California Marine Life Protection Act Initiative
Draft Methods Used to Evaluate Marine Protected Area Proposals in the MLPA South Coast Study Region
Section 3.0 and Appendix A – Protection Levels

Revised September 25, 2009

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

Status of this chapter: The SAT has approved of the approach presented as the conceptual model in Figure 3-1 and the level of protection designations for the activities included in this chapter.

Summary of the MLPA Guidelines Regarding 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 proposals allowing various uses, the SAT has developed a framework for assessing the level of protection provided by a proposed MPA.

The level of protection (LOP) concept is simple: the more permissive an MPA, the lower its LOP. Permissiveness, as used here, means the degree to which the MPA's regulations permit impacts to habitat or community structure. If a proposed MPA permits activities having high impact on habitat or community structure, then that MPA is said to have a low LOP. An MPA which permitted no human activity at all would on the other hand be said to have a high LOP.

Why Categorize MPAs by Protection Levels?

The SAT needs a method by which to evaluate the overall conservation value of entire proposed arrays of MPAs. Each MPA in a proposal will be designated as one of three types of marine protected areas: state marine reserve (SMR), state marine conservation area (SMCA), or state marine park (SMP). While the SMR, where no appreciable take of any species is allowed, is clearly the most protective of the MPA types, the relationship between the SMCA and the SMP is less clear. There is great variation in the type and magnitude of activities that may be permitted within these MPAs. It is expected that proposals will, in addition to naming each of its MPAs with one of these types, also specify what activities are to be permitted in each MPA. This gives designers of MPA proposals flexibility in crafting MPAs that either individually or collectively fulfill the various goals and objectives specified in the MLPA. However, this flexibility may mean that to evaluate an array of MPAs only by their type designations may lead to deceptive results. For this reason, the SAT looks beyond the MPA type to the proposed permitted activities to determine the LOP an MPA will afford.

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 attributed to an SMR is based on the assumption that no other appreciable level of take or alteration of the ecosystem will be allowed. Thus, of the three types of MPAs, 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 may 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).

Conceptual Framework for Assigning Levels of Protection

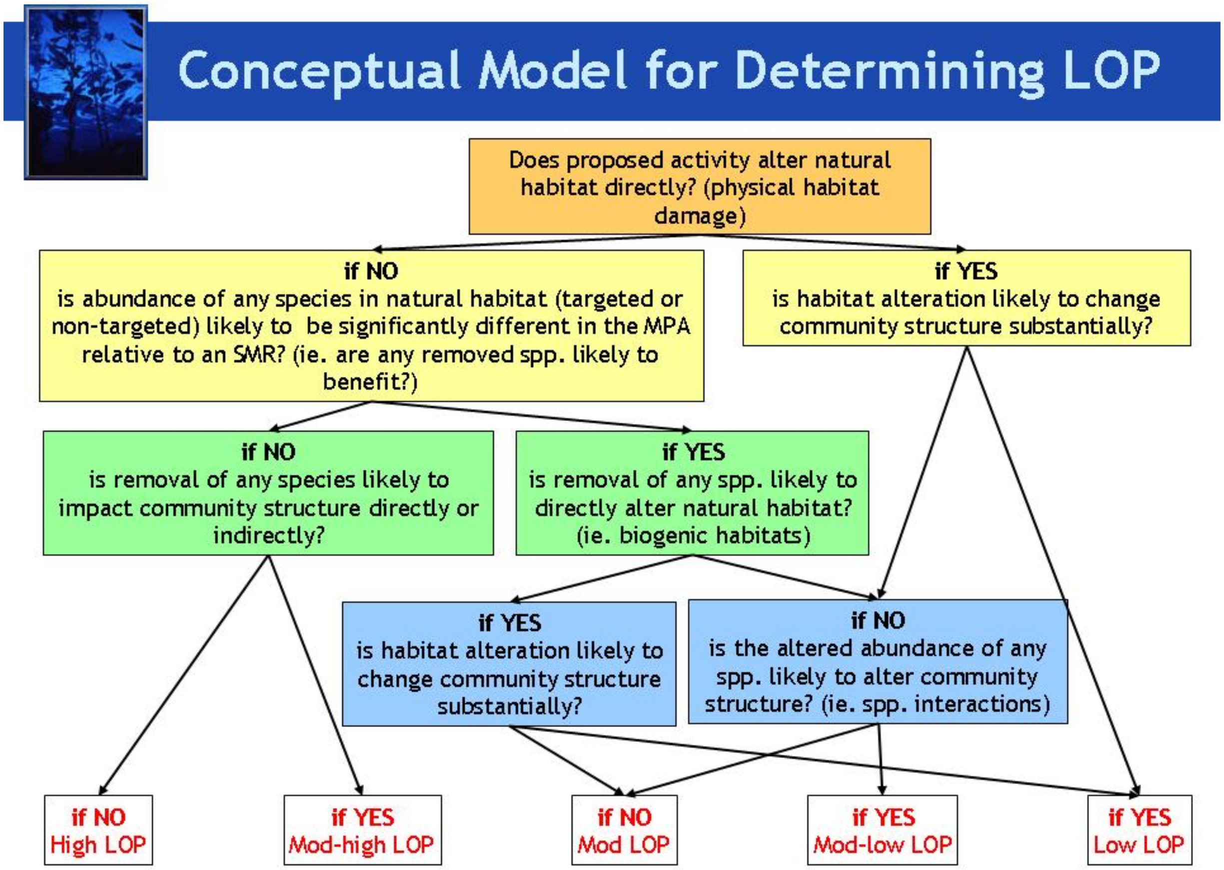
Levels of protection are based upon the likely impacts of proposed activities to the ecosystems within the MPA. Conceptually, the SAT seeks to answer the following question in assigning levels of protection: “How much will an ecosystem differ from an unfished ecosystem if one or more proposed activities are allowed?” To arrive at answer, the SAT will evaluate each activity that is proposed to be permitted in an MPA, asking “How much will this ecosystem differ from an unfished system if this one activity is allowed?” Where multiple permitted activities are proposed, the one with the greatest impact is the one that will “win,” meaning that the LOP ascribed to the MPA will be the LOP that would result if that single, highest-impact activity were the only one allowed.

Marine reserves (SMRs) are, by definition, unfished ecosystems, therefore we ascribe to them the highest protection level, “very high.” To MPAs that allow extractive activities are ascribed 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 3-1 presents the decision flow for determining the level of protection of a proposed MPA based on one permitted activity. It asks questions about the activity so as to result in a LOP designation for the MPA where that activity will be allowed. This same decision flow will be used for every activity that is proposed to be permitted, so that the one resulting in the lowest LOP designation for a particular MPA is the one that will determine the LOP designation actually assigned.

As the term is used here, “activity” refers to:

- take of a particular species,
- by a particular method,
- at a particular range of depths.

Figure 3-1. Conceptual Model for Determining the Level of Protection in an MPA Based on an Extractive Activity Permitted There



In applying the conceptual model presented in Figure 3-1 the SAT makes three important assumptions:

- Any extractive activity can occur at high intensity.
- 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.
- 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 five sources of data in the analysis: 1) California Recreational Fisheries Survey angler interviews (CRFS interviews), 2) CRFS onboard observer data (CRFS observer data), 3) DFG commercial landing receipt data, 4) DFG log book data from recreational commercial passenger fishing vessels (CPFVs), and, where adequate scientific information was lacking, 5) 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. 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. For example, an interviewed angler or CPFV logbook may report yellowtail as the primary target but may have switched fishing effort to target kelp bass during the trip. Both yellowtail 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 yellowtail, 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. 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 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 data include both examined catch and catch that was not examined by a sampler but reported by anglers as discarded either dead or alive. CRFS data are reported as numbers of fish.

Commercial landing receipts 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."

Logbook data from CPFV recreational fishing trips in the study region 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 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 LOP designation resulting from any allowed activity is the one 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 – Proposed activities were assigned this level of protection if the SAT concluded that the activity: 1) does not directly alter habitat, 2) is unlikely to significantly alter the abundance of any species relative to an SMR, and 3) is unlikely to have an impact on community structure relative to an SMR. The mobility of removed species (both target and associated catch) was an important factor in determining the activity's impact on abundance and community structure. 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 different in a fished area relative to an SMR. Altered abundance of a species, and the associated changes in ecological interactions (e.g. predator/prey, competitive, or mutualistic relationships) are what drives changes in community structure. If the proposed activity is unlikely to alter the abundance of *any* species relative to an SMR, community structure is expected to be unaltered as well and the activity is expected to have little impact on the ecosystem.

Moderate-high – Activities were assigned this level of protection if the SAT concluded that the activity: 1) does not directly alter habitat, 2) is unlikely to significantly alter the abundance of any species relative to an SMR, but 3) has some potential to alter community structure relative to an SMR. Activities assigned this level of protection are generally characterized by substantial uncertainty regarding ecosystem impacts. This uncertainty arises in one of three ways: 1) the movement range of the target species is either uncertain or short enough that reserve effects are possible, yielding uncertainty as to whether the abundance of this species will be altered relative to an SMR, 2) the level or composition of incidental catch is uncertain making it unclear whether the abundance of any non-target species will be altered relative to an SMR, or 3) the ecological role of any removed species is unclear, leading to uncertainty about how removal may alter community structure relative to an SMR.

Moderate – Activities were assigned to this level of protection if the SAT concluded that the activity was likely to alter either habitat or species abundance in the area relative to an SMR, but that these changes were unlikely to impact community structure substantially. Activities that are likely to cause minor habitat perturbations or alter the abundance of species that play a minor ecological role (e.g. one of many prey items) received this level of protection.

Moderate-low – Activities were assigned to this level of protection if the SAT concluded the activity was likely to: 1) alter species abundance relative to an SMR, and 2) alter community structure significantly through the change in abundance of a species that plays an important ecological role (e.g. top predator) but does not form biogenic habitat. Activities assigned this level of protection may also alter habitat if that habitat alteration is unlikely to have a significant impact on community structure.

Low – Only activities that alter habitat in a way that is likely to significantly alter community structure were assigned to this level of protection. Activities with the potential to alter habitat substantially either through direct contact with fishing gear or removal of habitat-forming organisms received this low level of protection.

Table 3-1. Level of Protection and the Activities Associated with Levels of Protection in the MLPA South Coast Study Region

	Level of Protection	MPA Type	Activities Associated with a Protection Level
	Very high	SMR	No take
	High	SMCA	Coastal pelagic finfish, bonito, and market squid (pelagic seine, dip-net, crowder); <u>pelagic finfish, bonito, and white seabass (spear);</u> jumbo squid (squid jigs); swordfish (harpoon); **In water depth > 50m:** pelagic finfish, bonito and white seabass (H&L)
	Moderate-high	SMCA	Catch and release in <10m water or using surface gear (H&L single barbless hooks and artificial lures only); pier-based fishing (H&L, hoop-net); halibut (spear); **In water depth 30<50m <u>on mainland</u>:** pelagic finfish, bonito and white seabass (H&L)

	Moderate	SMCA SMP	spot prawn (trap/pots); sea cucumber (scuba/hookah); grunion (hand harvest); giant kelp (hand harvest); clams (hand harvest)
	Moderate-low	SMCA SMP	Catch and release in >10m (H&L); shore-based finfish (H&L); kelp bass, barred sand bass, lingcod, cabezon, and rockfish (H&L, spear); sheephead (H&L, spear, trap); spotted sand bass and halibut (H&L); lobster (trap, hoop net, scuba); urchin (scuba/hookah); rock crab and Kellet's whelk (trap); finfish (H&L, spear, trap) **In water depth <50m at islands and <30m on mainland:** pelagic finfish, bonito and white seabass (H&L)
	Low	SMCA SMP	rock scallop (scuba); mussels (hand harvest); giant kelp (mechanical harvest); marine algae other than giant and bull kelp (hand harvest); ghost shrimp (hand harvest)

Only SAT-approved designations are included in this table. It should be noted that staff is working with the SAT to coordinate terminology for particular gear types that is consistent with both the activities being proposed by the RSG and as defined in regulations under California Fish and Game Code. Thus the descriptions here may change in a future version of this document.

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 resident species that are likely to otherwise receive protection within the MPA. Although depth- and habitat-related bycatch information for specific fisheries are not readily available, it is likely that bycatch 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[1] 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 DFG, contributed to SAT's categorization of MPAs into levels of protection.

In assigning depth-dependent levels of protection the SAT recognizes that other MPA design considerations may necessitate capturing multiple depth zones within an MPA. For example, an MPA designed to allow take of pelagic finfish in deep (>50m depth) waters may include a small area of shallower (<50m depth) habitat because of the necessity for straight-line MPA

[1] 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.

boundaries. To accommodate these real-world design constraints in assigning depth-dependent levels of protection the SAT considers an MPA to include a given depth-zone only if it contains more than 0.2 square miles of that depth zone.

The SAT's LOP Designations for Potential Allowed Uses

The Science Advisory Team considers each potential allowed use individually to arrive at the decisions summarized in Table 3-1. A complete decision matrix of all uses for which an LOP designation has been approved by the SAT is in Appendix A of this document. This subsection presents an in-depth description of the rationale for each decision made by the SAT.

It should be noted that the following explanations are only those approved thus far by the SAT. The matrix in Appendix A includes decisions for which the full textual explanation, as given in this subsection, will appear in the following revision of this document.

Pelagic finfish,[2] Pacific bonito, and white sea bass (hook and line or spear)

Direct impacts – Take of pelagic finfish by hook and line is unlikely to alter habitat directly 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*) and white seabass (*Atractoscion nobilis*) are not defined as pelagic finfish in California regulations, but they share many characteristics with the above species and are often caught in conjunction with other pelagics. Pelagic finfish are highly mobile species that are unlikely to benefit directly from MPAs constrained within state waters, thus the abundance of these species is unlikely to be altered in an area that allows take relative to a state marine reserve (SMR).

Fishing for pelagic finfish with spear gear requires visual contact with the target, thus the incidental catch in this fishery is likely to be minimal. Data on associated catch of pelagic finfish using hook and line gear were extracted from commercial passenger fishing vessel (CPFV) observer data collected by DFG, but were difficult to interpret because they do not resolve the targeted species. Observer catch records for bonito, mackerel, yellowtail, white seabass, and barracuda all indicate a high associated catch of basses (kelp bass and barred sand bass) and other reef-associated fishes, including rockfish, halfmoon, scorpionfish, and sheephead. CPFV angler interview data (which resolves catch by target but does not account for target switching within a trip) confirms the associated catch

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[2] 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.

relationship between pelagic finfish and nearshore resident species. If associated catch of resident species is substantial, the abundance of these species may be altered by take of pelagic finfish relative to an SMR.

Catch information was insufficient to assess the magnitude of incidental catch, though one study observed an average of 28% incidental catch on CPFVs in southern California (Hanan and Curry 2009). However, the primary gear and methods used to take pelagic finfish are virtually identical to those used when targeting nearshore resident species, such as kelp bass and barred sandbass. Thus the SAT concluded that avoidance of shallow nearshore habitats was the only way to reliably reduce incidental catch of resident species. The SAT used the depth distribution of kelp forests and sandbass breeding aggregations to delineate depth zones where incidental catch of resident species was more or less likely. Also, data from Hanan and Curry (2009) showed that incidental catch rates of basses and other reef-associated fishes decreased with increasing depth, with the highest incidental catch rates occurring in water shallower than approximately 25 meters.

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 – spear, any depth

High – hook and line, if water depth in MPA is greater than 50m; and

Mod-high – hook and line surface gear on mainland if water depth in MPA is less than 50m but greater than 30m due to potential increase in associated catch of resident species

Mod-low – hook and line if water depth is less than 30m on the mainland or 50m at the islands

Rock scallop (scuba hand collection)

Direct impacts – Hand collection of rock scallops (*Crassadoma gigantea*) 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. The removal of rock scallops is likely to have an impact on community structure by altering reef structure and habitat for benthic invertebrates.

Rock scallops 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 harvest of rock scallops is likely to alter their abundance relative to an SMR.

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:

Low

Urchin hand collection

Direct impacts – Hand collection of urchins causes some habitat disturbance (divers may move rocks to better remove the urchins) but these habitat effects are unlikely to alter community structure significantly.

Several species of sea urchins inhabit shallow rocky reefs along the coast of California. The two most abundant species on shallow rocky reefs throughout the coast of California are the red and purple sea urchin (*Strongylocentrotus franciscanus* and *purpuratus*, respectively). In southern California, two other species can be locally abundant on rocky reefs, the crowned sea urchin, *Centrostephanus coronatus* and the white sea urchin, *Lytechinus anamesus*. The red urchin is the only species taken commercially in California waters. All but the white sea urchin are relatively sedentary species. Thus, the abundance of red sea urchins within an area may be altered by harvest relative to an SMR, depending on the level of protection and rates of predation by other sea urchin predators. However, divers harvest selectively so there is little or no catch of non-target species.

Indirect impacts – Urchins are ecologically important species in most shallow rocky ecosystems (Lawrence 1975, Harrold and Pearse 1987). They can be important herbivores, prey, competitors and facilitators of other species in nearshore rocky habitats. Throughout their range, populations of sea urchins can impact (decrease) the abundance of macroalgae, thereby altering both the total abundance of macroalgae, the relative abundance of species of macroalgae in a kelp forest, and the abundance of invertebrates and fishes associated with habitats created by macroalgae (Graham 2004, Graham et al 2008). Sea urchins feed on both drift (i.e. detached) and attached growing macroalgae. Their impact on the local abundance of drift and attached algae is a function of their local abundance, food availability and abundance of their predators. In low abundance, with sufficient drift availability and the presence of predators, red sea urchins restrict their distribution to crack and crevices and feed on drift. With insufficient drift abundance (Ebeling et al 1985, Harrold and Reed, 1985, Tegner and Dayton 1991) or reduced predator abundance (Cowen 1983), red sea urchins emerge from cracks and crevices and form “feeding fronts” that remove all macroalgae where they travel (see Table 2 in Harrold and Pearse, 1987). Other triggers of destructive grazing events include episodes of strong recruitment of sea urchins and loss of abundant drift caused by reduction of kelp by other factors (storms, El Niño events, grazing amphipods).

Adult sea urchins are eaten by several predators in shallow rocky reefs, including the sea otter, *Enhydra lutris*, wolf eel, *Anarrhichthys ocellatus*, California spiny lobster, *Panulirus interruptus* (Tegner and Levin 1983, Berhens and Lafferty 2004), California sheephead, *Semicossyphus pulcher* (Cowen 1983), sunflower sea star, *Pycnopodia helianthodes*, and other species. Small sea urchins are eaten by other predators (e.g., other sea stars, crabs and other species). Three lines of evidence from the south coast study region suggest that these predators, when they occur in sufficient abundance, can control/suppress the abundance of their sea urchin prey. In one marine reserve in the northern Channel Islands (Anacapa Island), spiny lobster and California sheephead were more numerous, sea urchin density was lower and the abundance of giant kelp, *Macrocystis pyrifera*, was higher than areas outside the reserve (Behrens and Lafferty 2004). Similarly, after five years of protection, an increase in kelp abundance has been observed within the Channel Islands MPAs compared to adjacent areas, though there is no direct evidence for a trophic basis for this response (B. Kinlan pers Comm., The First Five Years of Monitoring the Channel Islands Marine Protected Area Network) Thirdly, between the extirpation of sea otters and the advent of the sea urchin fishery, kelp forests were extensive in southern California demonstrating that other factors besides fishermen controlled sea urchins (Crandall 1912). These interactions between multiple predators (including man) and their prey, suggest that these predators may compete for sea urchins. Thus, the local impacts of human take may diminish the local growth, reproduction and abundance of the other predators of sea urchins in a marine protected area. In addition, at high densities, sea urchins experience high mortality from disease (Lafferty 2004) reducing the local abundance of sea urchin populations.

Sea urchins compete with other herbivores for both drift and intact algae. They also compete with other species for refuge from predators in cracks and crevices. In particular, sea urchins compete with abalone for both drift algae and refuge space (Karpov et al. 2001). In contrast, red sea urchins serve as nursery sites for other small invertebrates, protecting them from predators during their vulnerable life stages. Young abalone seek shelter beneath the spines of red sea urchins and the density of abalone recruits can be greater in northern California MPAs where red sea urchins are protected from take[3].

Based on the various species interactions described above, removal of urchins by urchin harvest is likely to have impacts on community structure, especially the total and relative abundance of other sea urchin predators, within an MPA.

Level of protection:

Moderate-low – due to indirect ecosystem effects

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

Spot prawn (trap):

Direct impacts – Take of California spot prawn (*Pandalus platyceros*) with traps involves bottom contact but is unlikely to alter habitat.

Spot prawn are a moderately mobile species (Boutillier and Bond, 2000) which may benefit directly from MPAs within state waters. Tagging studies of spot prawn from British Columbia show that individuals remain within a mile or two of their release location over several months (Boutillier, unpublished data). This finding is supported by a study that found significant differences in parasite loads between populations separated by only 10s of kilometers (Bower and Boutillier, 1990). 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. No data on associated catch for the spot prawn fishery 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, thus the fishing activity is unlikely to alter the abundance of any non-target species.

Indirect impacts – Spot prawn are micro-predators, feeding on other shrimp, plankton, small mollusks, worms, sponges, and fish carcasses. In turn, spot prawn are one of many available prey items for fishes and marine mammals. Any change to ecological interactions caused by reduced abundance of spot prawn is likely to have only minor impacts on community structure within an MPA.

Level of protection: **Moderate**

Sea cucumber (scuba/hookah hand collection):

Direct impacts – Hand collection of sea cucumber (*Parastichopus parvimensis*) has the potential to alter habitat (anchoring and search activities can disturb both rock and kelp as habitat), but habitat alterations are unlikely to have a significant impact on community structure.

Sea cucumber are relatively sedentary bottom-dwelling species that are likely to benefit directly from MPAs within state waters. 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 (Schroeder et. al. 2001). The low adult movement of sea cucumber indicates that the abundance of sea cucumber is likely to be lower in a fished area as compared to a no-take marine reserve. Because divers harvest selectively, there is little or no catch of non-target species, thus the fishing activity is unlikely to alter the abundance of any non-target species.

Indirect impacts – Sea cucumbers are detritivores and prey for sea stars (especially Pycnopodia) in the nearshore rocky environment. Any change to ecological interactions caused by reduced abundance of sea cucumber is likely to have only minor impacts on community structure within an MPA.

Level of protection: **Moderate**

Grunion (hand collection):

Direct impacts – Collecting grunion (*Leuresthes tenuis*) by hand from beaches is unlikely to alter habitat.

Grunion are a highly mobile species that is unlikely to benefit from MPAs constrained within state waters unless those MPAs protect spawning sites. Genetic studies of grunion indicate panmixia within the Southern California Bight (Gaida et al, 2003) and high genetic similarity between populations in San Francisco Bay and Los Angeles (Johnson et al, 2009). These genetic studies support the conclusion that grunion are highly mobile. However, 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 breed at the beach where they were spawned (Martin, K., personal communication). Due to natal homing and spawning aggregations, the abundance of spawning grunion may be altered by hand collection relative to an SMR. Because collectors harvest selectively, there is little or no catch of non-target species, thus the fishing activity is unlikely to alter the abundance of any non-target species.

Indirect impacts – Although grunion are a highly mobile pelagic species they form spawning aggregations and deposit large numbers of eggs on sandy shores. Spawning grunion and their eggs are important, if sporadic, prey in the nearshore ecosystem, thus an altered abundance of grunion may have some minor impacts on the beach community but is unlikely to change community structure significantly.

Level of protection: **Moderate**

Kelp bass (hook and line or spear):

Direct impacts – Take of kelp bass (*Paralabrax clathratus*) by hook and line or spear is unlikely to alter habitat as gear rarely touches the seafloor.

Kelp bass 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 hundreds of kilometers, possibly in search of better habitat (Collyer & Young 1953) (Young 1963) (Quast 1968). 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 one km or more (Lowe et al 2003). Using passive acoustic telemetry methods, Mason (2008) found 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 (Tetreault and Ambrose 2007) (Froeschke et al 2006). Tetreault and Ambrose 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. 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 that their abundance is likely to be altered by take relative to an SMR.

CRFS observer and interview data indicate that kelp bass catch using hook and line gear is often associated with catch of other resident reef species including barred sand bass, sheephead, halfmoon, blacksmith, and several nearshore rockfish species. This indicates that the abundance of non-target species may also be altered by hook and line fishing for kelp bass. No data was examined to determine associated catch using spear gear, but a targeted spear fishery is unlikely to produce incidental catch of non-target species.

Indirect impacts – Kelp bass are top predators on nearshore rocky reefs, so that their 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**

Barred sand bass (hook and line or spear):

Direct impacts – Take of barred sand bass (*Paralabrax nebulifer*) by hook and line or spear is unlikely to alter habitat as gear rarely touches the seafloor.

Barred sand bass are demersal fish which 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. DFG (1982) tagging studies from the 1980s indicate movements from five to 40 miles 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 (Mason 2008). In this study, eight 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 (Tetreault & Ambrose 2007), 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 (Baca Hovey et al 2002) 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. Due to breeding aggregations and likely low adult movement, catch of barred sand bass is likely to alter their abundance relative to an SMR.

Indirect impacts – Barred sand bass are important predators in the nearshore environment, so 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**

California sheephead (hook and line, spear, or trap):

Direct impacts – Take of California sheephead (*Semicossyphus pulcher*) by hook and line or spear is unlikely to alter habitat as gear rarely touches the seafloor. Use of trap gear involves bottom contact but is also unlikely to alter habitat significantly.

Sheephead are demersal fish which 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) 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) 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) 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 sheephead abundance is likely to be altered by take relative to an SMR.

Indirect impacts – Sheephead are important predators on nearshore rocky reefs, so 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 (Tegner & Dayton 1981) (Cowen 1983). Throughout their range, urchin populations can decrease kelp abundance, thereby altering the relative abundance of macroalgae in a kelp forest.

Level of protection: **Moderate-low**

Spotted sand bass (hook and line):

Direct impacts – Take of spotted sand bass (*Paralabrax maculatofasciatus*) by hook and line is unlikely to alter habitat as gear rarely touches the seafloor.

Spotted sand bass 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 (Allen, unpublished data). Spotted sand bass form breeding aggregations just near the entrances of embayments between May and September (Allen et al 1995). One study in southern California showed that different populations of spotted sand bass display varied mating strategies (Hovey & Allen 2000), which further supports the conclusion that spotted sand bass are relatively sedentary and thus their abundance is likely to be altered by take relative to an SMR.

Indirect impacts – Spotted sand bass are important predators in coastal embayments, so 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**

Spiny lobster (traps, hoop nets, or hand take by scuba):

Direct impacts – In the SCSR, spiny lobster (*Panulirus interruptus*) are taken using three main methods: recreational hand collection by scuba- or free-divers, 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), but these habitat effects are unlikely to alter community structure significantly.

The movement habits of spiny lobster are not well known. Some reports indicate that adult lobster migrate offshore into deeper waters during the winter months (DFG 2001) 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 (Hovel & Lowe, in prep). 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 (Iacchei 2005). 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.

Bycatch in the lobster fishery, while not well quantified, is likely low and unlikely to alter the abundance of any other species relative to an SMR. 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 ecosystem driver by reducing and stabilizing urchin populations (Tegner & Levin 1983) (Lafferty 2004) (Behrens & Lafferty 2004). 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**

Clams (all methods of hand harvest):

Direct impacts – Take of clams (numerous species) is unlikely to permanently alter habitat in the dynamic soft bottom environments where harvest takes place.

Clams are relatively sedentary animals with limited adult home ranges, thus their local abundance is likely to be altered by take relative to an SMR.

Indirect impacts – Clam digging may alter the behavior of local shorebirds and marine mammals, and could kill non-target infaunal species, including improperly placed sublegal clams. Though clams are an important food source for a variety of fishes and elasmobranchs, hand harvest is unlikely to have a large impact on community structure, since it only occurs in the intertidal zone, thereby leaving a large proportion of the clam population unharvested.

Level of protection: **Moderate**

Marine algae other than giant and bull kelp (hand harvest):

Direct impacts – Take of marine algae (all species except *Macrocystis pyrifera* and *Nereocystis luetkeana*) is unlikely to significantly alter habitat created by the geologic substrate. However, because marine algae provide structure and habitat for a wide variety of species, their removal alters the type and abundance of habitat available for hundreds of other species.

Several species of intertidal and subtidal algae may be taken by hand harvest in the South Coast Study Region. Since all species are sessile and their reproductive propagules travel short distances, their local abundance is likely to be altered by take relative to an SMR.

Indirect impacts – Marine algae provide structure and habitat for a rich and unique community of organisms. Therefore, its removal has the potential to change community structure substantially.

Level of protection: **Low**

Swordfish (harpoon):

Direct impacts – Take of swordfish (*Xiphias gladius*) by harpoon will not alter habitat.

Swordfish are a highly mobile pelagic species found in tropical and temperate waters worldwide. Their wide-ranging habits mean their local abundance is unlikely to be altered by take relative to an SMR.

Indirect impacts – Harpooning swordfish requires fishermen to make visual contact with the target, therefore associated catch is extremely low.

Level of protection: **High**

Halibut (spear):

Direct impacts – California halibut (*Paralichthys californicus*) are a moderately mobile species that inhabits a wide range of habitats in California. Although the movement patterns of halibut are not fully understood, several studies indicate that young (mostly sub-legal sized) California halibut stay within

2-5 km of their tagging release site for months or years, while some move hundreds of km within that same time period (Domeier and Chun 1995, Posner and Lavenberg 1999) There is also information to suggest that larger halibut may be more mobile than small. Because the mobility of adult halibut is not well known, it is unclear whether their abundance will be altered by take relative to an SMR. Spearfishing for halibut is unlikely to disturb habitat.

Indirect impacts – Though associated catch through spearfishing is likely to be extremely low, removal of halibut could have indirect impacts on community structure. Halibut are important predators in the benthic ecosystem, and although they are moderately mobile, any reduction in their abundance could alter local trophic interactions.

Level of protection: **Moderate-High**

Halibut (hook and line):

Direct impacts – California halibut (*Paralichthys californicus*) are a moderately mobile species that inhabits a wide range of habitats in California. Although the movement patterns of halibut are not fully understood, several studies indicate that young (mostly sub-legal sized) California halibut stay within

2-5 km of their tagging release site for months or years, while some move hundreds of km within that same time period (Domeier and Chun 1995, Posner and Lavenberg 1999) There is also information to suggest that larger halibut may be more mobile than small.

Because the mobility of adult halibut is not well known, it is unclear whether their abundance will be altered by take relative to an SMR. However, associated catch includes demersal sharks, skates and rays, other flatfish, and a variety of reef fish including rockfish, lingcod, and cabezon. There is also a substantial likelihood of associated catch of barred sandbass (Appendix XX). Many of these species, including barred sandbass, would otherwise be protected by MPAs. Fishing for halibut with hook and line gear (including longlines) involves bottom contact but causes little habitat disturbance.

Indirect impacts – Halibut are important predators in the benthic ecosystem, feeding on a variety of schooling fish and benthic organisms (Cailliet et al. 2000) . Although they are moderately mobile, any reduction in their abundance could alter local trophic interactions.

Level of protection: **Moderate-Low**

Jumbo squid (hook and line):

Direct impacts – Jumbo squid, also known as Humboldt squid (*Dosidicus gigas*), are a highly mobile species. Their abundance is unlikely to be altered by take relative to an SMR, and fishing for jumbo squid using hook and line is unlikely to disturb habitat.

Indirect impacts – Take of jumbo squid is unlikely to change local community structure, given their high mobility. Associated catch is very low when fishing for jumbo squid, since squid jigs do not readily catch other species.

Level of protection: **High**

Mussels (hand harvest):

Direct impacts – Take of mussels (*Mytilus californianus* and *M. galloprovincialis*) by hand is unlikely to directly damage the rocky substrate to which they attach. However, mussels are a functionally sessile species, so their local abundance is likely to be altered by take relative to an SMR.

Indirect impacts – Mussels create important biogenic habitat for a huge variety of species (Suchanek 1992, Lohse 1993), and are an important prey item for numerous rocky shore predators. Their removal significantly alters the species community at that given location.

Level of protection: **Low**

Squid (pelagic seine, dip-net, crowder):

Direct impacts – Market squid (*Loligo opalescens*) are a highly mobile pelagic species that is unlikely to benefit directly from MPAs within state waters. 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. Dip-nets and crowders do not contact the bottom, and though pelagic seine gear rarely touches the seafloor, it causes little or no direct habitat damage. Landings of non-target species are low and comprised almost entirely of other highly-mobile schooling fish (Appendix XX), thus the direct impacts of the fishing activity on the resident ecosystem are expected to be low.

Indirect impacts – As noted above, squid are highly mobile species and squid fishing gear has very low incidental catch of other highly mobile species, so the indirect impacts of the fishing activity on the resident ecosystem are expected to be low.

Level of protection: **High**

Rock crabs (trap):

Direct impacts – Take of rock crabs (*Cancer antennarius*, *C. productus*, and *C. anthonyi*) by trap is unlikely to damage habitat, though traps do contact the bottom.

Rock crabs are important predators and scavengers in the benthic marine ecosystem of southern California. A tagging study from central California showed them to have low mobility as adults; almost half of the recovered tagged crabs were found at their original release site up to 18 months after release, and 7 km was the maximum distance any crab traveled (Carroll 1982). Additionally, data from southern California shows that in Santa Monica Bay, which is closed to crab fishing, crabs are larger, size frequencies are broader, and experimental catch rates are higher than in areas open to crab fishing (Leet et al. 2001). These studies indicate that rock crab abundance is likely to be altered by take relative to an SMR.

Indirect impacts – Rock crabs play an important ecosystem role as scavengers and predators, and are prey for a variety of other predators. Thus their removal from the ecosystem is likely to impact community structure.

Level of protection: **Moderate-Low**

Coastal pelagic finfish and bonito (seine, dip-net, crowder):

Direct impacts – Coastal pelagic finfish[4] and bonito (*Sarda chiliensis*) are highly mobile pelagic species that are unlikely to benefit directly from MPAs within state waters. Dip-nets and crowders do not contact the bottom, and though pelagic seine gear rarely touches the seafloor, it causes little or no direct habitat damage. Landings of non-target species are low and comprised almost entirely of other highly mobile schooling fish (Appendix XX), therefore the direct impacts of the fishing activity on the resident ecosystem are expected to be low.

Indirect impacts – Coastal pelagic finfish and bonito feed on a variety of planktonic organisms and smaller fish. Since these schooling species and their prey are highly mobile,

[4] The term "coastal pelagic finfish" includes: northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*).

and incidental catch is low and comprised mainly of other highly mobile species, the indirect ecosystem impacts of take are predicted to be low.

Level of protection: **High**

Cabezon, rockfish, and lingcod (hook and line or spear):

Direct impacts – Cabezon (*Scorpaenichthys marmoratus*), rockfish (many species, *Sebastes* spp.), and lingcod (*Ophiodon elongatus*) are important members of rocky reef communities. They have low adult mobility, thus their abundance is likely to be altered by catch relative to an SMR. Associated catch for any of these species could include other reef fishes with low mobility. Fishing for these species with spear does not involve bottom contact, though fishing with hook and line gear (including longlines) could involve bottom contact but causes little habitat disturbance. It is important to note that a level of protection was determined for cabezon, rockfish, and lingcod individually. Since all three received the same level of protection for the same reasons, they are being presented here as a group.

Indirect impacts – Cabezon, rockfish, and lingcod are important predators in rocky reef ecosystems. Decreasing their abundance through take could have strong indirect impacts on rocky reef trophic systems.

Level of protection: **Moderate-Low**

Kellet's whelk (trap):

Direct impacts – Kellet's whelk (*Kelletia kelletii*) is an important benthic predator in rocky reefs, kelp forests, and soft bottom communities. Though little data are available, the morphology of adult Kellet's whelks indicates they have low mobility, so their abundance is likely to be altered by catch relative to an SMR. It should be noted that Kellet's whelk is not a targeted fishery at this time; the species is legally taken as incidental catch in crab traps. However, a fishery is developing and members of the South Coast Regional Stakeholder Group have proposed MPAs that specifically allow the take of Kellet's whelk. Crab traps that currently trap Kellet's whelk contact the habitat, but cause little damage.

Indirect impacts – Kellet's whelk is an important predator, particularly on herbivorous snails and other grazers. Therefore removal of the species from a given location could indirectly affect a number of other species in the ecosystem, particularly algae including kelps.

Level of protection: **Moderate-Low**

Ghost shrimp (all methods of hand harvest):

Direct impacts – Take of ghost shrimp (*Neotrypaea californiensis*) directly alters habitat by removing these important habitat engineers from the ecosystem.

Ghost shrimp are a relatively sedentary species that create branched burrows in mudflats in estuaries and bays. They are important bioturbators and their burrows create habitat for a wide variety of species, including pea crabs, gobies, and burrowing clams. Additionally, they are a significant portion of the biomass in some mudflats and are important prey for some fishes and birds.

The local abundance of ghost shrimp is likely to be altered by take relative to an SMR for two reasons. First, adults have limited home ranges, so local abundance is sensitive to the removal of individuals. Second, the trampling associated with collecting ghost shrimp may amplify the decrease in shrimp abundance. For example, Wynberg and Branch (1994) found a 70% population decline of a similar ghost shrimp species when only 10% of the population was actually removed. They attributed the difference to smothering in collapsed burrows caused by trampling on the surface.

Indirect impacts – Since ghost shrimp are important habitat engineers and modify their environment to the benefit of other species, their removal could limit the available habitat for a suite of associated species, thereby altering mudflat community structure. Additionally, the trampling associated with ghost shrimp collection could reduce other macrofauna populations (Wynberg and Branch 1997) and could kill non-target infaunal species.

Level of protection: **Low**

Shorefishing (hook and line):

Direct impacts – Fishing from shore using hook and line gear may cause some disturbance of intertidal habitat, but is unlikely to significantly alter habitat.

Recreational anglers in the SCSR take a wide range of species from shore, some of which have small home ranges, limited depth distribution or special breeding habits that make them especially vulnerable to shore-based fishing. Although shorefishing only directly targets fishes in a relatively narrow band along the coastline, the impacts of shorefishing may extend further offshore or into adjacent habitats by altering the abundance of species that utilize multiple habitats and depth zones throughout their life cycle.

Sandy Shores: Surfperches are the most common group of fishes taken from sandy shores, comprising 69% of the catch. Barred surfperch, are the most common species, but walleye, sliver, black, and shiner surfperch are also caught. Croakers (mostly yellowfin, corbina, and spotfin croaker) are the second most common group caught from sandy shores, comprising 13% of the catch. Other groups caught from sandy shores include California halibut (5%), jacksmelt and other silversides (3%), leopard and smoothhound sharks (3%), various skates and rays (2%), and basses (2%). All of these species move from shallower to deeper depths and back with the possible exception of barred surfperch, whose range may be more limited to the sandy surf zone.[5] Surfperches, in particular may be especially vulnerable to shore fishing as some species aggregate in the surf zone to breed. For some species the effects of extraction from sandy beach surf zones may be

[5] Pers. comm. Milton Love, Associate Research Biologist, UC Santa Barbara

limited to that habitat, whereas effects on many others are likely to extend into adjacent deeper (less than 30 m depth) sand habitat offshore.[5]

Rocky Shores: Sea chubs (opaleye and halfmoon) are the most common group of fishes taken from the rocky shore, comprising 32% of the catch. Surfperch, especially barred, black, and walleye perch are the second most common group caught from rocky shores, comprising 29% of the catch. Other groups caught from rocky shores include jacksmelt, skates and rays (6%), kelp and other basses (4%), grass and other rockfishes (3%), California halibut (2%), sheephead and other wrasses (2%), and cabezon (2%). 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.

Estuaries: Silversides (jacksmelt and topsmelt) are the most common group of fishes taken from shore in estuarine environments, comprising 25% of the catch. Croakers, especially white, yellowfin and spotfin croakers, are the second most common group caught from estuarine shores comprising 19% of the catch. Other groups caught from estuarine shores include the basses, especially spotted sandbass (17%), mackerel and bonito (11%), California halibut (8%), skates and rays (6%), and surfperches (5%). Many of the species caught from shore in estuaries are known to utilize multiple habitats, thus the extraction of these species from estuaries likely influences species abundance in adjacent habitats.

Indirect impacts – Many of the species removed through shorefishing play important roles in the nearshore community. For example, surfperches and croakers are important invertebrate predators , sea chubs (opaleye and halfmoon) are important omnivorous grazers, silversides are micro-omnivores and all groups provide important prey for a variety of larger fishes marine birds and mammals. By altering the abundance of multiple species shorefishing is likely to have impacts on community structure within an MPA both within the range of the actual fishing gear as well as in adjacent depth zones and habitats.

Level of protection: **Moderate-low**

Pier fishing (hook and line, hoop net, dip net):

Direct impacts – Pier fishing is a subset of shorefishing that occurs from artificial structures that are supported by pilings and usually extend over soft bottom habitat. Fishing from piers using hook and line and hoop net gear may involve some contact with the underlying soft bottom habitat, but is unlikely to significantly alter habitat.

Recreational anglers in the SCSR take a number of species from piers, mostly mobile schooling fishes as well as some lobsters and rock crabs. Highly mobile scombrid fishes (Pacific mackerel and bonito) are the most common group taken by hook and line from piers comprising 37% of the catch. Other mobile schooling fishes commonly caught from piers include Pacific sardine (15%), jacksmelt and other silversides (15%), and anchovies

(7%). Less mobile groups caught from piers, include croakers (8%), surfperches (7%), and kelp and other basses (3%). Catch records were not available for hoop-net gear which is sometimes employed from piers to catch lobsters and rock crabs.

Fishing from piers has a limited zone of influence relative to other types of shore fishing because it occurs only on isolated man-made structures. The artificial habitat formed by pier structures attracts a variety of marine species including some relatively sedentary rocky reef species (such as kelp bass), but these small populations may not be highly connected to nearby rocky reefs due to intervening soft-bottom habitat. Catch from piers is primarily composed of highly mobile species and thus pier fishing is likely to have little impact on the abundance of any species in nearby natural habitats.

Indirect impacts – Most species caught from piers are highly mobile and MPAs are likely to have little impact on the local abundance of these species, thus the indirect ecosystem impacts of pier fishing are predicted to be low.

Level of protection: **Moderate-high**

Giant kelp (mechanical harvest):

Direct impacts – Mechanical harvest of giant kelp (*Macrocystis pyrifera)* does not directly alter the substrate in a kelp bed because gear never touches the seafloor. However, mechanical harvest significantly alters the abundance of kelp by removing large swaths of kelp canopy to a depth of approximately 4 feet (CDFG 2000). Kelp canopy forms important habitat for a variety of invertebrates and marine fishes including juvenile rockfish. Several studies indicate that repeated kelp harvest may retard kelp growth rates and possibly weaken holdfasts, making kelp more vulnerable to uprooting in stormy conditions (Miller and Geibel 1973, McCleneghan and Houk 1985) but the results of all available studies are inconclusive in this regard.

Indirect impacts – Although studies have shown mechanical kelp harvest to have no measurable effects on adult fishes (Quast 1968b, Davis 1968), several studies have shown that juvenile rockfish and other canopy species shift their distribution away from harvested areas and this shift makes some fish more vulnerable to predation (Miller and Geibel 1973, McCleneghan and Houk 1985). Removal of large patches of kelp canopy may also increase the abundance of understory algae by making more light available for their growth (Kimura and Foster 1984). The combined effects of the removal of important canopy habitat and the resultant shifts in algal assemblages are likely to significantly alter kelp forest communities.

Level of protection: **Low**

Giant kelp (hand harvest):

Direct impacts – Hand harvest of giant kelp (*Macrocystis pyrifera)* does not directly alter the substrate in a kelp bed because gear never touches the seafloor. In contrast to mechanical harvest, hand harvest of giant kelp removes smaller patches of kelp canopy, clipping kelp stipes off at or near the surface. Due to the shallow and patchy removal of kelp canopy realized with hand harvest, a relatively small proportion of the available kelp canopy habitat within a kelp bed is likely to be removed through hand harvest. Kelp canopy forms important habitat for a variety of invertebrates and marine fishes including juvenile rockfish.

Indirect impacts – No studies were found that explicitly evaluate the impacts of kelp hand harvest on marine communities, therefore conclusions must be drawn through comparison to the effects of mechanical harvest. Studies have shown mechanical kelp harvest to have no measurable effects on adult fishes (Quast 1968b, Davis 1968) and the same pattern is likely to hold true for hand harvest. Several studies have shown that juvenile rockfish and other canopy species shift their distribution away from areas where kelp is harvested mechanically and this shift makes some fish more vulnerable to predation (Miller and Geibel 1973, McCleneghan and Houk 1985). Since hand harvest of kelp removes kelp canopy in a patchy distribution, the impact on the distribution of juvenile fish is likely to be less dramatic than that of mechanical harvest. Studies have shown that removal of large patches of kelp canopy through mechanical harvest may increase the abundance of understory algae by making more light available for their growth (Kimura and Foster 1984). In contrast, the smaller patches of canopy removed by hand harvest and the fact that hand harvest cuts kelp at or near the surface indicates that light availability to understory algae is likely to be increased only slightly and for a brief period of time as kelp canopy from harvested plants is likely to regenerate quickly. In conclusion, the patchy and shallow nature of kelp canopy removal due to hand harvest is likely to have little impact on the underlying kelp forest community.

Level of protection: **Moderate**

Catch and release (hook and line):

Direct impacts – Catch and release fishing with hook and line is unlikely to alter habitat directly as gear rarely touches the seafloor.

In catch and release fishing, fish are brought to the surface, removed from the line, and released back into the water. Since no fish are explicitly removed from the ecosystem, the impacts of catch and release fishing depend on the post-release survivorship of the caught fish. Factors influencing survivorship include hooking location, depth of capture, and handling time at the surface (Bartholomew and Bohnsack 2005).

Studies have found a significant correlation between deep hooking (gut or internal organs) and subsequent mortality (Aalbers et al. 2004, Cooke and Suski 2004, Lyle et al. 2007). Deep hooking can be minimized through the use of unbaited artificial lures, which fish are less likely to swallow (Payer et al. 1989, Diggles and Ernst 1997, Nelson 1998). These lures frequently embed in the mouth, allowing for lower handling time at the surface as well.

Depth of capture is also an important determinant of post-release survival (Morrissey et al. 2005, St. John & Syers 2005). Fish caught at deeper depths are more likely to sustain barotraumas due to the rapid change in pressure as they are brought to the surface. Barotraumas include swim bladder rupture or expansion, stomach eversion, organ torsion, and subcutaneous gas bubbles (Jarvis and Lowe 2008). In a recent study, Jarvis and Lowe (2008) found a significant positive relationship between the number of barotraumas in rockfish and their depth of capture, regardless of species.

The SAT determined that fish caught at depths of less than 10m would likely suffer the fewest barotraumas, and that artificial lures and single barbless hooks would cause a low number of gut hookings. Therefore, the levels of protection for catch and release are divided into two categories. Catch and release fishing using artificial lures and single barbless hooks in waters shallower than 10m or in deeper waters with surface gear only will receive a level of protection of moderate-high. Catch and release fishing that does not adhere to these guidelines will receive a level of protection of moderate-low, due to increased likelihood of barotraumas or gut hooking, and thus decreased post-release survival.

Indirect impacts – The few studies that have investigated interspecific differences in post-release survival have shown that even closely-related species can vary in their ability to survival catch and release fishing (e.g. Jarvis and Lowe 2008). Therefore, without having detailed information about how sensitive each species is to catch and release fishing, it is difficult to predict indirect impacts. However, the abundance of some sensitive species with limited adult movement may be decreased by catch and release, and thus community structure may be altered within an MPA.

Level of protection:

Moderate-high – hook and line gear in depths shallower than 10m, from shore, or using surface gear provided only single barbless hooks and artificial lures are allowed

Moderate-low – hook and line in depths greater than 10m where surface gear is not specified or where gear other than single barbless hooks and artificial lures are allowed

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Appendix A. Levels of Protection for Potential Allowed Uses

This appendix shows all potential allowed usages for which the SAT has completed its analysis using the decision process given in chapter 3.

In applying the conceptual model presented in Figure 3-1, Table A-1 provides a decision matrix for some sample activities and the corresponding level of protection designated in Table 3-1. Table A-1 and Figure 3-1 should be viewed together to follow the decision pathway.

In Table A-1, colors across the top row correspond to the question level in the conceptual model in Figure 3-1, N/A indicates that question was not addressed following the decision flow.

Table A-1. Level of Protection Decision Matrix

	Question Level •	1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
barred sand bass (H&L or spear)	mod-low	NO	YES - target species has low movement & MPA effect has been shown	N/A	N/A	NO	N/A	YES - important predator
cabezon (H&L, spear)	high	NO	YES - target species has low movement, incidental catch includes other low mobility reef species	N/A	N/A	NO	N/A	YES - cabezon are important predators
catch and release (H&L barbless single hooks, and artificial lures only) in shallow <10m water or using surface gear	mod-high	NO	NO - likely low hooking mortality for most species using barbless single hooks with artificial lures (which result in fewer gut hookings), barotrauma unlikely in shallow waters (<10m), in estuarine environments unpublished data from LA shows a high tag return rate for spotted sandbass which indicates small populations and good survival rate	N/A	YES - sensitivity to handling varies by species, although we expect most species to have a high survival rate with proper handling, some species may be impacted by this catch and release fishing and thus impact community structure relative to an SMR	N/A	N/A	N/A
catch and release (H&L) in open coast environments >10m depth	mod-low	NO	YES - likelihood of barotrauma and mortality increases with depth	N/A	N/A	NO	N/A	YES - many removed species are important predators

Question Level •		1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
clams (hand harvest)	moderate	NO - dynamic soft-bottom is not highly sensitive to this disturbance	YES - clams don't move around much, maybe some incidental take or death of other sessile marine invertebrates	N/A	N/A	NO	N/A	NO - clams are an important food source for many fish and elasmobranchs, but hand harvest only occurs in the intertidal zone (a small portion of the depth distribution of clams) thus the impact of harvest on community structure is likely to be limited
coastal pelagic finfish* and bonito (seine, dip-net, crowder)	high	NO - bottom contact does occur with seine gear, but infrequently	NO - target species are highly mobile, incidental catch is comprised primarily of other highly mobile species	N/A	NO - target species are highly mobile and low incidental catch of resident species	N/A	N/A	N/A
ghost shrimp (hand harvest)	low	YES – ghost shrimp are important habitat engineers	N/A	N/A	N/A	N/A	YES – ghost shrimp burrows host a wide variety of species, so their removal alters community structure	N/A
giant kelp (hand harvest)	moderate	NO - doesn't damage the substrate, per se	YES - kelp doesn't move			YES - kelp canopy FORMS habitat (notably for the juveniles of commercialy important fish), so removing it removes habitat	NO - under current technology and spatial harvest methods, hand harvest results in only patchy removal of surface kelp canopy which likely does not substantially alter community structure	

	Question Level •	1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
giant kelp (mechanical harvest)	low	NO - doesn't damage the substrate, per se	YES - kelp doesn't move	N/A	N/A	YES - kelp canopy FORMS habitat (notably for the juveniles of commercialy important fish), so removing it removes habitat	YES - kelp provides structure for a rich and unique community, removal by mechanical harvest extends deeper than hand harvest and removes broad swaths of canopy, changing community structure substantially	N/A
grunion (hand take)	moderate	NO	YES - genetics suggest highly mobile, but likely breeding site fidelity	N/A	N/A	NO	N/A	NO - eggs are a source of food on breeding beaches
halibut (H&L)	high	NO	YES - halibut move moderate to long distances, incidental catch includes resident species (e.g. barred sand bass)	N/A	N/A	NO	N/A	YES - resident species caught in association with halibut are important predators and their removal is likely to influence community structure
halibut (spear)	mod-low	NO	NO - halibut move moderate to long distances so abundance is unlikely to change relative to an SMR, spear fishing is likely to have low incidental catch	N/A	N/A	NO	N/A	YES - halibut are important predators in benthic ecosystem, any change in abundance could have impacts on community structure

	Question Level •	1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
jumbo squid (squid jigs/ drift)	high	NO	NO - jumbo squid are highly mobile, incidental catch is low due to use of squid jigs which do not readily capture other species	N/A	NO - jumbo squid are highly mobile and low incidental catch of resident species	N/A	N/A	N/A
Kellet's whelk (trap)	mod-low	NO	YES - target species has low movement & MPA effect has been shown	N/A	N/A	NO	N/A	YES - important benthic predator, especially on grazers and thus may have indirect effects on kelp abundance and associated community
kelp bass (H&L or spear)	mod-low	NO	YES - target species has low movement & MPA effect has been shown	N/A	N/A	NO	N/A	YES - impt predator
lingcod (H&L, spear)	mod-low	NO	YES - target species has low movement, incidental catch includes other low mobility reef species	N/A	N/A	NO	N/A	YES - lingcod are important predators in nearshore rocky reef
lobster (trap, hoop net, scuba)	mod-low	NO - gear contacts bottom but habitat damage unlikely	YES - target species has low movement & MPA effect has been shown	N/A	N/A	NO	N/A	YES - important urchin predator and thus may have indirect effects on kelp and associated community

	Question Level •	1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
marine algae other than giant and bull kelp (hand harvest)	low	NO - doesn't damage the substrate, per se	YES - marine algae doesn't move	N/A	N/A	YES - all marine algae FORM habitat, so removing it removes habitat	YES - marine algae provide structure for a rich and unique community, removal has the potential to change community structure substantially	N/A
mussels (hand harvest)	low	NO - doesn't damage the substrate, per se	YES - mussels are sessile	N/A	N/A	YES - mussels FORM habitat, so removing them removes the habitat	YES - mussel beds are associated with a unique community, removing them changes community structure	N/A
pelagic finfish*, white seabass, and bonito (H&L) <30m depth on mainland and <50m depth at islands	mod-low	NO	YES - target species are highly mobile, incidental catch of resident benthic species (kelp bass on rocky reef and barred sand bass on soft bottom) is very likely in shallow water	N/A	N/A	NO	N/A	YES - incidentally caught resident species play an important predatory role in the nearshore environment
pelagic finfish*, white seabass, and bonito (H&L) >50m depth	high	NO	NO - target species are highly mobile, incidental catch of resident species is likely to be low deeper than 50m where no kelp occurs	N/A	NO - target species are highly mobile and low incidental catch	N/A	N/A	N/A
pelagic finfish*, white seabass, and bonito (H&L) 50>30m depth using surface gear on mainland	mod-high	NO	NO - target species are highly mobile, incidental catch of resident species is likely to be moderate as you fish closer to kelp beds	N/A	YES - incidental catch of resident benthic species could change community structure	N/A	N/A	N/A

	Question Level •	1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
pelagic finfish*, white seabass, and bonito (spear)	high	NO	NO - target species are highly mobile, selective harvest by spear should result in little or no incidental catch	N/A	NO - target species are highly mobile and low incidental catch	N/A	N/A	N/A
pier-based fishing (H&L, hoop net)	mod-high	NO	NO - most H&L catch is highly mobile species, especially coastal pelagics but some catch of less mobile croaker (8%), surfperch (7%) , and basses (3%), small hoop net catch of lobsters.	N/A	YES - a few resident species are caught from piers and this could have an impact on community structure	N/A	N/A	N/A
rock crab (trap)	mod-low	NO - bottom contact occurs but damage unlikely	YES - yellow crabs and brown rock crabs likely have a limited home range, several tagging studies show that individuals stay in the same area for months to 1 year while others may participate in migrations on the order of 10km.	N/A	N/A	NO	N/A	YES - important predators and scavengers (predators of small urchins) and thus take likely to impact community structure
rock scallop (scuba)	low	YES	N/A	YES - rock scallop removal modifies rugosity of reef and local diversity of benthic species	N/A	N/A	N/A	N/A

Question Level •		1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
rockfish (H&L, spear)	mod-low	NO	YES - target species have low movement, incidental catch includes other low mobility reef species	N/A	N/A	NO	N/A	YES - rockfish are important predators in nearshore rocky reef
sea cucumber (scuba/hookah)	moderate	NO	YES - target species abundance and size shown to decrease where not protected	N/A		NO		NO - detritivore and prey
sheephead (H&L, spear, trap)	mod-low	NO - traps contact bottom but habitat damage unlikely	YES - target species has low movement & MPA effect has been shown	N/A		NO		YES - impt urchin predator
shore-based finfish (H&L)	mod-low	NO	YES - a wide range of species may be caught from shore--some have limited depth distribution or special breeding habits that make them vulnerable to fishing from shore--catch includes resident estuarine species (spotted sandbass, juvenile halibut), resident rocky reef species (opaleye, kelp bass, rockfish, sheephead), and surf-zone species (breeding surfperch).	N/A		NO		YES - many removed species are important predators in nearshore evironments.

	Question Level •	1	2		3		4	
Allowed Use	LOP Desig-nation	Does proposed activity alter natural habitat directly?	Is abundance of any species likely to be significantly different in the MPA relative to an SMR?	Is habitat alteration likely to change community structure substantially?	Is removal of any species likely to impact community structure directly or indirectly?	Is removal of any species likely to directly alter habitat?	Is habitat alteration caused by species removal likely to change community structure substantially?	Is the altered abundance of any species likely to alter community structure substantially?
spot prawn (trap)	moderate	NO - traps contact bottom but habitat damage unlikely	YES - genetics and parasites suggest low movement in BC, no studies from CA	N/A	N/A	NO	N/A	NO - predator and prey
spotted sand bass (H&L)	mod-low	NO	YES - target species has low movement, restricted to estuaries	N/A	N/A	NO		YES - impt predator in estuarine embayments
squid (seine, dip-net, crowder)	high	NO - bottom contact does occur with seine gear, but infrequently	NO - target species are highly mobile, incidental catch is comprised primarily of other highly mobile species	N/A	NO - target species are highly mobile and low incidental catch of resident species	N/A	N/A	N/A
swordfish (harpoon)	high	NO	NO - swordfish are highly mobile and harpoon fishing requires visual contact, thus low incidental catch	N/A	NO - highly mobile	N/A	N/A	N/A
urchin (scuba/hookah)	mod-low	NO	YES - target species has low movement	N/A	N/A	NO	N/A	YES - impt grazer of kelp which can change the entire structure of ecosystem