California Marine Life Protection Act Initiative
Methods Used to Evaluate Marine Protected Area Proposals in the MLPA South Coast Study Region (Draft)
Section 4.0 – Protection Levels

Draft revised January 16, 2009

4.0 PROTECTION LEVELS (GOALS 1, 2, 4 AND 6)

4.1 Summary of Guidelines: Level of Protection

The MLPA calls for an improved network of MPAs which includes a "marine life reserve component," and may include "areas with various levels of protection." To facilitate comparison between MPA networks with varied allowed uses, the Science Advisory Team has developed a framework for assessing the level of protection provided by an MPA.

In assigning MPA protection levels the SAT considers:

- The proposed allowed uses within each MPA (e.g. specific fishing methods)
- The depth in which allowed uses could occur (For example, fishing for coastal pelagics in different depth zones could confer different levels of protection)

Why Categorize MPAs by Protection Levels?

The MLPA identifies three types of marine protected areas: 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 crafting 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 protection levels 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 permitted 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.

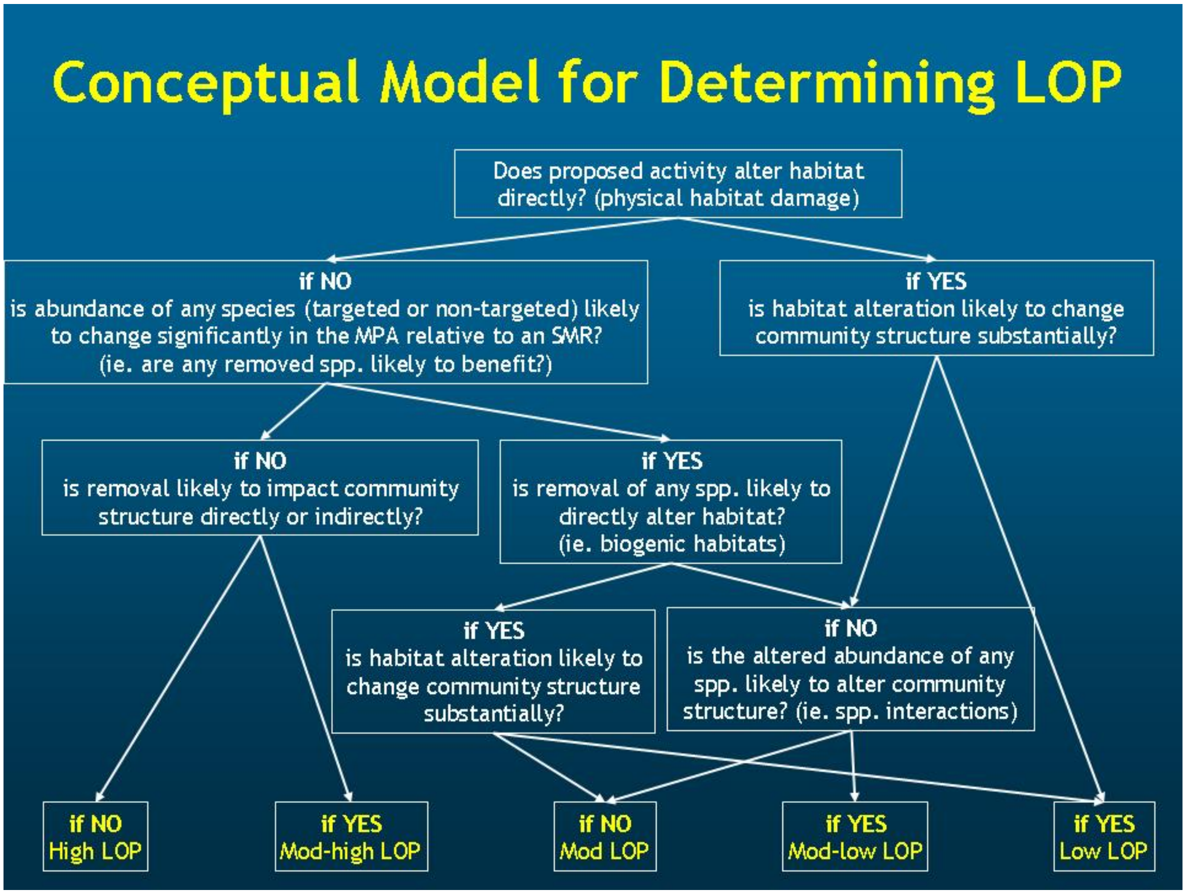
State marine conservation areas (SMCA) potentially have the most variable levels of protection and conservation of the three MPA designations because they may allow any combination of commercial and recreational fishing, as well as other extractive activities (e.g., kelp harvest).

4.2 ~~Assigning~~ Conceptual Framework for Assigning Levels of Protection

Levels of protection are based upon the likely impacts of proposed activities to the ecosystems within the MPA. Conceptually, the SAT seeks to answer the following question in assigning levels of protection: “How much will an ecosystem differ from an unfished ecosystem if one or more proposed activities are allowed?”

Marine reserves (SMRs) are, by definition, unfished ecosystems, therefore they receive the highest protection level, “very high”. MPAs that allow extractive activities receive levels of protection ranging from “high” for low impact activities, to “low” for activities that alter habitat and thus are likely to have a large impact on the ecosystem. Both direct impacts (those resulting directly from the gear used or removal of target or non-target species) and indirect impacts (ecosystem-level effects of species removal) are considered in the levels of protection analysis. Figure 1 presents the decision flow for determining the level of protection.

Figure 1. Conceptual model for determining the level of protection in an MPA that allows extractive activities.



In applying the conceptual model presented in Figure 1 the SAT makes three important assumptions:

1) any extractive activity can occur at high intensity
2) for the purpose of comparison, an unfished system is a marine reserve that is successful in protecting that ecosystem from all effects of fishing and other extractive uses within the MPA
3) the proposed activity is occurring in isolation (i.e. without cumulative effects of multiple allowed activities)

The SAT identifies the impacts of a proposed activity by considering two main categories of impacts: (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 removal of target and 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 resident species that are likely to benefit from MPAs are considered to have impacts on species interactions, especially if those species play an integral role in the food web or perform a key ecosystem function (e.g. biogenic structure).

Associated Catch

To consider the catch associated with specific gear types and target species, the SAT examined ~~four~~ five sources of data in the analysis: 1) California Recreational Fisheries Survey angler interviews (CRFS interviews), 2) C~~alifornia~~ R~~ecreational~~ F~~isheries~~ S~~urvey~~ onboard observer data (CRFS observer data) 3~~2~~) CDFG commercial landing receipt data, 4~~3~~) CDFG log book data from recreational Commercial Passenger Fishing Vessels (CPFVs), and, where adequate scientific information was lacking, 5~~4~~) input from stakeholders familiar with relevant species or fisheries.

The CRFS data, commercial landing receipt data, and CPFV log book data are all limited in their ability to accurately reflect 'bycatch' because catch information is not clearly linked to a specific target species. ~~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. CRFS angler interviews, commercial landing receipt data, and CPFV log book data all report catch at the trip level, with a single target per trip. Anglers 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 captured in the data~~reflected accurately by the sampling~~. For example, an interviewed angler or CPFV logbook may report ~~a trip as a~~ bonito as the primary target~~trip~~ but may have~~, at some point,~~ switched fishing effort to target kelp bass during the trip. Both bonito and kelp bass may have been retained, but at the trip level there is insufficient resolution in the data to determine if those kelp bass were caught incidentally while fishing for bonito, or were caught cleanly in a separate fishing event on the same trip. In the case of CRFS onboard observer data, the fishing target is not indicated, only the catch is recorded, which further complicates efforts to identify incidental catch. ~~Nevertheless, the ecological impacts from that fishing trip include the removal of bonito 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. CRFS observer data consist of observations of landed and returned catch by a trained CRFS observer sampling a sub-set of anglers fishing at each location on sampled trips. CRFS interview~~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 provided in Appendix A. The CRFS onboard observer data highlight catch that was caught incidentally to a target species.

Commercial landing receipts 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 fishermen 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 CPFV recreational fishing trips in the study region are provided in Appendix A. 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.

4.3 Levels of Protection for the South Coast Study Region

The levels of protection as they apply to the south coast study region are presented below. For an MPA that allows multiple activities, the lowest level of protection for any allowed activity is assigned to that MPA. The SAT acknowledges that multiple uses within an MPA may have cumulative impacts on the ecosystem that exceed those of the individual activities. Such cumulative impacts are difficult to predict and the SAT has not addressed this concern in assigning levels of protection.

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, causes 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 hook and line fishing for pelagic finfish[1] near the surface in deep-water (>50m depth), and pelagic seine fishing for coastal pelagic finfish[2] in deep water (>50m depth).

Moderate-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 hook and line fishing for pelagic finfish 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 sea bass or rockfish is higher; and 2) there is a potential impact to the MPA ecosystem if a pelagic predator is removed at this depth[3]. 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.[3]

Moderate-low – 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, kelp bass, barred sand bass, rockfish, lingcod, cabezon, ~~greenling, rockfish, kelp bass,~~ and surfperches.

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

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[1] Pelagic finfish: ~~northern anchovy (*Engraulis mordax*),~~ barracudas (*Sphyraena* spp.), billfishes* (family Istiophoridae), dolphinfish (*Coryphaena hippurus*), Pacific herring (*Clupea pallasi*), ~~jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*),~~ salmon (*Oncorhynchus* spp.), ~~Pacific sardine (*Sardinops sagax*),~~ blue shark (*Prionace glauca*), salmon shark (*Lamna ditropis*), shortfin mako shark (*Isurus oxyrinchus*), thresher sharks (*Alopias* spp.), swordfish (*Xiphias gladius*), tunas (family Scombridae), and yellowtail (*Seriola lalandi*). *Marlin is not allowed for commercial take.

[2] Coastal pelagic finfish: northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), and Pacific sardine (*Sardinops sagax*).

[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.

Table 2. Level of protection and the activities associated with levels of protection in the MLPA South Coast Study Region

	Level of Protection	MPA Types	Activities associated with this protection level
	Very high	SMR	No take
	High	SMCA	In water depth > 50m: pelagic finfish[1], bonito, and white sea bass by hook and line; *coastal pelagic finfish[2] by seine*
	Moderate-high	SMCA	In water depth < 50m: pelagic finfish[1], bonito, and white sea bass by hook and line; *coastal pelagic finfish[2] by seine; squid (pelagic seine)*
	Moderate	SMCA SMP	spot prawn (trap); sea cucumber (scuba/hookah); grunion (hand harvest); *abalone (snorkel); halibut, shore-based finfish, croaker, and flatfishes (H&L); clams (hand harvest); giant kelp (hand harvest);*
	Moderate-low	SMCA SMP	Kelp bass, barred sand bass, sheephead *lingcod, cabezon, rockfish*, and other reef fish (H&L, spear, trap); spotted sand bass and *surfperches* (H&L); lobster (trap, hoop net, diving); rock scallop (scuba);*Urchin (scuba/hookah)*;
	Low	SMCA SMP	*mussels (any method); all trawling; giant kelp (mechanical harvest); mariculture (existing methods in NCCSR)*

Note: uses indicated in gray italics were assigned levels of protection in the North Central Coast Study Region and are currently being evaluated by the SAT for the South Coast Study Region.

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 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, 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. Although depth- and habitat-related bycatch catch information for specific fisheries are not readily available, it is likely that bycatch catch is highest in shallow water where bottom fish move close to the surface and become susceptible to the fishing gear.

Participants at a national conference[4] 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

[4] 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.

in depths where seafloor is <50m (27 fathoms,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 levels of protection.

Various extractive activities and associated levels of protection are described below. ~~Further supporting data can be found in Appendix A.~~
~~NEW PROPOSED LEVELS OF PROTECTION FOR THE SCSR:~~

Pelagic finfish[5] and Pacific bonito (hook and line):

Direct impacts – pelagic finfish are highly mobile species that are unlikely to benefit directly from MPAs constrained within state waters. Fishing for these species near the surface (including hook and line fishing for bait fish) causes little or no direct habitat damage as gear rarely touches the seafloor.

Pelagic finfish targeted in the study region, include yellowtail, barracuda, dorado, mackerel, marlin, swordfish, mako and thresher sharks, and albacore, yellowfin, bluefin, and skipjack tunas. Pacific bonito (*Sarda chiliensis*) are not defined as pelagic finfish in CDFG regulations, but they share many characteristics with the above species and are often caught in conjunction with other pelagic finfish. Data on associated catch of pelagic finfish were extracted from CPFV observer data collected by CDFG, but were difficult to interpret due to likely target-switching during fishing trips. Catch records for bonito, mackerel, yellowtail, and barracuda all indicate a high associated catch of basses (kelp bass and barred sand bass) that met or exceeded the catch of the pelagic finfish in question. High associated catches of basses and other reef-associated fishes, including rockfish, halfmoon, scorpionfish, and sheephead indicate that these associated catches are likely an artifact of target switching during a fishing trip, but it is impossible to be certain that some of these species are not caught while targeting pelagic finfish in nearshore waters.

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 increases. In the NCCSR, the SAT received 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.

[5] Pelagic finfish: northern anchovy (*Engraulis mordax*), barracudas (*Sphyraena* spp.), billfishes* (family Istiophoridae), dolphinfish (*Coryphaena hippurus*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), salmon (*Oncorhynchus* spp.), Pacific sardine (*Sardinops sagax*), blue shark (*Prionace glauca*), salmon shark (*Lamna ditropis*), shortfin mako shark (*Isurus oxyrinchus*), thresher sharks (*Alopias* spp.), swordfish (*Xiphias gladius*), tunas (family Scombridae), and yellowtail (*Seriola lalandi*). *Marlin is not allowed for commercial take.

Indirect impacts – Pelagic finfish generally feed on mobile forage species such as small schooling fishes, crab larvae, squid, shrimps and planktonic organisms. As both pelagic finfish 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 pelagic finfish 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 less than 50m due to potential increase in associated catch of resident species

The 50m depth contour undulates along the coastline, thus it is difficult to create MPA boundaries that follow the 50m depth contour while also adhering to other guidelines such as CDFG feasibility guidance to use straight lines of latitude and longitude. To apply the assignment of a level of protection based around the 50m depth contour the following criteria will be used:

1) The entire MPA "cluster" (see section 5.0 for description) will be considered together (both the inshore and offshore combination of SMR and SMCA or SMP).
2) For a high level of protection no more than 15% of the total area in the cluster that is shallower than 50m or 15% of either rock or soft-bottom habitats shallower than 50m may allow trolling for pelagic finfish (including salmon).
    a. This method applies only to the shallow (<50m) habitats that are of sufficient size to count towards the size and spacing guidelines (9 square miles, see section 5.0 for more details).
3) MPA clusters that allow trolling across more than 15% of the total <50m area or the shallow (<50m) rock or soft-bottom habitats will receive a moderate-high level of protection.

White seabass (hook and line): *(possibly lump with ~~coastal~~ pelagics)*
Direct impacts – White seabass (*Atractoscion nobilis*) are highly mobile[6] pelagic species that are unlikely to benefit directly from MPAs constrained within state waters. Fishing for white seabass with hook and line gear causes little or no direct habitat damage as gear rarely touches the seafloor. An analysis of recreational catch information for white seabass state-wide indicates that a wide variety of reef and sandy-bottom species including kelp bass, barred sandbass, and halibut 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. However, these catch records are difficult to interpret due to likely target-switching during fishing trips. It is possible that much of this associated catch was due to target switching when white seabass catch was poor, but it is likewise possible that some of these species are unintentionally caught while targeting white seabass in nearshore waters.

[6] Dr. James Lindholm, pers. comm. and unpublished data

Indirect impacts – tagging studies of white seabass[6] in the Santa Barbara Channel Islands indicate the species is highly mobile. 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.

Level of protection:

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

Spot prawn (trap):

Direct impacts – California spot prawn (*Pandalus platyceros*), are moderately mobile species[7] that may benefit directly from MPAs within state waters. Tagging studies of spot prawn from British Columbia show that they remain within a mile or two of their release location over several months.[8] This finding is supported by a study that found significant differences in parasite loads between populations separated by only 10s of kilometers.[9] The moderate adult movement of spot prawn indicates that the abundance of spot prawn is likely to be lower in a fished area as compared to a no-take marine reserve.

Spot prawn fishing with traps involves bottom contact but causes little habitat disturbance. No data on associated catch were examined, but data from other trap fisheries (Dungeness crab in the north central coast) indicates that bycatch in the trap fishery is likely to be low.

Indirect impacts – Spot prawn feed on other shrimp, plankton, small mollusks, worms, sponges, and fish carcasses. In turn, spot prawn are important prey for fishes and marine mammals. Due to their role as predator and prey, removal of spot prawn is likely to have some impacts on community structure within an MPA

Level of protection:

Moderate – due to indirect ecosystem effects.

Sea cucumber (scuba/hookah hand collection):

Direct impacts – Sea cucumbers (*Parastichopus parvimensis*) are relatively sedentary bottom-dwelling species that are likely to benefit directly from MPAs within state waters, therefore removing sea cucumbers from an MPA could reduce the protection afforded them. A study conducted in the northern Channel Islands before and after the onset of the sea cucumber dive fishery showed a significant decline in sea cucumber abundance at

[7] Boutillier, J. A., and J. A. Bond. 2000. Using a fixed escapement strategy to control recruitment overfishing in the shrimp trap fishery in British Columbia. J. Northw. Atl. Fish Sci. 27:261-271.
[8] Boutillier, J.A. unpublished data.
[9] Bower, S.M. and J.A. Boutillier. 1990. Sylon (Crustacea: Rhizocephala) infections on the shrimp in British Columbia. *In:* Pathology in Marine Science. S.O. Perkins and T.C. Cheng (eds.). Academic Press. p. 267-275

fished sites after the onset of fishing, relative to two no-take marine reserves on Anacapa Island.[10]

Hand collection of sea cucumbers 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 – Sea cucumbers are important detritivores and prey for sea stars (especially Pycnopodia) in the nearshore rocky environment, therefore removal of this species is likely to have impacts on community structure within an MPA.

Level of protection:
Moderate – due to indirect ecosystem effects

Grunion (hand collection):

Direct impacts – Grunion (*Leuresthes tenuis*) are a highly mobile species that is likely to benefit from MPAs constrained within state waters only if those MPAs protect spawning sites. Genetic studies of grunion indicate panmixia within the Southern California Bight[11] and high genetic similarity between populations in San Francisco Bay and Los Angeles.[12] These genetic studies suppor the conclusion that grunion are highly mobile.

Collecting grunion by hand on spawning beaches targets this species during the vulnerable spawning period. Unlike squid, which also form spawning aggregations, grunion spawn multiple times in a single season, and may display natal homing, returning to spawn at the beach where they were spawned[13]. Because grunion may otherwise be protected by MPAs, the direct impacts of the grunion fishery are expected to be moderate.

Indirect impacts – Although grunion are a highly mobile pelagic species they form spawning aggregations and deposit large numbers of eggs on sandy shores. Because of the importance of spawning grunion and their eggs as prey in the nearshore ecosystem, the abundance of grunion may have indirect ecosystem impacts on resident species.

Level of protection:
Moderate – due to indirect ecosystem effects

[10] Schroeter, S. C., D. C. Reed, D. J. Kushner, J. A. Estes, and D. S. Ono. 2001. The use of marine reserves in evaluating the dive fishery for the warty sea cucumber (Parastichopus parvimensis) in California, U.S.A. Can. J. Fish. Aquat. Sci. 58.
[11] Gaida, I. H., D. G. Buth, S. D. Matthews, A. L. Snow, S. B. Luo, and S. Kutsuna. 2003. Allozymic variation and population structure of the California grunion, Leuresthes tenuis (Atheriniformes: Atherinopsidae). Copeia 2003: 594-600.
[12] Johnson, P. B., K. L. Martin, T. L. Vandergon, R. L. Honeycutt, R. S. Burton, and A. Fry. 2009. Microsatellite and Mitochondrial Genetic Comparisons Between Northern and Southern Populations of California Grunion Leuresthes tenuis. (Copeia, in press.)
[13] Martin, K. personal communication.

Kelp bass (hook and line, or spear, or trap):

Direct impacts – Kelp bass (*Paralabrax clathratus*) are demersal fish that occur on nearshore rocky reefs and kelp forests. Several studies have shown kelp bass to have small home range sizes. Tag recapture studies conducted by the California DFG in the 1940s and 50s showed that 80% of fish move on the order of 1-2 km although some individuals moved 100s of km,[14,15,16] possibly in search of better habitat. More recent studies using acoustic telemetry have confirmed these results indicating that most kelp bass utilize a small core area (average 0.003 km^2), although some individuals made excursions from this core of 1 km or more.[17] The Using passive acoustic telemetry methods, Mason (2008) foundsame study indicated that kelp bass tagged in the small (0.06 sq mile) Catalina Marine Science Center Reserve were detected within the reserve 317 days out of the subsequent year[18]. Increases in the size and abundance of kelp bass have been demonstrated in a number of small MPAs in Southern California.[19,20] Tetreault and Ambrose (2007) examined kelp bass populations in five small (all < 2 km^2) marine reserves and found that on average, kelp bass were 2.8 times more abundant and 1.4 times larger inside the reserves as compared to nearby control sites. Additionally, Froeschke et al. (2006) found kelp bass densities were significantly higher inside the Catalina reserve as compared to control sites outside the reserve. These studies support the conclusion that kelp bass are relatively sedentary and likely to benefit from MPAs located in state waters.

Indirect impacts – Kelp bass are top predators on nearshore rocky reefs, therefore removal of this species is likely to have impacts on community structure within an MPA. Kelp bass are carnivorous ambush predators, feeding on a variety of small fish and invertebrates including other kelp bass, pipefishes, flatfishes, blacksmith, surfperch, crabs, squid, polychaetes, tunicates, and hydrozoans. Kelp bass also scavenge urchins from sheephead attacks.

Level of protection:

Moderate-low – due to indirect ecosystem effects

Barred sand bass (hook and line or spear):

[14] Collyer, R. D., and P. H. Young. 1953. Progress report on a study of the kelp bass, Paralabrax clathratus. Fish Bulletin 39:191–208.

[15] Young, P. H. 1963. The kelp bass (Paralabrax clathratus) and its fishery, 1947–1958. Fish Bulletin 122:1–67.

[16] Quast, J. C. 1968. Observations on the food and biology of the kelp bass, Paralabrax clathratus with notes on its sportfishery at San Diego, California. California Department of Fish and Game Fish Bulletin 139:81–108.

[17] Lowe, C. G., D. T. Topping, D. P. Cartamil, and Y. P. Papastamatiou. 2003. Movement patterns, home range, and habitat utilization of adult kelp bass Paralabrax clathratus in a temperate no-take marine reserve. Marine Ecology Progress Series 256:205-216.

[18] Mason, T.J. 2008. Home range size, habitat use, and the effects of habitat breaks on the movements of temperate reef gamefishes in a southern California marine protected area. Master's Thesis. Department of Biological Sciences, California State University, Long Beach.

[19] Tetreault, I., and R. F. Ambrose. 2007. Temperate marine reserves enhance targeted but not untargeted fishes in multiple no-take MPAs. Ecological Applications 17:2251-2267.

[20] Froeschke, J. T., L. G. Allen, and D. J. Pondella. 2006. The fish assemblages inside and outside of a temperate marine reserve in southern California. Bull. Southern California Acad. Sci. 105:128-142.

Direct impacts – Barred sand bass (*Paralabrax nebulifer*) are demersal fishes that occur in mixed sandy and rocky habitat and are often associated with kelp and seagrass beds or artificial reefs. The movements of barred sand bass are not well known. CDFG tagging studies from the 1980s indicate movements from 5 to 40 miles[21] but more recent acoustic tagging studies from a small marine reserve on Catalina Island show that at least some barred sand bass stay within a small area most of the year[22]. In this study, 8 barred sand bass were tagged within the small (0.06 sq mile) Catalina Marine Science Center Reserve. These tagged fish were detected inside the reserve an average of 314 days out of the subsequent year. Another study showed a significant increase in the density of barred sand bass inside the small (0.04 sq mile) Heisler Park Reserve as compared to nearby control sites[23] indicating that barred sand bass may be sufficiently sedentary to benefit directly from MPAs. During the breeding season (May-August) barred sand bass are known to form breeding aggregations in soft bottom habitats ranging from 20-30m depth[24] but it is unclear how far they move to reach these breeding sites. The locations of many barred sand bass breeding sites are known and the aggregations are often targeted by the recreational fishery, thus barred sand bass are likely to benefit from MPAs that protect their breeding sites.

Indirect impacts – Barred sand bass are important predators in nearshore environment, therefore removal of this species is likely to have impacts on community structure within an MPA. Barred sand bass are carnivorous ambush predators, feeding on a variety of small fish and invertebrates including surfperch, sardines, anchovies, midshipman, crabs, clams, and squid.

Level of protection:
Moderate-low – due to indirect ecosystem effects

California Sheephead (hook and line, spear, or trap):
Direct impacts – sheephead (*Semicossyphus pulcher*) are demersal fish that occur on nearshore rocky reefs and kelp forests. The movements of sheephead have not been studied extensively, but existing studies indicate that they have high site fidelity and a small home range. Topping et al (2005)[25] used acoustic tags to monitor the movement of

[21] California Department of Fish and Game (CDFG). 1982. California Fish and Wildlife Plan. Volume II-Species Plans, Part C-Living Marine Resources. Preliminary Draft. June 1982. California Department of Fish and Game, 1416 Ninth Street, Sacramento, California, 95814.
[22] Mason, T.J. 2008. Home range size, habitat use, and the effects of habitat breaks on the movements of temperate reef gamefishes in a southern California marine protected area. Master's Thesis. Department of Biological Sciences, California State University, Long Beach.
[23] Tetreault, I. and R. F. Ambrose (2007). "Temperate marine reserves enhance targeted but not untargeted fishes in multiple no-take MPAs." Ecological Applications 17(8): 2251-2267.
[24] Baca Hovey, C., L. G. Allen, and T. E. Hovey. 2002. The reproductive pattern of barred sand bass (Paralabrax nebulifer) from southern California. CalCOFI Rep. 43:174-181.
[25] Topping, D. T., C. G. Lowe, and J. E. Caselle. 2005. Home range and habitat utilization of adult California sheephead, Semicossyphus pulcher (Labridae), in a temperate no-take marine reserve. Marine Biology 147:301-311.

sheephead within the small (0.06 sq mile) Catalina Marine Science Center Reserve. The 16 sheephead in this study used a small core area (average 0.015 km^2) and were detected within the reserve 266 days over the subsequent year. Increases in the size and abundance of sheephead have been demonstrated in a number of small MPAs in Southern California. Tetreault and Ambrose (2007)[19] examined sheephead populations in five small (all < 2 km^2) marine reserves and found that on average, male sheephead were 3.7 times more abundant and 1.2 times larger inside the reserves as compared to nearby control sites. Female sheephead were 1.6 times more abundant and 1.3 times larger inside reserves as compared to control sites. Additionally Froeschke et al. (2006)[20] found that sheephead densities were significantly higher inside the Catalina reserve as compared to control sites outside the reserve. These studies support the conclusion that kelp bass are relatively sedentary and likely to benefit from MPAs located in state waters.

Indirect impacts – Sheephead are important predators on nearshore rocky reefs, therefore removal of this species is likely to have impacts on community structure within an MPA. Sheephead are carnivores with powerful crushing jaws. They feed mainly on invertebrates including urchins and other echinoderms, mussels, clams, gastropods, crabs, spiny lobster, barnacles, squid, bryzoans, and polychaetes. Importantly, sheephead predation on urchins may act as an ecosystem driver by reducing and stabilizing urchin populations[26,27]. Throughout their range, urchin populations can impact (decrease) kelp abundance, thereby altering the relative abundance of macroalgae in a kelp forest.

Level of protection:
Moderate-low – due to indirect ecosystem effects

Spotted sand bass (hook and line):

Direct impacts – spotted sand bass (*Paralabrax maculatofasciatus*) occur over sand or mud habitat in shallow bays, harbors, and coastal lagoons that contain eelgrass and surfgrass. Spotted sand bass are predominantly a warm water species and their distribution in the Southern California Bight is restricted to warm-water embayments. The movements of spotted sand bass are not well known, but tagging studies have shown that adults rarely range beyond the embayment where they settled as juveniles.[28] Spotted sand bass form breeding aggregations just near the entrances of embayments between May and September.[29] One study in southern California showed that different populations of spotted sand bass, display varied mating strategies[30] which further supports the conclusion that

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[26] Tegner, M. J., and P. K. Dayton. 1981. Population Structure, Recruitment and Mortality of Two Sea Urchins (Strongylocentrotus franciscanus and S. purpuratus) in a Kelp Forest. Marine Ecology Progress Series 5:255-268.
[27] Cowen, R. K. 1983. The effect of sheephead (Semicossyphus pulcher) predation on red sea urchin (Strongylocentrotus franciscanus) populations: an experimental analysis. Oecologia 58:249-255.
[28] Allen, L.G. unpublished data.
[29] Allen, L. G., M. S. Love, and J. W. Smith. 1995. The life history of the spotted sand bass (Paralabrax maculatofasciatus) within the southern California bight. CalCOFI Rep. 36:193-203.
[30] Hovey, T. E., and L. G. Allen. 2000. Reproductive patterns of six populations of the spotted sand bass, Paralabrax maculatofasciatus, from Southern and Baja California. Copeia 2000:459-468.

spotted sand bass are relatively sedentary and thus likely to benefit from estuarine MPAs in Southern California.

Indirect impacts – Spotted sand bass are important predators in coastal embayments, therefore removal of this species is likely to have impacts on community structure within an MPA. Spotted sand bass are carnivores and feed mainly on demersal invertebrates including clams, crabs, squid, and polychaetes.

Level of protection:
Moderate-low – due to indirect ecosystem effects

Lobster (traps, hoop nets, or hand take by scuba):
Direct impacts – The movement habits of spiny lobsters, *Panulirus interruptus* are not well known. Some reports indicate that adult lobsters migrate offshore into deeper waters during the winter months[31] but the distance and prevalence of this migration are not well documented. Recent studies have shown that the home range and habits of spiny lobster may vary markedly from site to site and may be related to predator abundance and habitat quality.[32] A study conducted in a small MPA (0.6 sq mi) on Catalina Island where lobster take had been prohibited for 23 years showed that legal-sized lobsters were significantly more abundant inside the no-take area than in nearby fished areas.[33] This suggests that at least some portion of the lobster population is relatively sedentary and likely to benefit directly from MPAs within state waters. Thus the abundance of lobsters in an area that allows lobster fishing is likely to be lower than that in a no-take marine reserve.

In the SCSR lobster are taken using three main methods: recreational hand collection using scuba or free diving, recreational take using hoop nets, and commercial take using traps or pots. All three of these methods may cause some habitat disturbance (anchoring and placement of traps which can disturb rock and kelp habitat). Bycatch in the lobster fishery is likely low but it is not well quantified. Anecdotal reports from the recreational hoop-net fishery indicate that sheephead, nearshore rockfish, sand bass, California scorpionfish, octopus, rock crab, sheep crab, miscellaneous invertebrates, sharks, skates, and rays make up the most common invaders of recreational hoop nets.

Indirect impacts – Lobsters are important predators in the nearshore rocky environment, therefore removal of this species is likely to have impacts on community structure within an MPA. Adult lobsters feed on a variety of algae and invertebrates including urchins, snails, mussels, and clams. Importantly, lobster predation on urchins may act as an important

[31] CA DFG, 2001. California's Living Marine Resources: A Status Report. California Department of Fish and Game, December 2001.
[32] K. Hovel and C. Lowe, in prep
[33] Iacchei, M., P. Robinson, et al. (2005). "Direct impacts of commercial and recreational fishing on spiny lobster, *Panulirus interruptus*, populations at Santa Catalina Island, California, United States." New Zealand Journal of Marine and Freshwater Research 39: 1201-1214.

ecosystem driver by reducing and stabilizing urchin populations.[34,35,36] Throughout their range, urchin populations can impact (decrease) kelp abundance, thereby altering the relative abundance of macroalgae in a kelp forest.

Level of protection:
Moderate-low – due to indirect ecosystem effects

Rock scallop (scuba hand collection):

Direct impacts – Rock scallops (*Crassadoma gigantea*) are a sessile bivalve that inhabits rocky reefs. Due to their sessile nature rock scallops are likely to benefit directly from MPAs within state waters, therefore removing rock scallops from an MPA could reduce the protection afforded them.

Hand collection of rock scallops is done in one of two ways. Either the diver cuts the scallop from it's shell underwater, leaving the shell attached to the rock, or the diver pries the scallop, shell and all, from the rock. Either method causes some habitat disturbance, but prying the shell from the rock causes damage to the reef as well as removing the habitat formed by the scallop shell. Because divers harvest selectively, there is little or no catch of non-target species.

Indirect impacts – Rock scallops are planktivores and prey to sea stars and shell borers in the nearshore rocky environment. Removal of this species is likely to have moderate impacts on community structure within an MPA.

Level of protection:
Moderate – due to indirect ecosystem effects

[34] Tegner, M., Levin, L., 1983. Spiny lobsters and sea urchins: analysis of a predator-prey interaction. Journal of Experimental Marine Biology & Ecology 73: 125-150.
[35] Lafferty, K. D. 2004. Fishing for lobsters indirectly increases epidemics in sea urchins. Ecological Applications 14:1566-1573.
[36] Behrens, M. D., and K. D. Lafferty. 2004. Effects of marine reserves and urchin disease on southern Californian rocky reef communities. Marine Ecology Progress Series 279:129-139.