California MLPA Master Plan Science Advisory Team
Levels of Protection Work Group
Draft Levels of Protection for the MLPA South Coast Study Region
December 16, 2008

Note: *This document was adapted from the levels of protection section of the evaluation methods document for the MLPA North Central Coast Study Region. Sections of the explanatory text that were significantly changed are highlighted in yellow.*

Summary of Guidelines: Level of Protection

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.

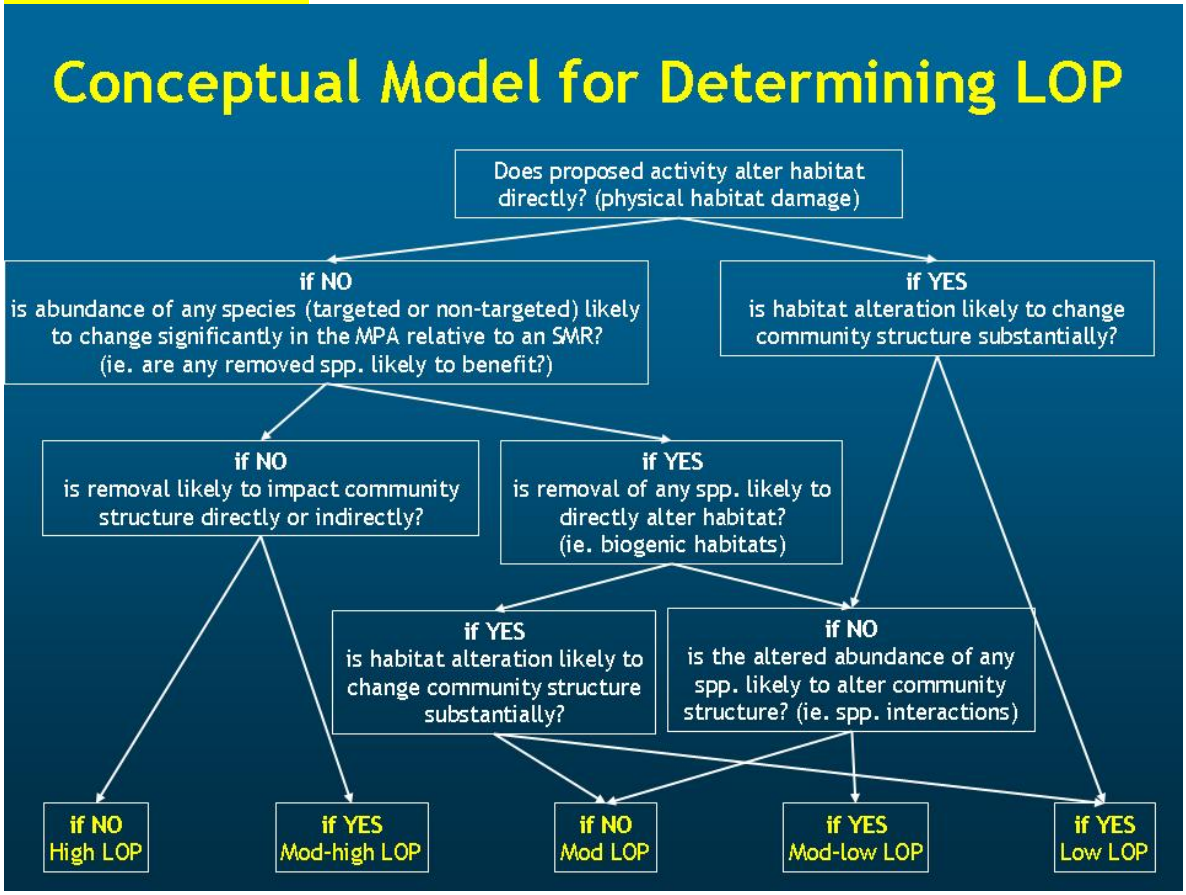
State marine conservation areas (SMCA) potentially have the most variable levels of protection and conservation of the three MPA designations because they may allow any combination of commercial and recreational fishing, as well as other extractive activities (e.g., kelp harvest).

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 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 sources of data in the analysis: 1) California Recreational Fisheries Survey (CRFS), 2) CDFG commercial landing receipt data, 3) CDFG log book data from recreational Commercial Passenger Fishing Vessels (CPFVs), and, where adequate scientific information was lacking, 4) input from stakeholders familiar with relevant species or fisheries. [update for SCSR]

The CRFS data, commercial landing receipt data, and CPFV 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. 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 reflected accurately by the sampling. For example, an angler may report a trip as a bonito trip but, at some point, switch fishing effort to target kelp bass. 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. 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. 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 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 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.

Levels of Protection

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 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, lingcod, cabezon, greenling, rockfish, kelp bass, and surfperches.

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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.

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.

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[4] and bonito by hook and line; coastal pelagic finfish[5] by seine
	Moderate-high	SMCA	Dungeness crab (trap); In water depth < 50m: pelagic finfish[Error! Bookmark not defined.] and bonito by hook and line; coastal pelagic finfish[Error! Bookmark not defined.] by seine; squid (pelagic seine)
	Moderate	SMCA SMP	halibut, white seabass, shore-based finfish, croaker, and flatfishes (H&L); smelt (H&L and hand/dip nets); clams (hand harvest); giant kelp (hand harvest); spot prawn (trap); sea cucumber (diving); grunion (hand take)
	Moderate-low	SMCA SMP	Urchin (scuba); abalone (snorkel); lingcod, cabezon, greenling, rockfish, kelp bass, barred sand bass, sheephead and other reef fish (H&L, spear, trap); surfperches (H&L); spotted sand bass (H&L); lobster (trap, hoop net, diving); rock scallop (diving)
	Low	SMCA SMP	mussels (any method); all trawling; giant kelp (mechanical harvest); mariculture (existing methods in NCCSR)

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.

[4] 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.

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

Participants at a national conference[6] 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 (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 MLPA SOUTH COAST STUDY REGION

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[7] 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.[8] 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.[9] 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

[6] 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.
[7] CA DFG, 2001. California's Living Marine Resources: A Status Report. California Department of Fish and Game, December 2001.
[8] K. Hovel and C. Lowe, in prep
[9] 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.

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 ecosystem driver by reducing and stabilizing urchin populations.[10,11,12] 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

Barred sand bass (hook and line or spear):

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[13] 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[14]. 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[15] 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[16] 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

[10] 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.
[11] Lafferty, K. D. 2004. Fishing for lobsters indirectly increases epidemics in sea urchins. Ecological Applications 14:1566-1573.
[12] 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.
[13] 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.
[14] Mason, T.J. 2008. The effects of habitat composition, quality, and breaks on home ranges and site fidelity of barred sand bass (Paralabrax nebulifer) compared with three other species of exploited nearshore reef fishes. Master's Thesis. Department of Biological Sciences, California State University, Long Beach.
[15] 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.
[16] 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.

fish and invertebrates including surfperch, sardines, anchovies, midshipman, crabs, clams, and squid.

Level of protection:

Moderate-low – due to indirect ecosystem effects

Kelp bass (hook and line or spear):

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,[17,18,19] 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.[20] The same 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. Increases in the size and abundance of kelp bass have been demonstrated in a number of small MPAs in Southern California.[21,22] 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

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[17] Collyer, R. D., and P. H. Young. 1953. Progress report on a study of the kelp bass, Paralabrax clathratus. Fish Bulletin 39:191–208.
[18] Young, P. H. 1963. The kelp bass (Paralabrax clathratus) and its fishery, 1947–1958. Fish Bulletin 122:1–67.
[19] 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.
[20] 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.
[21] 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.
[22] 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.

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)[23] used acoustic tags to monitor the movement of 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)[21] 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)[22] 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[24,25]. 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.[26] Spotted sand bass form breeding aggregations just near the entrances of embayments between May and

[23] 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.
[24] 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.
[25] 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.
[26] Allen, L.G. unpublished data.

September.[27] One study in southern California showed that different populations of spotted sand bass, display varied mating strategies[28] which further supports the conclusion that 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

Spot prawn (trap):

Direct impacts – California spot prawn (*Pandalus platyceros*), are moderately mobile species[29] 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.[30] This finding is supported by a study that found significant differences in parasite loads between populations separated by only 10s of kilometers.[31] 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 (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

[27] 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.
[28] 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.
[29] 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.
[30] Boutillier, J.A. unpublished data.
[31] 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

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 fished sites after the onset of fishing, relative to two no-take marine reserves on Anacapa Island.[32]

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

Rock scallop (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

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[33]

[32] 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.
[33] 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.

and high genetic similarity between populations in San Francisco Bay and Los Angeles.[34] 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[35]. 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

LEVELS OF PROTECTION ADAPTED FROM THE NCCSR:

Pelagic finfish[36] 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

[34] 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.)
[35] Martin, K. personal communication.
[36] 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.

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.

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.

LEVELS OF PROTECTION FROM THE MLPA NORTH CENTRAL COAST STUDY REGION THAT NEED TO BE REVISITED FOR THE MLPA SOUTH COAST STUDY REGION:

White seabass (hook and line): *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – White seabass (*Atractoscion nobilis*) are highly mobile 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 (Appendix A(5)) 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. 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 is poor.

Indirect impacts – tagging studies of white seabass in the Santa Barbara Channel Islands indicate the species is highly mobile.[37] 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:

Moderate - due to catch associated with fishing for white seabass

Crab traps: *evaluated for the NCCSR for Dungeness crab,, should be revisited for the SCSR where the dominant species are yellow and brown rock crabs*

Direct impacts – Dungeness crab (*Cancer magister*) are a moderately mobile species that may benefit directly from MPAs within state waters. 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 (Appendix A(4)). Although infrequent, sea otters have been known to become entangled in traps of various kinds including crab traps[38,39]; a leatherback sea turtle was entangled and drowned at Point Reyes in 1996; and a humpback whale was entangled in multiple trap lines outside of San Francisco Bay in 2005 [40]. An example of the effect of a spatial closure on the abundance [catch per unit effort (CPUE)] and size distribution of Dungeness crabs can be found in studies at the mouth of the Glacier Bay National Park fishing closure[41]. Both the abundance (CPUE) and size of legal-sized male crabs in this area 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).

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

[37] Dr. James Lindholm, pers. comm. and unpublished data
[38] Newby, T. C. 1975. "A sea otter (*Enhydra lutris*) food dive record". Murrelet 56:19.
[39] Richardson, S. and Allen, H. 2000. "Draft Washington state recovery plan for the sea otter." Washington Department of Fish and Wildlife, Olympia, Washington. 67pp.
[40] Pers. Comm, Sarah Allen, Science Advisor, Point Reyes Natl. Seashore
[41] 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.

moderate mobility (10-15 km)[42] 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

Coastal pelagic finfish[43] (pelagic seine gear): *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – Sardine (*Sardinops sagax*), anchovy (*Engraulis mordax*), herring (*Clupea pallasi*), mackerel (*Scomber japonicus*), and jack mackerel (*Trachurus symmetricus*) are highly mobile pelagic species that are unlikely to benefit directly from MPAs constrained within state waters. Fishing for coastal pelagic finfish with pelagic seine or hook and line gear near the surface in deep water causes little or no direct habitat damage as gear never touches the seafloor. Landings of non-target species are generally low and comprised almost entirely of other highly-mobile schooling fish Appendix A(6))[verify for SCSR], therefore the direct impacts of the fishing activity on the resident ecosystem are expected to be low in deep water. In shallow water, there is a greater potential for gear to contact the bottom and greater potential for capture of benthic-associated species such as schooling juvenile croaker. In shallow water, the direct impacts of seining for coastal pelagic finfish on the resident ecosystem are expected to be moderate.

Indirect impacts – Sardines, anchovies, herring, and mackerel 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 take of schooling coastal pelagics 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

Squid (pelagic seine gear): *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – Market squid (*Loligo opalescens*) are a highly mobile pelagic species that is unlikely to benefit directly from MPAs constrained within state waters unless those MPAs protect spawning aggregations. Fishing for squid with pelagic seine gear targets the species during the vulnerable spawning period, however, squid grow quickly and spawn only once making the population less vulnerable to spawning-targeted fishing than other species. Pelagic seine gear causes little or no direct habitat damage as gear rarely touches the seafloor [check for accuracy]. Landings of non-target species are low and comprised almost entirely of other highly-mobile schooling fish (Appendix A(7))[verify for SCSR], thus the direct impacts of the fishing activity on the resident ecosystem are expected to be low.

[42] 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.
[43] Coastal pelagic finfish: northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), and Pacific sardine (*Sardinops sagax*).

Indirect impacts – Although squid are a highly mobile pelagic species 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

Urchin hand collection: *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – Urchins (*Strongylocentrotus* spp.) are relatively sedentary species that are likely to benefit directly from MPAs within state waters, therefore removing urchins from an MPA could reduce the protection afforded them. 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[44]. 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:
Moderate-low – due to indirect ecosystem effects

Halibut hook and line: *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – California halibut (*Paralichthys californicus*) are a moderately mobile species that may benefit directly from MPAs within state waters. 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 (Appendix A(3))[verify for SCSR]. 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. 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.

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

Indirect impacts – California halibut are an important predator in the coastal ecosystem, feeding on a variety of schooling fish and benthic organisms.[45] 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.[46,47] There is also information to suggest that larger halibut may be more mobile than small. 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

Abalone hand collection: *evaluated for the NCCSR, should be revisited for the SCSR based on the possibility that commercial harvest may be re-opened in the Channel Islands. In the NCCSR all abalone harvest was recreational using snorkel gear, commercial harvest uses scuba and thus can harvest abalone from a broader range of depths.*

Direct impacts – Abalone (*Haliotis* spp.)are relatively sedentary organisms that are likely to benefit directly from MPAs within state waters, therefore removing abalone from an MPA could reduce the protection afforded them. Because divers harvest selectively, there is little or no catch of non-target species, with the exception of other invertebrates attached to the abalone themselves. However, divers sometimes accidentally remove sub-legal size individuals, which may kill the animal even though it is often immediately replaced. High numbers of scuba divers at local access sites has been shown to lead to localized habitat impacts[48] and the same may be true for free-divers. Divers may also cause behavioral responses in mobile species[49].

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

[45] Cailliet, G.M., et al. 2000. Biological characteristics of nearshore fishes of California: a review of existing knowledge and proposed additional studies. Final Report to Pacific States Marine Fisheries Commission.

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

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

[48] Schaeffer, T.N., M.S. Foster, M.E. Landrau, and R.K. Walder. 1999. Diver disturbance in kelp forests. Cal. Fish and Game 85: 170-176.

[49] Parsons, D.M. and D.B. Eggleston. 2006. Human and natural predators combine to alter behavior and reduce survival of Caribbean spiny lobster. J. Exp. Mar. Biol. Ecol. 334: 196-205.

abalone as prey to small predators. In the case of the (currently closed) commercial abalone fishery, use of diving or "hookah" gear may reduce the deep water abalone refugia thereby increasing the potential for local depletion of adult spawning stocks.

Level of protection:
Moderate – due to indirect ecosystem effects

Croaker (unspecified hook and line gear): *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – White croaker (*Genyonemus lineatus*) are a moderately mobile species that may benefit directly from MPAs within state waters. Fishing for croaker with hook and line gear causes little or no direct habitat damage as gear rarely touches the seafloor. The recreational fishing database (CRFS) shows that a variety of non-target species may be landed in association with croaker fishing including sculpin, a variety of surfperch, and flatfish. Because croaker and other species taken in association with the croaker fishery may otherwise be protected by MPAs, the direct impacts of the croaker fishery are expected to be moderate.

Indirect impacts – White croaker are important predator and prey in the shallow sandy benthic environment. Croaker feed on a variety of benthic invertebrates including crabs, shrimps, and worms, thus their abundance is likely to have indirect impacts on the benthic ecosystem. The mobility of croaker species are not well known, however studies in southern California show that toxin concentrations in croaker are high close to the sources of those toxins, but concentrations in fish just 2-5 km distant are significantly lower[50]. These studies indicate that croaker may live relatively sedentary lives.

Level of protection:
Moderate

Shorefishing: *evaluated for the NCCSR, should be revisited for the SCSR*

The ecological consequence of removing fish from shallow (< 10 m depth) waters using shore fishing techniques 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 (Appendix A(9)). 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.[51] For some species mentioned above, effects of extraction from sandy beach surf zones may be limited to that habitat, whereas

[50] Philips, C., M. Venkatesan, and T. Lin 2001. Linear alkybenzenes in muscle tissues of white croaker near a large ocean outfall in southern California, USA. Environmental Toxicology and Chemistry, 20(2):231-238.
[51] Pers. comm. Milton Love, Associate Research Biologist, UC Santa Barbara

effects on many others are likely to extend into adjacent deeper (less than 30 m depth) sand habitat offshore.[51]

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 (Appendix A(9)). 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.

Based on the potential level of fishing effort by an unrestricted recreational fishery and the diversity of species potentially extracted from a proposed MPA by shore fishing, the SAT recommends a level of protection of moderate.

Level of protection:
Moderate – due to diversity of species extracted and their ecosystem interactions

ACTIVITIES THAT WERE EVALUATED IN THE MLPA NORTH CENTRAL COAST STUDY REGION AND MAY NOT BE RELEVANT FOR THE MLPA SOUTH COAST STUDY REGION:

Mariculture activities: *evaluated for the NCCSR, should be revisited for the SCSR*
Mariculturists in Tomales Bay and Drake's Estero culture several bivalve species using four main methods. Impacts vary according to method, but a general list of potential impacts are:

- Bivalves and associated farming equipment can reduce eelgrass cover, change species distributions in eelgrass beds, and alter sediment deposition patterns.
- Farming equipment can preempt space in the intertidal, altering shorebird foraging and distributions.
- Maintenance operations can trample sediments, damage eelgrass beds, and disturb shorebirds and perhaps marine mammals.
- Wooden culturing racks are commonly treated with a highly toxic preservative that can leach into the environment and accumulate in organisms and sediments, but the use of wooden racks reportedly is being eliminated in the north central coast study region (NCCSR).
- Bivalves and associated farming equipment provide large amounts of hard substrate habitat that may not be naturally present, altering communities.
- Almost all cultured species are non-indigenous species, and historic shipments of live animals from their native range have accidentally introduced other species to mariculture areas, some of which have had substantial impacts. Mariculture stock is no longer being imported from foreign sources, and disease is carefully monitored to reduce transmission. However, the potential exists for cultured species to provide a foundation for the continued establishment of non-native species that may be introduced via other vectors.

- Bivalves serve a critical ecosystem function by filtering bacteria and phytoplankton which accumulate nutrients and heavy metals from the water. Whether these changes are perceived to be positive or negative is a complex value judgment.

Additional information on mariculture in the MLPA North Central Coast Study Region is provided in Appendix A(10).

Level of protection:
Low – due to habitat impacts (for existing mariculture methods, new methods may require review and discussion)

Clam hand digging: *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – Clams are relatively sedentary species that are likely to benefit directly from MPAs within state waters, therefore removing clams from an MPA could reduce the protection afforded them. 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

Striped Bass (unspecified hook and line gear): *evaluated for the NCCSR, should be revisited for the SCSR*

Direct impacts – Striped bass (*Morone saxatilis*) are a non-native and highly mobile pelagic species that is unlikely to benefit directly from MPAs constrained within state waters. Fishing for striped bass with hook and line gear causes little or no direct habitat damage as gear rarely touches the seafloor. The recreational fishing database (CRFS) shows that a variety of non-target species may be landed in association with striped bass fishing. Significantly, more than 7% of the catch is comprised of demersal sharks, skates and rays, a group of important benthic predators with generally low reproductive rates. However, the CRFS dataset includes data from San Francisco bay and it is likely that much of the shark, skate, and ray catch occurs in the bay, not in the study region. Because some species taken in association with the striped bass fishery may otherwise be protected by MPAs, the direct impacts of the striped bass fishery are expected to be moderate. More information can be found in Appendix A(8).

Indirect impacts –Because of the high mobility of striped bass, MPAs are likely to have little impact on their local abundance, and the indirect ecosystem impacts of striped bass take

are predicted to be low. Incidental removal of other species (including skarks, skates, and rays), however, may have broader impacts on the benthic ecosystem.

Level of protection:
Moderate