA would likely have little impact on local abundance, therefore the ecosystem impacts caused by removing these species are considered to be low.

To consider the catch associated with specific gear types and target species, the SAT examined four sources of data in the analysis: 1) California Recreational Fisheries Survey (CRFS), 2) CDFG landing receipt data, 3) CDFG log book data, and, where adequate scientific information was lacking, 4) input from stakeholders familiar with species or fisheries.

The CRFS data, landing receipt data, and log book data are all limited in their ability to accurately reflect 'bycatch' because information is reported at the trip level. Bycatch, in this document, means fish or other marine life that are taken (both landed and discarded) in a fishery but which are not the target of the fishery. Fishers may switch target species during a trip and retain a mixed species catch but this shift in effort to a different target species is not always reflected accurately by the sampling. For example, a fisher may report a trip as a salmon trip but, at some point, switch fishing effort to target halibut. Both salmon and halibut may have been retained, but at the trip level there is insufficient resolution in the data to determine if those halibut were caught incidentally while fishing for salmon, or were caught cleanly in a separate fishing event on the same trip. Nevertheless, the ecological impacts from that fishing trip include the removal of salmon and any other species that were either retained or discarded. Due to the inability of these data to accurately reflect 'bycatch,' the term 'associated catch' is used in reference to data where it can not be determined if the reported catch was incidental to fishing for the target species. Associated catch is defined in this document as the removal or mortality of species other than the declared target species and includes any organisms that are: 1) captured incidentally in a fishery whether they are discarded (either dead or alive), kept for personal use, or sold; or 2) captured as a secondary target species where it could not be determined if effort shifted to a secondary target species.

The CRFS data used in this analysis may provide a better estimate of associated catch than commercial landing receipt data because it includes both landed and discarded catch. However, the CRFS data used in this analysis only reflect sampled trips, and are not expanded for total effort. These data include both examined catch and catch that was not examined by a sampler but reported by anglers as discarded either dead or alive. Because not all discarded fish were weighed, CRFS data are reported as numbers of fish. Additional CRFS onboard observer data for the study region are also being examined.

Commercial landing receipt data only provide data for species that were landed and brought to market. Discarded catch is not reported on landing receipts and was not available for this analysis. Thus, the commercial landing receipt data are likely to provide a reasonable estimate of associated catch only for marketable species that are legal to retain in conjunction with the primary target species. Again, commercial fishers may switch target species during a trip and report those on a single landing receipt. For each trip in which a given species made up the largest proportion of the catch, those species and all other species reported on the same landing receipts using similar gear are represented as a percent of the landed catch. Ecological impacts may result from removal of all of the species considered here as 'associated catch'.

Log book data from commercial passenger fishing vessels in the study region are being examined. These data report the number of landed and discarded target species as well as incidental catch and, in many cases, the depth where the majority of the catch was taken. However, in some cases it may be possible that a single target species was recorded for a trip where effort shifted to a secondary target species that was not recorded as a target. The data from those trips would be considered 'associated catch' rather than 'bycatch'.

Throughout this analysis, the associated catch for a fishery was only one consideration of the ecological consequences of that activity. As described above, in determining the level of protection to assign to an activity, the SAT considered both direct and indirect impacts, such as habitat disturbance or removal of individuals from the ecosystem, and the consequences those individuals may have on the ecosystem or community dynamics.

Levels of Protection

The levels of protection are presented below. For a MPA that allows multiple activities, the lowest level of protection for any allowed activity is assigned to that MPA.

Very High – no take of any kind allowed. This designation applies only to SMRs.

High – MPAs were assigned this level of protection if the SAT concluded that the allowed fishing activity has a very low associated-catch of resident species, cause minimal habitat damage, and is likely to have little impact on ecosystems in the MPA. The mobility of the target species was an important factor in determining ecosystem impacts. Individuals of highly mobile species are expected to move frequently between MPAs and unprotected waters, so local abundance of these species is unlikely to be enhanced by MPAs. Because the fishing activity is likely to have little impact on populations of target or any other species (low associated

catch), the activity is expected to have little impact on the ecosystem. For example, fishing activities that received a high level of protection include salmon trolling near the surface in deep-water (>50m depth), and pelagic seine fishing for anchovies, sardines, and herring.

Mod-High – Fishing activities assigned to this level of protection cause minimal habitat damage, but have either more associated catch or a greater likelihood of ecosystem impacts than those in the high protection category. For example, MPAs that allow salmon trolling in waters shallower than 50m depth were assigned to this level of protection because: 1) The likelihood of increased associated catch of resident benthic species such as rockfish is higher; and 2) there is a potential impact to the MPA ecosystem if a pelagic predator is removed at this depth[1]. Similarly, MPAs that allow crab fishing with traps/pots were assigned this level of protection because crabs are only moderately mobile and interact directly with the resident ecosystem. It is difficult to predict whether local populations of crabs will be affected by MPAs, but if they are, a reduction in the crab population in fished areas could have ecosystem-wide impacts.

Moderate – Fishing activities assigned to this level of protection have higher associated catches of resident species or a greater likelihood of ecosystem impacts than those assigned to the mod-high category. Examples of fishing activities that received a moderate level of protection include hook and line fishing for halibut and other flatfish, diving for abalone, shore-based fishing with hook and line gear in larger MPAs, and hand harvest of giant kelp.[2]

Low-mod – Fishing activities assigned to this level of protection either directly target resident species, have significant associated catch of resident species, or target species whose removal is expected to have an impact on the resident ecosystem. Examples of fishing activities that received a low-mod level of protection include harvest of urchin, lingcod, cabezon, greenling, rockfish, and surfperches.

Low – Only fishing activities that cause habitat destruction were assigned to this category. Harvest of bull kelp, mussels, and other habitat-forming organisms received a low level of protection, as did trawl fishing and mechanical harvest of giant kelp.

Table 2. Level of protection and the activities associated with the level of protection

	Level of Protection	MPA Types	Activities Associated with this Protection Level
	Very high	SMR	No take
	High	SMCA	salmon (troll H&L in water with bottom depth greater than 50m), sardine, anchovy, and herring (pelagic seine)
	Mod-high	SMCA	salmon (troll H&L in water with bottom depth less than 50m), Dungeness crab (traps/pots), squid (pelagic seine)

[2] Benthic-pelagic linkages in MPA design: a workshop to explore the application of science to vertical zoning approaches. November 2005. Sponsored by NOAA National Marine Protected Area Center, Science Institute, Monterey, CA.

	Moderate	SMCA SMP	salmon (non-troll H&L), abalone (diving), halibut, white seabass, shore-based finfish and flatfishes (H&L), clams (hand harvest), giant kelp (hand harvest)
	Low-mod	SMCA SMP	Urchin (diving), lingcod, cabezon, greenling, rockfish, and other reef fish (H&L), surfperches (H&L)
	Low	SMCA SMP	bull kelp and mussels (any method), all trawling, giant kelp (mechanical harvest)

Coastal MPAs are most effective at protecting species with limited range of movement and close associations to seafloor habitats. Less protection is afforded to more wide-ranging, transient species like salmon and other coastal pelagics (e.g., albacore, swordfish, pelagic sharks). This has led to proposals of SMCAs that prohibit take of bottom-dwelling species, while allowing the take of transient pelagic species. However, fishing for some pelagic species, (like salmon) near the sea floor or over rocky substrate in relatively shallow water, may increase the likelihood of inadvertently catching bottom species that are intended for protection within the MPA (e.g., lingcod, cabezon, rockfishes). Although depth- and habitat-related associated catch information for specific fisheries are not readily available, it is likely that associated catch is highest in shallow water where bottom fish move close to the surface and become susceptible to the fishing gear. In addition, for recreational salmon fishing, the practice of "mooching" has a higher potential for associated catch than that of trolling.

Participants at a national conference[3] on benthic-pelagic coupling considered the nature and magnitude of interactions among benthic (bottom-dwelling) and pelagic species, and the implications of these interactions for the design of marine protected areas. At this meeting, scientists, managers and recreational fishing representatives concluded that bycatch is higher in depths where seafloor is <50m (164 ft) and is lower in depths where seafloor is >50m. This information, along with associated-catch information provided by CDFG, contributed to SAT categorization of MPAs into six possible levels of protection.

Salmon trolling:

Direct impacts – salmon trolling causes little or no direct habitat damage as gear rarely touches the seafloor. Data on associated catch are available from CDFG for both recreational and commercial fisheries (Table 3). However, these data are not depth-specific and the recreational data do not distinguish trolling from mooching. In addition to these data, NOAA's National MPA Center convened an expert workshop of fisheries biologists, marine ecologists, MPA managers and recreational fishermen at the MPA Science Institute in November 2005 in Monterey, California. This workgroup concluded that shallow troll gear in deep water (seafloor >50m) is sufficiently far from the seafloor that there is little or no bycatch of resident benthic species. In shallower water (seafloor <50m), however, the work group concluded that bycatch of resident species (e.g., rockfish species and lingcod)

[3] Benthic-pelagic linkages in MPA design: a workshop to explore the application of science to vertical zoning approaches. November 2005. Sponsored by NOAA National Marine Protected Area Center, Science Institute, Monterey, CA.

increases. The SAT is examining the additional log book data with respect to the 50m depth guideline and has received additional input from RSG members indicating that incidental take of resident species is related to several variables, including water depth, habitat (rock versus sand), trolling speed, trolling depth and bait. Thus, the 50 m isobath may be adjusted with consideration of bottom habitat (i.e. proximity to rocky habitat).

Indirect impacts – Salmon generally feed on mobile forage species such as herring, sardines, anchovies, krill, squid, and smelt (REFERENCE). As both salmon and their prey are highly mobile, MPAs are likely to have little impact on the local abundance of these species. Thus, the indirect ecosystem impacts of salmon take are predicted to be low.

Level of protection:

High – if water depth in MPA is greater than 50m, and Mod-high – if water depth in MPA is within bottom depth of less than 50m due to potential increase in associated catch of resident species

Table 3. Associated catch estimates for salmon fisheries (Note: CRFS observer data, log book data, and updated commercial landing receipt data are being examined and will be included in future updates to this document)

Caught on recreational trips targeting salmon w/ H&L (2000-2007)*	# of fish	% of Fish caught
salmon	**53,228**	**94.96%**
rockfish	1,584	2.83%
other (<1% of catch)	1,240	2.21%
Total	56,052	

Caught on commercial trips targeting salmon w/ troll H&L gear (2000-2006)**	lbs of fish	% of Fish wt caught
salmon	**2,605,461**	**99.58%**
other (<1% of catch)	10,994	0.42%
Total	2,616,455	

Caught on commercial trips targeting salmon w/ non-troll H&L gear (2000-2006)**	lbs of fish	% of Fish wt caught
salmon	**37,053**	**71.29%**
halibut	10,810	20.80%
rockfish	1,710	3.29%
reef spp.	1,197	2.30%
pelagic spp.	865	1.66%
other (<1% of catch)	342	0.66%
Total	51,977	

* Recreational data are from CRFS surveys and include ocean only catches for all of the Wine and San Francisco districts. The Wine district includes portions of Mendocino County outside of the study region but does not include Tomales Bay.
** Associated catch data for commercial fisheries includes data from the study region only for blocks that are contained within or intersect the state waters. Additionally these data include landed fish only and do not include any discarded catch.

Salmon mooching (non-troll H&L):

Direct impacts – Salmon mooching gear can have contact with the bottom, but likely causes little habitat damage. Based on the slower speed that gear or bait travels through the water, there may be greater bycatch of benthic species including rockfish and lingcod which are likely to otherwise be protected by MPAs. Commercial catch data show that more than 20% of the fish landed on non-troll salmon trips are halibut. This likely reflects a switch in target species, not true bycatch. However, it is impossible to determine the true magnitude and composition of the incidental catch. Nevertheless, this indicates that on trips where salmon are commercially caught using non-trolling hook and line gear more than 20% of the catch associated with those trips and landed were not salmon.

Indirect impacts – Salmon generally feed on mobile forage species such as herring, sardines, anchovies, krill, squid, and smelt. As both salmon and their prey are highly mobile, MPAs are likely to have little impact on the local abundance of these species. Thus, the indirect ecosystem impacts of salmon take are predicted to be low.

Level of protection:

Moderate – due to associated catch

Abalone hand collection:

Direct impacts –Because divers harvest selectively, there is little or no catch of non-target species. However, divers sometimes accidentally remove sub-legal size individuals, which may kill the animal even though it is often immediately replaced. High numbers of divers at local access sites can lead to localized habitat impacts (REFERENCE) and behavioral responses of mobile species.

Indirect impacts – Abalone are important herbivores that feed in the nearshore rocky environment, therefore removal of this species is likely to have impacts on community structure within an MPA. Although abalone have deep water refugia generally beyond free-diving depths, localized depletion of shallow adult spawning stocks within an MPA, combined with short larval dispersal distances, could reduce the local availability of young abalone as prey to small predators.

Level of protection:

Moderate – due to indirect ecosystem effects

Urchin hand collection:

Direct impacts – Hand collection of urchins causes some habitat disturbance (anchoring, which can disturb both rock and kelp as habitat). Because divers harvest selectively, there is little or no catch of non-target species.

Indirect impacts – Urchins are important herbivores and prey in the nearshore rocky environment, therefore removal of this species is likely to have impacts on community structure within an MPA. Throughout their range, urchin populations can impact (decrease) kelp abundance, thereby altering the relative abundance of macroalgae in a kelp forest. Young abalone seek shelter beneath the spines of sea urchins and the density of abalone recruits can be greater in northern California MPAs where urchins are protected from take (Rogers-Bennet and Pearse 2001)[4]. Although it is possible that urchin harvest could have the effect of increasing kelp forest habitat and the species associated with this habitat, it is also possible that altering the abundance of this important benthic species could have other unforeseen consequences for nearshore ecosystems. Regardless of whether ecosystem impacts caused by urchin harvest are perceived as good or bad, it is likely that changes in urchin abundance will have ecosystem-wide consequences.

Level of protection:
Low-mod – due to indirect ecosystem effects

Clam hand digging:

Direct impacts – Clam digging causes significant disturbance to soft-bottom intertidal habitats and may also alter the behavior of local shorebirds and marine mammals. There are impacts associated with this activity as excavation may kill non-target infaunal species, and improperly placed sublegal clams. The depth distribution extends beyond depths at which hand digging is feasible, thereby restricting the proportion of the population harvested.

Indirect impacts – clams are important filter-feeders in the nearshore soft-bottom ecosystem and prey for sharks, skates and rays, therefore removal of this species is likely to have impacts on community structure within an MPA.

Level of protection:
Moderate – due to habitat disturbance and impacts to non-target species

Halibut hook and line:

Direct impacts – Halibut fishing with hook and line gear (including long-lines) involves bottom contact but causes little habitat disturbance. Associated catch includes demersal sharks, skates and rays, other flatfish, and a variety of reef fish including rockfish, lingcod, and cabezon that would otherwise be protected by MPAs (Table 4). In the recreational fishery, 29% of reported catch on halibut trips was composed of non-target species, but it is possible that this high associated catch rate reflects switching of target species within a trip.

[4] Rogers-Bennett, L. and J.S. Pearse. 2001**.** Indirect Benefits of Marine Protected Areas for Juvenile Abalone. Conservation Biolology. 15(3):642-7.

In the commercial fishery, roughly 5% of species landed on halibut trips were non-target species. There is no information available on discarded commercial catch.

Indirect impacts – California halibut are an important predator in the coastal ecosystem, feeding on a variety of schooling fish and benthic organisms (REFERENCE). A change in local abundance of halibut may have impacts on communities within MPAs, however, the movement patterns of halibut are not fully understood. Several studies indicate that young (mostly sub-legal sized) California halibut are only moderately mobile and most stay within 2-5 km of their tagging release site for months or years although some move hundreds of km within that same time period.[5,6] There is also information to suggest that larger halibut may be more mobile than small and anecdotal reports from fishermen indicate that California halibut in the study region engage in seasonal migration. Given available information on halibut movement it is unclear whether local populations and their effect on ecosystems within an MPA will change due to protection by the size of MPAs proposed in this process.

Level of protection:

Moderate – due to associated catch and the importance of halibut as a top predator

Table 4. Associated catch estimates for halibut fisheries

Caught on recreational* trips targeting halibut w/ H&L (2000-2007)	# of fish	% of Fish caught
halibut	**7,888**	**70.63%**
demersal sharks, skates & rays	1,209	10.83%
pelagics wetfish	514	4.60%
freshwater or estuarine spp.	513	4.59%
rockfish	388	3.47%
surfperch	318	2.85%
reef spp.	185	1.66%
other (<1% of catch)	152	1.36%
Total	11,168	

Caught on commercial trips targeting halibut w/ H&L gear (2000-2006)**	lbs of fish	% of Fish wt caught
halibut	**399,356**	**94.77%**
reef spp.	7,923	1.88%
salmon	5,488	1.30%

[5] Domeier, M. L., C.S. Chun (1995). "A tagging study of the California halibut (Paralichthys californicus)." CalCOFI Rep. **36**: 204-207.

[6] Posner, M., R.J. Lavenberg (1999). "Movement of California halibut along the coast of California." California Fish and Game **85**(2): 45-55.

rockfish	3,639	0.86%
other (<1% of catch)	4,996	1.19%
Total	421,402	

* Recreational data are from CRFS surveys and include ocean only catches for all of the Wine and San Francisco districts. The Wine district includes portions of Mendocino County outside of the study region but does not include Tomales Bay.

** Associated catch data for commercial halibut with H&L gear includes data from the study region only for blocks that are contained within or intersect the state waters. Additionally these data include landed fish only and do not include any discarded catch.

Halibut trawl:

Direct impacts – Bottom trawling for halibut causes significant habitat disturbance and is associated with catch of a variety of species including other flatfishes and rockfish (Table 5). The SAT notes that there is currently no trawling allowed in state waters.

Indirect impacts – California halibut are an important predator in the coastal ecosystem, feeding on a variety of schooling fish and benthic organisms (REFERENCE). A change in local abundance of halibut may have impacts on communities within MPAs, however, the movement patterns of halibut are not fully understood. Several studies indicate that young (mostly sub-legal sized) California halibut are only moderately mobile and most stay within 2-5 km of their tagging release site for months or years although some move hundreds of km within that same time period.[7,8] There is also information to suggest that larger halibut may be more mobile than small and anecdotal reports from fishermen indicate that California halibut in the study region engage in seasonal migration. Given available information on halibut movement it is unclear whether local populations and their effect on ecosystems within an MPA will change due to protection by the size of MPAs proposed in this process.

Halibut are an important predator in the coastal ecosystem, feeding on a variety of schooling fish and benthic organisms. A change in local abundance of halibut may have impacts on communities within MPAs, however, the movement patterns of halibut are not fully understood. Several studies indicate that young (mostly sub-legal sized) halibut are only moderately mobile and most stay within 2-5 km of their tagging release site for months or years, although some individuals move hundreds of km within that same time period[9,10]. There is also information to suggest that larger halibut may be more mobile than small and

[7] Domeier, M. L., C.S. Chun (1995). "A tagging study of the California halibut (*Paralichthys californicus*)." CalCOFI Rep. **36**: 204-207.

[8] Posner, M., R.J. Lavenberg (1999). "Movement of California halibut along the coast of California." California Fish and Game **85**(2): 45-55.

[9] Domeier, M. L., C.S. Chun (1995). "A tagging study of the California halibut (Paralichthys californicus)." CalCOFI Rep. **36**: 204-207.

[10] Posner, M., R.J. Lavenberg (1999). "Movement of California halibut along the coast of California." California Fish and Game **85**(2): 45-55.

anecdotal reports from fishermen indicate that halibut in the study region engage in seasonal migration. Given available information on halibut movement it is unclear whether local populations will change as a result of the protection afforded by MPAs of the size proposed in this process.

Level of protection:
Low

Table 5. Associated catch estimates for halibut trawling

Caught on commercial* trips targeting halibut w/ trawl gear (2000-2006)	lbs of fish	% of Fish wt caught
halibut	**456,419**	**61.24%**
other flatfish	248,130	33.29%
demersal sharks, skates and rays	19,631	2.63%
rockfish	11,523	1.55%
reef spp.	5,803	0.78%
other (<1% of catch)	3,807	0.51%
Total	745,311	

** Associated catch data for commercial halibut with trawl gear includes portions of the blocks intersecting the study region that lie outside state waters. Additionally these data include landed fish only and do not include any discarded catch.

Crab traps:

Direct impacts – Crab traps contact the bottom but cause only minor habitat disturbance. Catch associated with Dungeness crab trapping includes rock crabs, octopus, sea stars, and female Dungeness crabs in low numbers (Table 6). Although infrequent, sea otters have been known to become entangled in traps of various kinds including crab traps[11,12]; a leatherback sea turtle was entangled and drowned at Point Reyes in 1996 (Pers. Comm., Sarah Allen); and a humpback whale was entangled in multiple trap lines outside of San Francisco Bay in 2005 (Pers. Comm., Sarah Allen).The effect of a spatial closure on the abundance [catch per unit effort (CPUE)] and size distribution of Dungeness crabs was determined at the mouth of the Glacier Bay National Park fishing closure (Taggart et al 2004[13]). Both the abundance (CPUE) and size of legal-sized male crabs increased relative to that within the Park prior to closure and outside the Park after the closure. Sample sites were located 15-20 km outside of, and 10-20 km inside of, the closure boundary (at the mouth of Glacier Bay).

[11] Newby, T. C. 1975. "A sea otter (*Enhydra lutris*) food dive record". Murrelet 56:19.
[12] Richardson, S. and Allen, H. 2000. "Draft Washington state recovery plan for the sea otter." Washington Department of Fish and Wildlife, Olympia, Washington. 67pp.
[13] Taggart, S. J., T. C. Shirley, C.E. O'Clair and J. Mondragon. 2004. Dramatic increases in the relative abundance of large male Dungeness crabs, Cancer magister, following closure of commercial fishing in Glacier Bay, Alaska. Amer. Fish. Soc. Symp. 42:243-253.

Indirect impacts – Dungeness crabs are key predators in the benthic environment and their abundant larvae provide food for a variety of pelagic species. A significant reduction in Dungeness crab populations could have ecosystem-wide impacts, however, crabs show moderate mobility (10-15 km)[14] and it is unclear whether protection through MPAs of the sizes proposed would have an effect on local populations.

Level of protection:
Mod-high - due to ecosystem impacts

Table 6. Associated catch estimates for the crab fishery

Caught on commercial trips targeting crab with traps/pots (2000-2006)**	lbs of fish	% of Fish wt caught
Dungeness	**5,654,239**	**99.66%**
other crab	14,580	0.26%
octopus	2,780	0.05%
other (<0.1% of catch)	1,910	0.03%
Total	5,673,510	

** Associated catch data for commercial crab trapping includes only data from the study region for blocks that are contained within or intersect the state waters. Additionally these data include landed fish only and do not include any discarded catch.

White seabass:

Direct impacts – fishing for white seabass with hook and line gear causes little or no direct habitat damage as gear rarely touches the seafloor. White seabass have not been regularly declared as a fishing target in the study region over the past 7 years, so it was impossible to assess associated catch specific to this study region. An analysis of recreational catch information (Table 7) for white seabass state-wide indicates that a wide variety of reef species including rockfish, kelp bass, and lingcod are regularly caught on trips targeting white seabass. In fact, 77% of the catch on trips targeting white seabass was of non-target species, mostly kelp bass (in southern California), which are not abundant in the study region. Moreover, it is not clear that these other species are incidental catch, but instead may be targeted when seabass catch is poor. Thus, information on overall associated catch, especially in northern California, is poor.

Indirect impacts – tagging studies of white seabass in the Santa Barbara Channel Islands indicate the species is highly mobile (Dr. James Lindholm, pers. comm. and unpublished data). White seabass mainly feed on highly mobile coastal pelagics such as herring, anchovies, and squid, thus they are likely to have a low impact on the resident benthic ecosystem.

[14] Smith, B. D., G.S. Jamieson (1991). "Movement, spatial distribution, and mortality of male and female dungeness crab Cancer magister near Tofino, British Columbia." Fishery Bulletin **89**(1): 137-148.

Level of protection:
Moderate - due to catch associated with fishing for white seabass

Table 7. Associated catch estimates for the white seabass fishery

Caught on recreational* trips targeting white seabass w/ H&L (2000-2007, all California)	# of fish	% of Fish caught
reef spp.	1,716	41.48%
white seabass	**1,377**	**33.28%**
rockfish	238	5.75%
pelagic spp.	232	5.61%
shallow sand and kelp spp.	176	4.25%
demersal sharks, skates & rays	117	2.83%
halibut	110	2.66%
pelagics wetfish	108	2.61%
other (<1% of catch)	63	1.52%
Total	4,137	

* Recreational data are from CRFS surveys and include ocean only catches for all of the Wine and San Francisco districts. The Wine district includes portions of Mendocino County outside of the study region but does not include Tomales Bay.

Sardine, Anchovy, and Herring (pelagic seine gear):

Direct impacts – fishing for wetfish (coastal pelagics) with pelagic seine gear causes little or no direct habitat damage as gear never touches the seafloor. Landings of non-target species are low and comprised almost entirely of other highly-mobile schooling fish (Table 8), therefore the direct impacts of the fishing activity on the resident ecosystem are expected to be low.

Indirect impacts – Sardines, anchovies, and herring feed on a variety of planktonic organisms. As these schooling species and their prey are highly mobile, MPAs are likely to have little impact on the local abundance of these species. Thus, the indirect ecosystem impacts of wetfish take are predicted to be low.

Level of protection:
High

Table 8. Associated catch estimates for the wetfish pelagic seine fishery

Caught on Commercial trips targeting sardine (2000-2006)**	lbs of fish	% of Fish wt caught
sardine	**1,938,608**	**96.63%**
anchovy	66,300	3.30%
other wetfish	1,300	0.06%
Total	2,006,208	

Caught on Commercial trips targeting anchovy (2000-2006)**	lbs of fish	% of Fish wt caught
anchovy	**327,500**	**88.92%**
sardine	40,800	11.08%
Total	368,300	

** Associated catch data for commercial wetfish includes only data from the study region for blocks that are contained within or intersect the state waters. Additionally these data include landed fish only and do not include any discarded catch.

Squid (pelagic seine gear):

Direct impacts – fishing for squid with pelagic seine gear causes little or no direct habitat damage as gear never touches the seafloor. Landings of non-target species are low and comprised almost entirely of other highly-mobile schooling fish (Table 9), thus the direct impacts of the fishing activity on the resident ecosystem are expected to be low.

Indirect impacts – Although squid are a highly mobile pelagic species (like other wetfish) they form spawning aggregations and deposit large numbers of eggs near the bottom. Because of the importance of spawning squid and their eggs as prey in the nearshore ecosystem, the abundance of squid may have indirect ecosystem impacts on resident species.

Level of protection:
Mod-high

Table 9. Associated catch estimates for the squid pelagic seine fishery

Caught on Commercial* trips targeting market squid (2000-2006)	lbs of fish	% of Fish wt caught
market squid	**18,561,205.00**	**100.00%**
other wetfish	10.00	0.00%
Total	18,561,215.00	

** Associated catch data for market squid includes only data from the study region for blocks that are contained within or intersect the state waters. Additionally these data include landed fish only and do not include any discarded catch.

Shorefishing:

The ecological consequence of removing fish from shallow (< 10 m depth) waters from the shoreline depends on habitat type (sandy versus rocky bottom), the species associated with these habitats, their ecological roles, their relative range of movement alongshore and across depth ranges, and how many of each of those species are removed by shore fishing. The most commonly taken fish species taken by recreational anglers from the sandy shore include approximately 6 species of surfperches, 3 species of croakers, 2 species of sculpin, 7-9 species of flatfishes, 8 species of sharks, 7-9 species of skates and rays, stripped bass, and

sturgeon (Table Xa, CRFS database). All of these species move from shallower to deeper depths and back with the possible exception of barred, calico, and redtail surfperches, whose range may be more limited to the sandy surf zone (M. Love pers. comm.). The most commonly taken fish species taken by recreational anglers from the rocky shore include approximately 9 species of perches, 17 species of rockfishes, 6 species of sculpins, 4 species of greenling, 5 species of gunnels and pricklebacks, and the monkeyface and wolf eels (Table Xb, CRFS database). The horizontal range of movement of most of these rocky reef-associated species is limited and summarized in the MPA size guidelines section. The depth range of movement for most of these species ranges from shallows (5-10 m depth) to 30 m depth. Thus, extraction of reef-associated species from shallow waters likely influences species abundance on contiguous deeper rocky reefs to depths of 20-30 m. For some species mentioned above, effects of extraction from sandy beach surf zones may be limited to that habitat, whereas effects on many others are likely to extend into adjacent deeper (less than 30 m depth) sand habitat offshore (M. Love pers. comm.). Based on the potential level of fishing effort by an unrestricted recreational fishery and the diversity of species extracted by shore fishing from a proposed MPA, the SAT recommends a level of protection of (moderate or low).

Mariculture activities:
The SAT is considering direct and indirect impacts of various mariculture activities on habitats within MPAs.

Herring roe fishery:
The SAT is considering direct and indirect impacts of the herring roe fishery (specifically in Tomales bay) on habitats within MPAs.

4.0 HABITAT REPRESENTATION ANALYSES (GOALS 1, 2, 3, 4 AND 6)

Summary of Guidelines: Habitat Representation Analyses

In evaluating habitat representation the SAT considers:

- A habitat to be "present" within an MPA if that MPA contains enough habitat to capture 90% of the local biodiversity (this differs by habitat, see Table 3).
- The degree of habitat representation proposed within each of th 3 defined SAT subregions in the North Central Coast Study Region (North, South, and Farallons).
- In the north central coast region, habitats deeper than 100m are generally not available and therefore do not need to be represented.

Habitat Replication Analyses

Habitat replication is required by the Master Plan. The SAT evaluates habitat replication in two ways:

- For Goal 3, habitat replication *within the study region* is summarized. The analysis also provides information on the potential for MPAs to contribute to regional monitoring efforts.
- For Goal 4, habitat replication is expressed *within the biogeographical region (Point Conception to Oregon)* relative to the Master Plan guidelines of 3-5 replicates per biogeographic region. For the analysis, habitats replicated in the north central coast proposals are summarized with those implemented in the central coast study region.
- Proposals that follow the size and spacing guidelines (see below) automatically result in some habitat replication within the region.

MPA networks should include ‘key’ marine habitats and each of these habitats should be represented in multiple MPAs across biogeographical regions, upwelling cells, and environmental and geographical gradients. ‘Key’ marine habitats should be replicated in multiple MPAs with 3-5 MPAs containing each habitat type in the biogeographic region.

Habitats identified in the Master Plan and that exist in the study region include: sand beach, rocky intertidal, estuary, shallow sand, deep sand, shallow rock, deep rock, kelp, and seagrass beds. The SAT also acknowledged three distinct biogeographical subregions within the north central coast study region. These are identified by oceanographic features, geomorphology and differing species compositions. The following three subregions were identified for evaluation purposes:

- Alder Creek to North Beach road at Point Reyes Headlands
- North Beach Road at Point Reyes Headlands to Pigeon Point
- The state waters around the Farallon Islands.

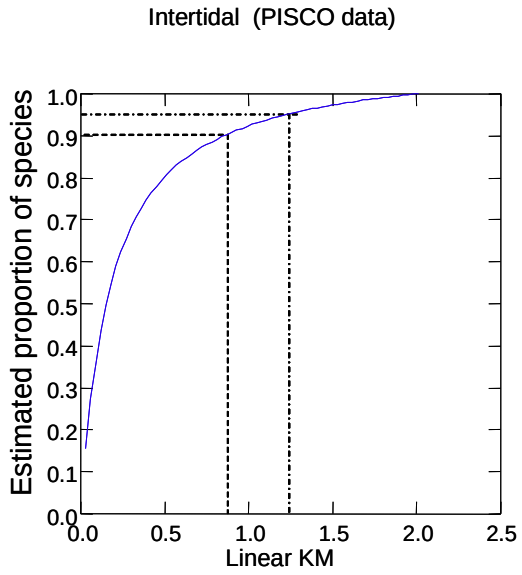
Habitat availability is assessed for each subregion as well as the entire study region. This provides the relative amount of available habitat in the study region and in each subregion as

area or linear measurements. Habitats with linear measurements include sandy or gravel beaches, rocky intertidal, coastal marsh, tidal flats, and surfgrass. In addition, MPAs in each proposal are assessed for eight habitats: hardbottom substrate 0-30m, hardbottom substrate 30-100m, softbottom substrate 0-30m, softbottom substrate 30-100m, kelp, estuary, sandy beach, and rocky shores. For each MPA proposal the percent of available habitat by subregion is determined in reference to the level of protection. In other words, the percent of habitat in a subregion that is covered by a specific level of protection is assessed.

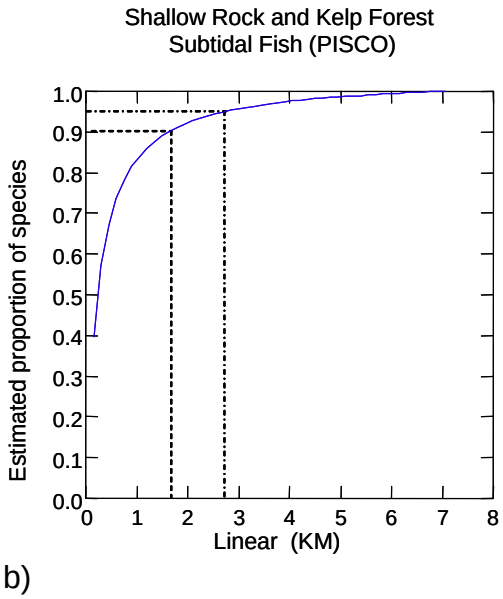
Guidance in the Master Plan requires that habitat be replicated in 3-5 MPAs in the biogeographic region. However, spacing guidelines may require greater replication of habitats. Benefits of MPAs are largely dependent on the habitat contained in them. An MPA that does not contain appropriate habitat for a particular species (e.g., kelp forest) provides no benefit to that species.

The SAT considered a MPA to include a specific habitat if the MPA encompassed a critical aerial extent of the habitat. This critical area was defined as an area sufficient to (1) encompass a high proportion of the species known to use the habitat (90%, see table 8) and, (2) sufficient abundance of such species to be resilient to movement and environmental perturbation. To determine the estimated area of habitat needed, the SAT examined biological survey data from a variety of habitat types present in the study region or from other areas in central California. Using a re-sampling procedure and accumulation functions (including Michaelis-Menton) the SAT estimated the amount of area needed to encompass 90% of the biodiversity of each habitat (see figures 1 and 2). Table 10 indicates that value for six habitat types.

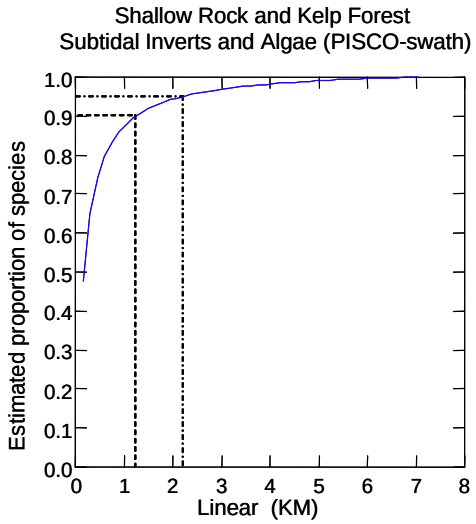
Figure 1. Estimated proportion of species per area of habitat



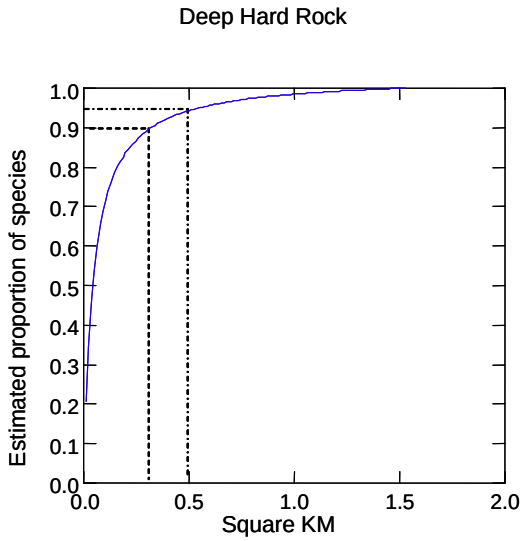
a)



b)


Shallow Rock and Kelp Forest
Subtidal Inverts and Algae (PISCO-swath)
Estimated proportion of species
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
8
Linear (KM)

c)


Deep Hard Rock
Estimated proportion of species
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
Square KM

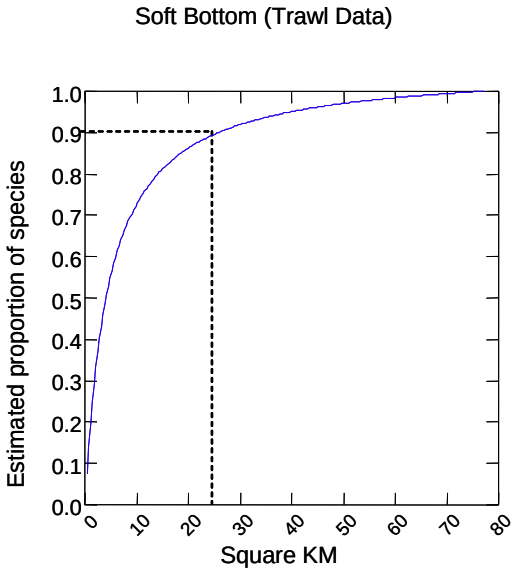
d)

Table 10. 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	**~0.5 linear miles**	**PISCO Biodiversity**
Shallow Rocky Reefs/Kelp Forests (0-30 M)	**~1 linear miles**	**PISCO Subtidal**
Deep Rocky Reefs (30-100 M)	**~0.1 square miles**	**Starr surveys**
Sandy Habitat (30-100 M)	**~10 square miles**	**NMFS triennial trawl surveys 1977-2007**
Sandy Habitat (0-30 M)	**~1 linear miles**	**Based on shallow rocky reefs**
Sandy Beaches	**~ 1 linear mile**	

For kelp, shallow sandy and shallow rocky habitats, protection of habitat must extend from shore to the 30 m contour. Survey data from the soft bottom (30-100m) habitat type indicates that a large area would need to be protected to ensure representative biodiversity (see figure 2 below). This may be a result of fishing pressure that reduces the abundance of species in this habitat however, it was impossible to assess the magnitude of the effect. A review of the depth distribution of soft-bottom fishes indicates that most fish that use the 30-100m depth range extend their distribution into shallower (0-30m) waters as well. Therefore, the area of soft 0-30, and 30-100 meter habitat was combined and this combined area was used to assess the % of biodiversity encompassed by a given MPA.

Figure 2. Estimated proportion of species per sq km of soft bottom habitat



There were several representative habitat types for which survey data was unavailable. The presence of these habitats in a given MPA was assessed as follows:

Soft bottom (0-30m) – 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 % of biodiversity was assessed using the area/biodiversity relationship derived from 0-30m rocky reefs (1.0 linear mi = 90% biodiversity). To be considered present this habitat must also extend to the 30 m contour.

Sandy beaches – no data were available to make a scientific assessment of the relationship between beach length and biodiversity. The SAT considered sandy beach habitat present if there was at least 1 mile of sandy beach in a given MPA.

Kelp – the aerial images used by CDFG to estimate kelp coverage do not reliably capture presence of the dominant kelp species in the 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 (0-30m), so adequate protection of shallow rock habitat should ensure protection of kelp even where it does not appear on the maps. In the places where kelp does appear on CDFG maps, the SAT calculated the linear extent of the kelp beds and assessed the % biodiversity using the area/biodiversity relationship derived from 0-30m rocky reefs (1.0 linear mi = 90% biodiversity) to determine whether kelp habitat was present in a given MPA. To be considered present this habitat must also extend to the 30 m depth contour.

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 (0.5 linear mi = 90% biodiversity)

Non-representative (mainly estuarine) habitats were not assessed for presence absence as their distribution does not lend itself to spacing assessments.

For the upwelling center habitat category, the SAT counted all MPAs that included shallow and moderate depth habitats in the vicinity of the major upwelling centers of the north central coast – Point Arena and Point Reyes.

5.0 SIZE AND SPACING (GOALS 2 AND 6)

Summary of Guidelines: Size and Spacing Analyses

Size and spacing guidelines were developed to provide for the persistence of important bottom-dwelling fish and invertebrate groups within MPAs and their dispersal among MPAs and to promote connectivity in the network (Goals 2 and 6).

In evaluating the size of MPAs, the SAT considers:

- Whether MPAs cover an alongshore span of at least 3-6 miles (preferably 6-12 miles) to protect the neighborhood size of adult species, as recommended in science guidelines of the Master Plan
- Whether MPAs extend offshore to deep waters, as recommended in the Master Plan science guidelines. The SAT has determined that MPAs that extend to the state water boundary, three miles offshore, best meet this guidance.

The SAT makes operational the Master Plan guidance above by using a minimum size threshold of 9 square miles (3 miles alongshore and 3 miles offshore) to evaluate MPAs with regard to goals 2 and 6 of the MLPA. (No MPA that is smaller than 9 square miles could meet both the alongshore and onshore-offshore size guidelines mentioned above.)

In evaluating the spacing of MPAs, the SAT considers:

- Whether an MPA has sufficient habitat present (see Table 3 above), is of sufficient size (minimum cluster size of 9 square miles), and has at least moderate-high protection level to count toward the spacing analysis.
- Adjacent MPAs together as a "cluster."
- Whether similar habitats within MPAs are spaced within 31-62 miles of one another, as recommended in the Master Plan science guidelines. The SAT has made operational this guidance by considering the distance between MPAs that contain each of the key habitats. The spacing analysis is done separately for each habitat.

The spacing analysis is conducted separately for each habitat and with a focus on MPAs at three different levels of protection: at least "moderate-high" protection; at least "high" protection; and, finally, only MPAs with "very high" levels of protection. For example, in the "high" level of protection spacing analysis, only MPAs of at least "high" level of protection are considered (i.e. MPAs with "high" and "very high" levels of protection).

Guidance on spacing found in the Master Plan states:

- “For an objective of facilitating dispersal of important bottom-dwelling fish and invertebrate groups among MPAs, based on currently known scales of larval dispersal, MPAs should be placed within 50-100 km (31- 62 mi or 27- 54 nm) of each other.”

This guideline arises from a number of studies that examine the persistence of marine populations with a network of marine reserves[15,16,17] and its connection to larval dispersal. The spacing distances arise from a number of recent syntheses of data on larval dispersal in marine fish, invertebrates and seaweeds[18,19,20] and advances in modeling of larval transport (e.g., Siegel et al. 2003[21], Cowen et al. 2006[22]). As with adult movement, scales of larval movement vary enormously among species (meters to 100s of km). In contrast to adult movement, however, it is the short distance dispersers that pose the biggest challenge for connections between MPAs.

Since the spacing guidelines are targeted at ensuring connectivity among MPAs for different species, MPAs must be characterized by the habitats they contain. Thus, the spacing analysis must be based on the minimum amount of habitat contained in an MPA as described above. For each habitat the spacing analysis was conducted by measuring the distance between habitats in MPA "clusters", or group of MPAs, that meet the minimum SAT size guidelines (see below). Additionally, the spacing analysis was conducted for the three highest levels of protection, very high, high, and moderately high. Thus, in order for an MPA cluster to be counted for spacing for any given habitat at a given protection level, three criteria need to be fulfilled:

1. The habitat must be considered "present" in the cluster (see below for detail).
2. The cluster must be of at least minimum SAT recommended size (9 sq mi).
3. All parts of the cluster must meet the desired SAT protection level (moderate-high, high, or very high).

[15] Botsford, L.W., Hastings, A., and Gaines, S.D. 2001. Dependence of sustainability on the configuration of marine reserves and larval dispersal distance. Ecology Letters 4: 144-150.

[16] Gaines, S. D., B. Gaylord, and J. Largier. 2003. Avoiding current oversights in marine reserve design. Ecological Applications. 13:S32-46

[17] Gaylord, B., S. D. Gaines, D. A. Siegel, M. H. Carr. 2005. Consequences of population structure and life history for fisheries yields using marine reserves. *Ecological Applications*. 15:2180-2191.

[18] Shanks, A.L., Grantham, B.A. & Carr, M.H. 2003. Propagule dispersal distance and the size and spacing of marine reserves. Ecological Applications, **13**, S159–S169.

[19] Kinlan, B. and S. D. Gaines. 2003. Propagule dispersal in marine and terrestrial environments: a community perspective. Ecology. 84:2007-2020.

[20] Kinlan, B. , S. D. Gaines, and S. Lester. 2005. Propagule dispersal and the scales of marine community process. Diversity and Distributions. 11:139-148.2005.

[21] Siegel, D., B. P. Kinlan, B. Gaylord and S. D. Gaines. 2003. Lagrangian descriptions of marine larval dispersion. Marine Ecology Progress Series. 260:83-96.

[22] Cowen, R. K., C. B. Paris, A. Srinivasan. 2006 Scaling of connectivity in marine populations. Science. 311:522-527.

The spacing of habitats in MPAs was compared to the maximum spacing guidelines found in the Master Plan.

The SAT guidance in regard to offshore islands, specifically the Farallon Islands, is that current MPA size guidelines should apply, however the spacing guidelines should not. In terms of spacing, the Farallons will not be considered in the spacing analysis for MPAs along the mainland.

Guidance on size found in the Master Plan states:

- "For an objective of protecting adult populations, based on adult neighborhood sizes and movement patterns. MPAs should have an alongshore span of 5-10 km (3-6 mi or 2.5-5.4 nm) of coastline, and preferably 10-20 km (6-12.5 mi or 5.4- 11nm). Larger MPAs would be required to fully protect marine birds, mammals and migratory fish."
- "For an objective of protecting the diversity of species that live at different depths and to accommodate the movement of individuals to and from shallow nursery or spawning grounds to adult habitats offshore, MPAs should extend from the intertidal zone to deep waters offshore".

The first size guideline arises primarily from data on the movement of adult and juvenile fish and invertebrates. Since MPAs will be most effective if they are substantially larger than the distance that individuals move, larger MPAs provide benefit to a wider diversity of species.

A summary of existing scientific studies of adult movement shows that adult movement varies greatly among California's marine species (Table 11). A recent synthesis and analysis of movement information for west coast rocky reef fishes indicates that the range of movement for 75 percent of individuals of a species (the 75th percentile movement range) was 3 km or less for 85% of the 26 species for which data are available (Jan Freiwald unpublished dissertation). However, the majority of movement data are available for shallow dwelling reef fishes (depth < 30-50m). This synthesis also shows that movement distance was not correlated with days at liberty for eleven species for which data are available, indicating that movement of these species was unlikely a diffusive process (i.e. increasing range with time). The analysis also showed that movement distances for deeper dwelling species (n= 6, 75th percentile = 35 km) was significantly greater than for shallower dwelling species (n= 18, 75th percentile = 2 km).

Therefore the choice of any MPA size determines the subset of species that could potentially benefit. For species with average movement distances of 100s to 1000s of miles, MPAs are unlikely to be a source of significant protection (except when they protect critical locations, e.g., spawning or nesting grounds). As a result, the Master Plan guidelines focus on species in the first three movement categories in Table 11. The minimum size guideline of 5 to 10 km targets species in the first two categories. The preferable 10 to 20 km size range attempts to provide substantially more benefit to the important group of species in category 3 (10 - 100 km movement). This group includes a number of important rockfishes from the California coast. Therefore, MPAs that meet the preferable size guideline should protect more biological diversity than MPAs that just meet the less stringent minimum guideline.

Table 11. Scales of adult movement for California coastal marine species *(This table is draft and needs final review by the authors)*

How Far do Adult Animals Move?

0 – 1 km	1 – 10 km	10 – 100 km	100 – 1000 km	> 1000 km
Invertebrates Abalone, Mussel, Octopus, Sea Star, Snail, Urchin **Rockfishes** Blk. & Yellow Brown, Copper, Grass,* Kelp, Olive, Quillback, Vermillion, Widow, Yelloweye **Other Fishes** Cabezon Greenling Surfperches Eels	**Rockfishes** Blue Bocaccio Gopher Greenspotted* **Other Fishes** walleye surfperch*	**Invertebrates** Dung. Crab** **Rockfishes** Black Yellowtail **Other Fishes** Lingcod, Anchovy, Herring, Sardine, Ca. Halibut **Birds** Gulls, Cormorants **Mammals** Harbor Seal, Otter	**Rockfishes** Canary **Fishes** Big Skate Pacific Halibut Sablefish** Salmonids** Sturgeon Whiting** **Birds** Gulls** **Mammals** Porpoises Sea Lions**	**Invertebrates** Jumbo Squid** **Fishes** Sharks** Tunas** **Turtles**** **Birds** Albatross** Pelican** Shearwater** Shorebirds** Terns** **Mammals** Dolphins Sea Lions** Whales**

* Studies of this species included fewer than 10 individuals
** Seasonal Migration

* studies of this species had fewer than 10 individuals

The second size guideline arises from an attempt to connect habitats across depth ranges. Many marine species spend different parts of their life cycle in different habitats that often span a range of depths. By connecting these different habitats in a single MPA, species that move among contiguous habitats will likely benefit.

Therefore, *Size Guideline #2 states:* "For an objective of protecting the diversity of species that live at different depths and to accommodate the movement of individuals to and from shallow nursery or spawning grounds to adult habitats offshore, MPAs should extend from the intertidal zone to deep waters offshore."

This guideline reflects the recommendation of the SAT that MPAs extend from the shore to the boundary of state waters (3 miles). Extending MPA boundaries to the edge of state waters has the added benefit of allowing for connections with future MPA designations in federal waters. The combination of these two size guidelines forms the basis for SAT evaluation of MPA areas that use both the alongshore and offshore dimensions and result in a minimum SAT size guideline of 9 sq mi.

Components of methodology of SAT analysis of MPAs relative to these size guidelines:

- The alongshore length and area of each proposed MPA was measured.
- When MPAs shared boundaries, the combined contiguous MPAs were considered as a single MPA cluster.
- The level of protection in each component of an MPA cluster was considered.
- The size of all MPAs and MPA clusters was tabulated with respect to the Master Plan minimum and preferable guidelines.
- The habitats which were represented in MPA clusters that meet Master Plan minimum and preferable size guidelines were considered.

6.0 PROTECTION OF FORAGING, BREEDING AND REARING AREAS (GOAL 2)

Summary of Guidelines and Evaluation Methods: Birds and Mammals

MPAs can protect birds and mammals by protecting their forage base and by reducing human disturbance to roosting sites, haul-outs, breeding colonies, and rookeries. To evaluate the protection afforded by proposed MPAs to birds and mammals the SAT:

- Identifies proposed MPAs or special closures that contribute to protection of birds and mammals.
- Identifies focal species likely to benefit from MPAs and for which data are available.
- Analyzes the proportion (of total numbers of individuals) of breeding bird/mammal at colonies and rookeries potentially benefiting by proposed MPAs.
- Analyzes the proportion of nearby foraging areas protected by MPAs, defined by evaluating protection of buffered areas around colonies.

For many species of fish and invertebrates, protection of a full range of representative and unique habitats will provide protection of their nursery areas. This analysis specifically focuses on birds, including seabirds, shorebirds and waterfowl, and mammals. Population in this evaluation refers to the number of animals that use a site for breeding or resting. Sharks will not be included in this analysis except in general terms as they relate to pinniped rookeries. Each proposed MPA or Special Closure will be assessed based on in situ information about how that area will contribute to protection of birds, mammals and sharks in the study region. For example, there are no large seabird colonies in Sonoma County compared to the Farallon Islands; however, there are concentrations of birds that may be significant for the northern part of the study region. Additionally, analysis will look at areas as they apply to each of the 3 subregions identified by the SAT (north of Point Reyes, south of Point Reyes and the Farallon Islands).

SAT Evaluation will focus on:

1. Protection of seabird breeding colonies and pinniped rookeries based on population size, location and species composition

The analysis examines whether or not MPA and Special Closure proposals cover areas containing significant colonies or colony complexes (i.e., groups of nearby colonies along a stretch of coast) of species likely to benefit from MPAs or closures. Evaluations will be based on the numbers of animals, or in some cases the proportion of the study region population, covered for species likely to benefit with a focus on species most likely to benefit. For specific colony protection, the evaluation will examine whether the proposal provided for specific protections, such as no-entry zones or other spatial regulations that would reduce human disturbance and whether or not the MPA or Special Closure protects significant numbers of animals. Special Closures would provide maximum benefit by nearly eliminating disturbance caused by boats irrespective of vessel type. MPAs that restrict fishing or other activities in waters surrounding colonies would provide less of a benefit than no-entry zones but likely

would provide a benefit by reducing the numbers of boats approaching and lingering near colonies.s might be more appropriate. Possible benefits of reduced disturbance include increased bird/mammal productivity, colony/population size, and species diversity (e.g., Carney and Sydeman 1999, Rojek et al. 2007).

Data used for these assessments mainly would be from the bird colony count data and GIS layers provided by the NOAA Biogeographic Assessment, from pinniped data compiled from Mark Lowry and Sarah Allen and already contained in the CDFG database (the SAT is also working with NOAA staff to get updated information), and other sources when necessary. Total numbers of seabirds and pinnipeds, and the proportions of subregional (i.e., north or south of Pt. Reyes, Farallon Islands) populations, for each species and all species combined breeding within each proposed MPA or Special Closure will be examined to evaluate to level of protection provided and which proposals provide the highest benefit . Level of benefit will then be categorized as: 1) High; 2) Medium; 3) Low; or 4) None.At the large and diverse South Farallon Islands colony, bird and mammal breeding areas are not evenly distributed. There is no GIS layer of such distribution, but maps are available in various publications and reports. The value of potential MPA and Special Closures would be evaluated based on these maps of distribution.

For sea otters, the SAT will utilize data from annual statewide surveys to overlay otter densities and proposed MPAs. Since the otter population has been expanding northward, the SAT may also examine potential future habitat. This would likely be done by examining amount of potential habitat, such as kelp beds, rocky substrate, etc.

2. Bird and mammal resting (roost/haulout/raft) locations based on population size, location and species composition

Many seabirds and pinnipeds require areas close to foraging locations where they can safely come to shore to rest, sleep, dry (i.e., cormorants, pelicans), or molt (some pinnipeds). Frequent disturbance at resting sites results in high levels of energy expenditure that can lead to poor body condition and/or cause animals to abandon the area (e.g., Carney and Sydeman 1999).

Assessment of roosting areas or haulout sites will be done using similar methods as for colonies/rookeries. For seabirds, data on major Brown Pelican roosts will be utilized and also will serve as a surrogate for other species unless other specific data are available. For pelicans, major roosts have been categorized as those typically containing: 1) 100-500 birds; 2) 500-1,000 birds; and 3) > 1,000 birds. For pinnipeds, total numbers and the proportions of subregional populations for each species and all species combined within each proposed MPA or Special Closure will be examined to evaluate to level of protection provided and which proposals provide the highest benefit . Level of benefit will then be categorized as: 1) high; 2) medium; 3) low; or 4) none.

3. Bird and mammal foraging concentrations based on population size, location and species composition

As upper trophic level predators, seabirds and marine mammals require an abundance of resources for survival and reproduction. With high life expectancies, low annual productivity, and high site fidelity, these animals are subject to population level impacts from reduced prey supplies or disturbance at foraging areas. High levels of disturbance at foraging areas can cause increased energy expenditure leading to poor body condition; this can be especially detrimental for species with long migration routes that may not have sufficient energy reserves to complete migration. Thus, protection of important prey species and foraging areas could have benefits, especially to species with limited foraging distributions.

For breeding species, the SAT will focus on three seabird and one marine mammal species most likely to benefit based on limited foraging ranges. For birds, the pelagic cormorant, Brandt's cormorant, and pigeon guillemot. For pinnipeds, the harbor seal. These species mainly forage in nearshore waters within a few miles of colonies. However, other species likely to benefit (e.g., double-crested cormorant, marbled murrelet) may also be added to evaluations on a case-by-case basis.

Evaluations of benefits to birds and mammals near colonies will be based on whether or not proposed regulations may benefit forage species (Table XX) or foraging habitats, how much foraging area will be protected near breeding areas, and how many animals stand to benefit. Zones extending three miles alongshore and to one mile offshore (the main foraging range of these species when breeding) from breeding colonies/rookeries will be drawn to examine the numbers of birds/mammals utilizing the area within the proposed MPA. In some cases, at-sea densities for certain species (e.g., Brandt's cormorant, common murre, harbor seal) plotted over proposed MPAs may be used as an additional evaluation tool.

For non-breeding birds (e.g., waterfowl, shorebirds), the SAT will evaluate whether proposed MPAs encompass important concentration areas and what proportion of estimated populations are encompassed within those areas:). - For waterfowl wintering in the coastal estuaries, the SAT will use count data provided by the U.S. Fish and Wildlife Service from the annual winter survey (recently provided to MLPA). For each species likely to benefit (e.g., brant, scaup, scoter, bufflehead, goldeneye) and for all species, long-term averages within each estuary will be used.

Because there is no data of precise distribution within the estuaries, evaluations will be based on numbers counted and proportions of local populations within each estuary, and proportion of each estuary captured in the proposed MPA that contributes to bird protection. For outer coast non-breeding waterfowl, the SAT will focus on species most likely to benefit: western/Clark's grebes; and surf scoter. For these, the SAT will utilize a combination of bird density data from the NOAA Biogeographic Assessment and habitat. These species are most common nearshore over soft bottom habitats. Because of the imprecision of density data, benefits to these species will be simply categorized (see below).

For migrant and wintering shorebirds, the SAT are trying to get data provided from recent surveys. These data, if available, would be evaluated using the same methods as for estuarine waterfowl.

For all evaluations, the level of benefit to each species within each proposed MPA will be categorized as: 1) High; 2) Medium; 3) Low; or 4) None.

Carney, K.M. and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68-79.

Rojek, N.A., M.W. Parker, H.R. Carter, and G.J. McChesney. 2007. Aircraft and vessel disturbances to Common Murres *Uria aalge* at breeding colonies in central California, 1997–1999. Marine Ornithology 35: 67–75.

Table XX. Known important prey items of Brandt's cormorant, pelagic cormorant, pigeon guillemot, and harbor seal in north-central California. Most fish taken by seabirds are in the juvenile stage.[1]

Species	Fish	Preferred foraging habitat
Brandt's cormorant	**Fish** Short-belly rockfish *Sebastes jordani* Yellowtail rockfish *Sebastes flavidus* Other rockfish *Sebastes* spp. Pacific sandlance *Ammodytes hexapterus* Plainfin midshipman *Porichthys notatus* Speckled sanddab *Citharichthys stigmaeus* *Hemilepidotus* spp. White seaperch *Phanerodon furcatus* Northern anchovy *Engraulis mordax* Pacific herring *Clupea pallasi* Pacific staghorn sculpin *Leptocottus armatus* *Hemilepidotus* spp. (Cottidae) Other sculpins (Cottidae) Pacific tomcod *Microgadus proximus* Northern Pacific hake *Merluccius productus* Shiner perch *Cymatogaster aggregata* Pacific tomcod *Microgadus proximus* Spotted cusk-eel *Chilara taylori* Butter sole *Isopsetta isolepis* Rex sole *Glyptocephalus zachirus* English sole *Parophrys vetulus* **Invertebrates** Market squid *Loligo opalescens*	Soft bottom
Pelagic cormorant	**Fish** Short-belly rockfish *Sebastes jordani* Yellowtail rockfish *Sebastes flavidus*	Submerged reefs

	Other rockfish *Sebastes* spp. Sculpins (Cottidae) *Coryphopterus nicholsii* *Chilara taylori* **Invertebrates** Mysid shrimp *Spirontocaris* sp.	
Pigeon guillemot	**Fish** Rockfish *Sebastes* spp. Pacific sanddab *Citharichthys sordidus* Blennies (Clinidae) Sculpins (Cottidae) Gunnels (Pholidae) Spotted cusk-eel *Chilara taylori* **Invertebrates** Red octopus *Octopus rufescens*	Submerged reefs
Harbor seal		

[1] Data on seabird prey items from Ainley et al. (1990) and PRBO Conservation Science (unpubl. data).

References:

Ainley, D.G., C.S. Strong, T.M. Penniman, and R.J. Boekelheide. 1990. The feeding ecology of Farallon seabirds. Pp. 51-127 in (D.G. Ainley and R.J. Boekelheide, eds.), Seabirds of the Farallon Islands: Ecology, Dynamics, and Structure of an Upwelling-system Community. Stanford University Press, Stanford, California.

7.0 RECREATIONAL, EDUCATIONAL AND STUDY OPPORTUNITIES (GOAL 3)

Summary of Guidelines and Evaluation Methods: Goal 3 Analyses

MLPA Initiative staff evaluate the potential recreational, educational, and study opportunities provided by each MPA proposal in terms of the MPAs' overall accessibility, proximity to educational institutions, inclusion of existing monitoring sites, and consideration of replication in design.

In evaluating the draft proposals Initiative staff considers:

- Access points within and near MPAs, including proximity to boat launches and ports. Proximity to MPAs that allow many uses versus MPAs that allow few uses may have different effects on different users.
- Inclusion of existing monitoring sites and close proximity to research institutions, which may increase study opportunities.
- Replication of habitats within MPAs, which may contribute to increasing research opportunities.

In Phase I of implementation for the central coast study region, MLPA Initiative staff and the SAT evaluation work group used some simple metrics to evaluate how well the proposed MPA packages address Goal 3 of the MLPA.

Goal 3 of the Marine Life Protection Act (MLPA) is:

> *"To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity*."

To complete the Goal 3 analysis, MLPA Initiative and CDFG staff used simple metrics and available data within geographic information systems (GIS) to evaluate North Central Coast Regional Stakeholder Group (NCCRSG) draft options for MPA arrays and draft external MPA proposals. Access is a key issue for recreational, education and study opportunities; the evaluation focused on proximity of MPAs to access points, boat launches and ports, and marine research institutions. The number of long-term monitoring sites inside MPAs and the replication of habitats within MPAs were also tabulated.

Evaluation of recreational opportunities focused on accessibility of different types of MPAs, specifically:

- *Number of access points within and near proposed MPAs.* This was determined by tabulating the number of access points inside or within 2 miles of a) proposed state marine reserves (SMRs) and high protection state marine conservation areas (SMCAs), and b) proposed moderate and low protection MPAs. Only shoreline MPAs were considered in the evaluation of access.
- *Distance of proposed MPAs to boat ramps/launches/ports*. This was determined by tabulating the number of MPAs within 0-5, 5-15, and 15-50 miles of a boat ramp,

launch, or port (excluding major ports). The 0-5mi distance reflects potential use of MPAs by users with small craft.

- *Distance of proposed MPAs from the region's major ports*. The number of MPAs within 0-5, 5-15, and 15-50 miles of a major port (i.e. San Francisco, Bodega, or Half Moon Bay).

Evaluation of educational and study opportunities focused on:

- *Distance of proposed MPAs from major marine research institutions.* This was determined by tabulating the number of MPAs within 0-15 and 15-50 miles of major marine research institutions in the study region (i.e., Bodega Bay Marine Lab of University of California, Davis and Romberg Tiburon Center for Environmental Studies of San Francisco State University).
- *Number of established long term marine research monitoring sites*. This was determined by tabulating the number of sites monitored by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) within a) proposed SMRs and high protection SMCAs, and b) within proposed MPAs of all protection levels.
- *Replication of habitats within the study region.* Replication of eight habitats within proposed MPAs was evaluated: sandy beaches, rocky shores, seagrass, kelp, hard substrate (0-30m), hard substrate (30-100m), soft substrate (0-30m), and soft substrate (30-100m). A habitat was considered to be present within an MPA if a threshold amount of that habitat was present, based on the Science Advisory Team evaluation. Habitat replication was considered for a) proposed high protection MPAs (very high, high, and moderate- high) and b) for all proposed MPAs

8.0 COMMERICAL AND RECREATIONALFISHERY IMPACTS

Summary of Guidelines and Evaluation Methods: Fishery Impacts

While fishery impacts are not the focus of the MLPA, they may be considered in designing MPA networks. The evaluation of maximum potential recreational and commercial fishery impacts utilizes region-specific data collected by MLPA contractor, Ecotrust, on areas of importance. Potential impacts to the abalone fishery are based on landings data from CDFG.

To evaluate recreational and commercial fishery impacts, MLPA Initiative staff and contractors:

- Organize impact analyses by port and/or fishery and summarize the impacts by total area or value affected within the study region or in total fishing grounds[23].
- Evaluate the impact of proposed MPAs to abalone index sites and abalone landings

Commercial and recreational fishing

In order to analyze the relative effects of the MPA proposals on commercial fisheries that are conducted in the waters in the North Central Coast Study Region (NCCSR), staff from Ecotrust, contracted by the MLPA Initiative, use data layers characterizing the spatial extent and relative stated importance of fishing grounds of eight commercial fisheries (i.e. California halibut, coastal pelagics, market squid, nearshore rockfish, deep nearshore rockfish, urchin, Dungeness crab and salmon) in the NCCSR. This information was collected by Ecotrust during interviews in the summer of 2007, using a stratified, representative sample of 174 fishermen whose individual responses regarding the relative importance of ocean areas for each fishery were standardized using a 100-point scale and normalized to the reported fishing grounds for each fishery.

In addition, staff prepare a similar assessment of the relative effects of the MPA proposals on recreational fisheries, which currently take place in NCCSR waters. In order to complete this analysis they use data layers characterizing the spatial extent and relative stated importance of recreational fishing grounds for California halibut, Dungeness crab, salmon, rockfish/lingcod complex, and striped bass (pier\shore only). Recreational fishers are also broken out by user group (i.e. commercial passenger fishing vessels, pier/shore based, kayak based and private vessels) and by sub-region (i.e. Region 1 - Ocean Beach in San Francisco County, Region 2 - San Francisco Bay access points to Point Reyes and Region 3 - Point Reyes north to Alder Creek). This information was collected by Ecotrust during interviews in the fall of 2007, using a stratified solicited sample of 101 recreational fishermen whose individual responses regarding the relative importance of ocean areas for each fishery (user group\target specie(s)\region) were standardized using a 100-point scale and normalized to the reported fishing grounds for each fishery.

Using the normalized data described above, staff 1) analyzes and evaluates the potential impacts on the commercial and recreational fishing grounds and 2) analyzes the

[23] Impact analyses represent a “worst case” scenario where fisherman cannot fish in a different location.

socioeconomic impacts on commercial fisheries in order to assess the relative effects of the draft MPA proposals. Results are reported at both the study region and port group levels for the commercial fisheries. Port groups have been defined as: Bodega Bay, Point Arena, Bolinas, San Francisco and Half Moon Bay. Recreational fishery results are reported by user group and sub-region.

The draft MPA proposals under review vary according to their spatial extent and the commercial and recreational fisheries they affect. Specifically, they vary by the number and types of fisheries permitted within the boundaries of particular MPAs within a network. Furthermore, study area (SA) fisheries themselves vary in spatial extent and frequently overlap. Most of them are conducted in fishing grounds that extend beyond the state waters of the NCCSR, and therefore reporting includes the effects both in terms of total fishing grounds (G) and those that fall within the study area. Since any one MPA may have different effects on different fisheries, and different fisheries may be affected differently by all MPAs, it is therefore necessary to consider single MPAs and single fishery uses independently. Note that because current fishery closures affect all proposals equally, they have no differential effect.

This analysis assumes that each of the MPA proposals completely eliminate fishing opportunities in areas closed to specific fisheries and that fishermen are unable to adjust or mitigate in any way. In other words, the analysis assumes that all commercial fishing in an area affected by an MPA would be lost completely, when in reality it is more likely that effort would shift to areas outside the MPA. The effect of such an assumption is most likely an overestimation of the impacts, or a "worst case scenario."

Each MPA is overlayed with each fishery considered in this study. MPAs are grouped according to level of protection, using the same levels of protection as defined in the Science Advisory Team (SAT) evaluations. In other words, for each MPA and protection level within each proposal, staff assess the commercial fisheries that would be affected are assessed.

Results are compiled by staff in a series of spreadsheets, summarizing the effects of the various MPA proposals on commercial fisheries, both in terms of the area affected and the relative value lost. The same method of analysis as developed in the Central Coast process are used (see Scholz et al., 2006)[24], creating a weighted surface that represents the stated importance of different areas for each fishery. More specifically, these stated importance values are multiplied by the proportion of in-study region landings (by port and by fishery). These estimates then feed into the socioeconomic impact analysis.

Additionally, the staff analysis considers the percentage of area and value affected within the fishing grounds which are constrained by existing fishery management areas closures and/or fishery exclusion zones (e.g. Rockfish Conservation Area). It evaluates and determines whether or not there are individuals who would be disproportionately affected (i.e., 100% or a larger portion of their grounds are inside a proposed MPA that would restrict fishing).

[24] Scholz, Astrid, Charles Steinback and M. Mertens. 2006. Commercial fishing grounds and their relative importance off the Central Coast of California. Report submitted to the California Marine Life Protection Act Initiative. May 4, 2006.

For the commercial fisheries staff also calculate the estimated maximum potential economic impact of each MPA proposal. To accomplish this, the maximum potential economic impact for each MPA proposal is estimated using methods similar to those utilized in the Central Coast process by Wilen and Abbott (2006)[25]. This analysis for the NCCSR, however, differs in a very important respect, that is, by having original survey data on fishermen operating costs collected through the interview process.

The methods used to assess the impact to the recreational fisheries for each of the MPA proposals is identical to that used to assess the impact on commercial fisheries with one exception. The commercial fishery analysis assessed impacts by multiplying stated importance values from the interviews by the proportion of in-study region landings (both by landing port and by fishery), and more specifically, by ex-vessel values for those landings. In contrast, no weighting occurs in the calculation of recreational fishery impacts, but rather, the analysis is done using only stated importance values from the interviews. No weighting occurs for the obvious reason that ex-vessel values do not exist for recreational fishery landings.

The percentage change in area for each of the recreational fisheries (both for user group and for sub-region) were determined by the intersection of each MPA proposal and the fishing grounds specific to that fishery. Each MPA within a proposal was classified by whether it would affect the fishery or not. If a fishery was affected by an MPA, the area and value were summarized and then divided by the total area and value for the entire fishing grounds (G), as derived from interviews with fishermen, and the total study area (SA).

Abalone

MPA proposals have the potential to impact the recreational abalone fishery and will be evaluated for impacts to management and landings.

Data from abalone index sites, fishery dependent creel survey sites and coded landing sites are used to manage the abalone fishery. Index sites are fishery independent survey sites used to provide a relative index of abalone population trends over time. The fishery dependent creel survey sites are specific sites along the coast used to intercept abalone harvesters and collect abalone and harvest data. These data are used in conjunction with the coded landing sites in tracking and estimating abalone harvest. The coded landing sites are specific sites included on each abalone permit report card. Every abalone harvested must be recorded to the nearest coded landing site on the abalone permit report card. There are eight recreational abalone index sites statewide, five of which are located within north central coast study region. Additionally, there are eight creel survey sites in the study region, which date back to 1975. There are twenty eight coded abalone fishery sites in the north central coast region.

[25] Wilen, James and Joshua Abbott, “Estimates of the Maximum Potential Economic Impacts of Marine Protected Area Networks in the Central California Coast,” final report submitted to the California MLPA Initiative in partial fulfillment of Contract #2006-0014M (July 17, 2006)

Index sites are comprised of high moderate use abalone fishery sites. As noted above population conditions at index sites are used as an indicator of stock status in the absence of broad-scale surveys across the entire fishery range. Further, index sites are long term survey sites and are used in setting total allowable catch for the fishery. The *Abalone Recovery and Management Plan* (http://www.dfg.ca.gov/marine/armp/index.asp) provides detailed discussion of index sites and management needs. For this reason, an MPA proposed at one of these index sites could potentially affects the continued utility of that site to function as an indicator of stock status. For example, an MPA that prohibits the take of abalone at an index site that was once fished would affect the usefulness of those data to continue to provide an index of abundance for a fished state.

CDFG and MLPA staff evaluates draft MPA proposals relative to their potential impact to the use of index sites for management. Proposed MPAs that encompass an index site will be identified. Changes in the allowance or disallowance of recreational take of abalone at an index site within an MPA will be highlighted. Although index sites are represented as a point, actual survey locations may vary from year to year so where an MPA is situated next to an index site transect locations will be plotted. The percent of the area that is incorporated in a MPA will be noted along with the proposed allowable take of abalone. MPAs that change the allowable take of abalone at an index site entirely will be identified.

Additionally, the impacts of MPA proposals on the recreational abalone fishery will be evaluated. Abalone landings are reported each year through the abalone permit report cards. Abalone harvesters must report every abalone they land. Pre-designated landing sites are listed on the report cards and each abalone landed must be reported by “coding” the harvest the nearest site. These sites are specific launches or coastal access points; it is possible that abalone may be harvested at locations other than the specific reported location. Nevertheless, the abalone permit report card system generates data that in turn provide a geographic distribution of abalone landings. Proposed MPAs that prohibit abalone harvest will be compared against the reported abalone landings. The percent of the total annual abalone landings will be reported for each MPA that prohibits the harvest of abalone and encompasses a coded landing location. Where a proposed MPA encompasses more than one coded landing location the combined landings will be provided as a percent of the total annual landings. This evaluation will provide an indication of the magnitude of the impact specific MPAs may have on the recreational abalone fishery.

APPENDIX A: Socioeconomic Impact Assessment Methods

The primary goal of this analysis is to estimate the socioeconomic impact to the commercial fishery sector associated with each of the MPA proposals. To accomplish this, staff from Ecotrust, contractor to the MLPA Initiative, will estimate the maximum potential economic impact for each of the MPA proposals using methods developed in the Central Coast process (see Wilen and Abbott, 2006). This analysis assumes that each of the MPA proposals completely eliminate fishing opportunities in areas closed to specific fisheries and that fishermen are unable to adjust or mitigate in any way (Wilen and Abbott, 2006). The results can then be considered by each group (i.e. stakeholders, SAT, BRTF, Initiative staff, FGC) as trade-offs for protections relative to socioeconomic impacts can be weighed in siting and evaluating MPA proposals. The remainder of this paper describes the steps needed to complete the maximum potential economic impact analysis.

1. Generate Baseline Estimates of Gross Economic Revenue

The first step involves calculating a baseline estimate from which to derive estimates of the socioeconomic impact associated with changes in commercial fisheries that might be induced by each MPA alternative and against which to compare those estimates. The baseline estimate is generated using gross fishing revenues from regional landing receipts. A 7 year average, 2000-2006, derived from the California Department of Fish and Game (CDFG) landing receipts reported for ports in the North Central Coast region is used, and then these values are converted into current dollar values (i.e. 2006 dollars).

More specifically, to generate baseline estimates of gross economic revenue (GER), for any fishery, *f*, $BGER_f$ is the average ex-vessel value of the fishery in 2006 dollars, where

$BGER_f = \sum_{p \in P} BGER(f, p)$, the sum of the baseline estimates of GER for this fishery over all ports.

Staff also define the fisheries specific to each port, or in other words, create a baseline estimate of gross economic revenue for each port. For a specific port, *p*, being considered in the North Central Coast region the baseline estimate ($BGER_p$) can be calculated as the sum of the baseline estimates of GER for this port over all fisheries:

$$BGER_p = \sum_{f \in F} BGER(f, p).$$

The baseline gross economic revenue ($BGER_{TOT}$) for <u>all</u> commercial fisheries ($f \in F$) being considered in the North Central Coast region is therefore

$$BGER_{TOT} = \sum_{f \in F} BGER_f = \sum_{f \in F} \sum_{p \in P} BGER(f, p)$$ or equivalently,

$$BGER_{TOT} = \sum_{p \in P} BGER_p = \sum_{p \in P} \sum_{f \in F} BGER(f, p).$$

2. Generate Gross Economic Revenue for the Various MPA Alternatives

The next step involves using results from the Ecotrust mapping exercise, specifically stated importance indices from the fishing grounds, to estimate the socioeconomic impact associated with changes in the commercial fisheries that might be induced by each MPA alternative. For a description of the methods used to create stated importance indices, please see Scholz et al. (2006).

For any fishery, *f*, port, *p*, and any MPA alternative, *a*:

$$GER(f, p, a) = BGER(f, p) - GEI(f, p, a)$$

where $GEI(f, p, a)$ is the estimated gross economic impact on fishery, *f*, at any port, *p*, under any alternative, *a*.

Therefore,

$$GER_f(a) = \sum_{p \in P} GER(f, p, a) \text{ and } GER_p(a) = \sum_{f \in F} GER(f, p, a)$$

as well as

$$GEI_f(a) = \sum_{p \in P} GEI(f, p, a) \text{ and } GEI_p(a) = \sum_{f \in F} GEI(f, p, a).$$

Gross economic revenue under any alternative, *a*, ($GER_{TOT}(a)$), for <u>all</u> commercial fisheries ($f \in F$) being considered in the North Central Coast region can be calculated as:

$$GER_{TOT}(a) = \sum_{f \in F} GER_f(a) = \sum_{p \in P} GER_p(a) = \sum_{f \in F} \sum_{p \in P} GER(f, p, a) = \sum_{p \in P} \sum_{f \in F} GER(f, p, a)$$

From this it can be said that, for any MPA alternative, *a*,

$$GEI_{TOT}(a) = BGER_{TOT} - GER_{TOT}(a)$$

where GEI_{TOT_a} is defined as the total gross economic impact on all commercial fisheries under any alternative, *a*. Therefore,

$$GEI_{TOT}(a) = \sum_{f \in F} GEI_f(a) = \sum_{p \in P} GEI_p(a) = \sum_{f \in F} \sum_{p \in P} GEI(f, p, a) = \sum_{p \in P} \sum_{f \in F} GEI(f, p, a).$$

3. Generate Baseline Estimates of Net Economic Revenue

In order to compute net economic benefits, staff 1) estimate the share of gross fishing revenues represented by costs, and 2) scale the baseline estimate (i.e. gross fishing revenues) calculated in Step 1 using the estimated cost shares. In the Central Coast process, an estimate of 65% was used across all fisheries (Wilen and Abbott, 2006). For the North Central

Coast process, several cost related questions were asked during interviews with fishermen in an effort to improve on this estimate as well as allow for the ability to account for cost variability between different fisheries in this analysis. After all interviews are completed, the cost data are broken out by fishery or fisheries. For example, cost data for a fisherman who fished both salmon and crab would be aggregated with only other interviewees participating in both those fisheries. A mean or median cost estimate is then calculated for each category.

Costs will be broken into two categories: fixed costs and variable costs. Fixed costs include costs that are independent of the number of trips a vessel makes or the duration of these trips. For example, vessel repairs and maintenance, insurance, mooring and dockage fees typically considered fixed costs. On the other hand, variable costs include costs that are dependent on the number of trips a vessel makes of the duration of these trips. Variable costs typically include fuel, maintenance, crew share, gear repair/replacement. For the purpose of this study, however, to account for sunk costs, the only variable cost is assumed to be crew wages and fuel costs. All other costs will be considered fixed costs.

For any fishery, *f*, net economic revenue is calculated as:

$$BNER_f = BGER_f - C_{X_f} - C_{V_f}$$

where C_{X_f} is the fixed cost associated with any fishery, *f*, and is set as a fixed dollar value, and C_{V_f} is the variable cost associated with any fishery , *f*, and is a fixed percentage of $BGER_f$. For further explanation, please see the Appendix.

Baseline net economic revenue ($BNER$) for <u>all</u> commercial fisheries ($f \in F$) being considered in the North Central Coast region can be calculated as:

$$BNER_{TOT} = \sum_{f \in F} BNER_f$$

4. Generate Estimates of Net Economic Revenue for the Various MPA Alternatives
In order to compute net economic revenue for each of the various MPA alternatives, staff analysis 1) estimates the share of gross fishing revenues represented by costs under each MPA alternative, and 2) scales the estimated gross fishing revenues for that alternative accordingly. Costs will be calculated using the methods described in Step 3.

For any fishery, *f*, and any MPA proposal, *a*,

$$NER_f(a) = GER_f(a) - C_{X_f} - C_{V_f} \ .$$

For any MPA alternative, *a*, net economic revenue for <u>all</u> commercial fisheries ($NER_{TOT}(a)$) can be calculated as:

$$NER_{TOT}(a) = \sum_{f \in F} NER_f(a)$$

5. Generate Estimate of the Potential Primary Economic Impact for the Various MPA Alternatives

Using the results from the previous steps, the potential primary net economic impact (NEI) of a particular MPA alternative, *a,* on a particular fishery, *f,* can then be calculated as:

$$NEI_f(a) = BNER_f - NER_f(a).$$

The potential primary NEI of any MPA alternative, *a,* on <u>all</u> commercial fisheries ($f \in F$) can then be calculated as:

$$NEI_{TOT}(a) = BNER_{TOT} - NER_{TOT}(a).$$

References

- Scholz, Astrid, Charles Steinback and M. Mertens. 2006. Commercial fishing grounds and their relative importance off the Central Coast of California. Report submitted to the California Marine Life Protection Act Initiative. May 4, 2006.
- Wilen, James and Joshua Abbott, "Estimates of the Maximum Potential Economic Impacts of Marine Protected Area Networks in the Central California Coast," final report submitted to the California MLPA Initiative in partial fulfillment of Contract #2006-0014M (July 17, 2006)

Example of Estimate Costs

For fishery *f*, assume the following proportion of gross economic revenue goes to the following costs:

- 20% = fixed costs
- 20% = crew wages
- 10% = fuel costs → 30% = variable costs

Assume that baseline gross economic revenue equals $10,000.00. Under the baseline, fixed costs equal $2,000 and variable costs equal $3,000, resulting in total costs of $5,000. Assume that under MPA alternative *a,* gross economic revenue now equals $5,000. Under this alternative, fixed costs will still equal $2,000; however, variable costs will be recalculated as:

$5,000 * 0.3 = $1,500

This results in total costs of $3,500 under MPA alternative *a.*