California MLPA Master Plan Science Advisory Team

Draft Supporting Text for Proposed Levels of Protection for the MLPA North Coast Study Region

Revised January 19, 2010

Summary of the MLPA Guidelines Regarding Level of Protection

The Marine Life Protection Act (MLPA) calls for an improved network of marine protected areas (MPAs) that 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 MLPA Master Plan Science Advisory Team (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 fishing 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 fishing 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 of designations may lead to deceptive results. For this reason, the SAT looks beyond the MPA type (SMR, SMP pr SMCA) to the proposed permitted activities to determine the LOP an MPA will afford.

Marine Protected Area (MPA) Types

SMRs provide the greatest level of protection to species and to ecosystems by prohibiting take (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.

SMPs 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). Although SMPs may have lower value for achieving MLPA goals 1 and 2, they may assist in achieving other MLPA goals.

SMCAs potentially have the most variable levels of protection and conservation of the three MPA types because they may allow any combination of commercial and recreational fishing.

Conceptual Framework for Assigning Levels of Protection

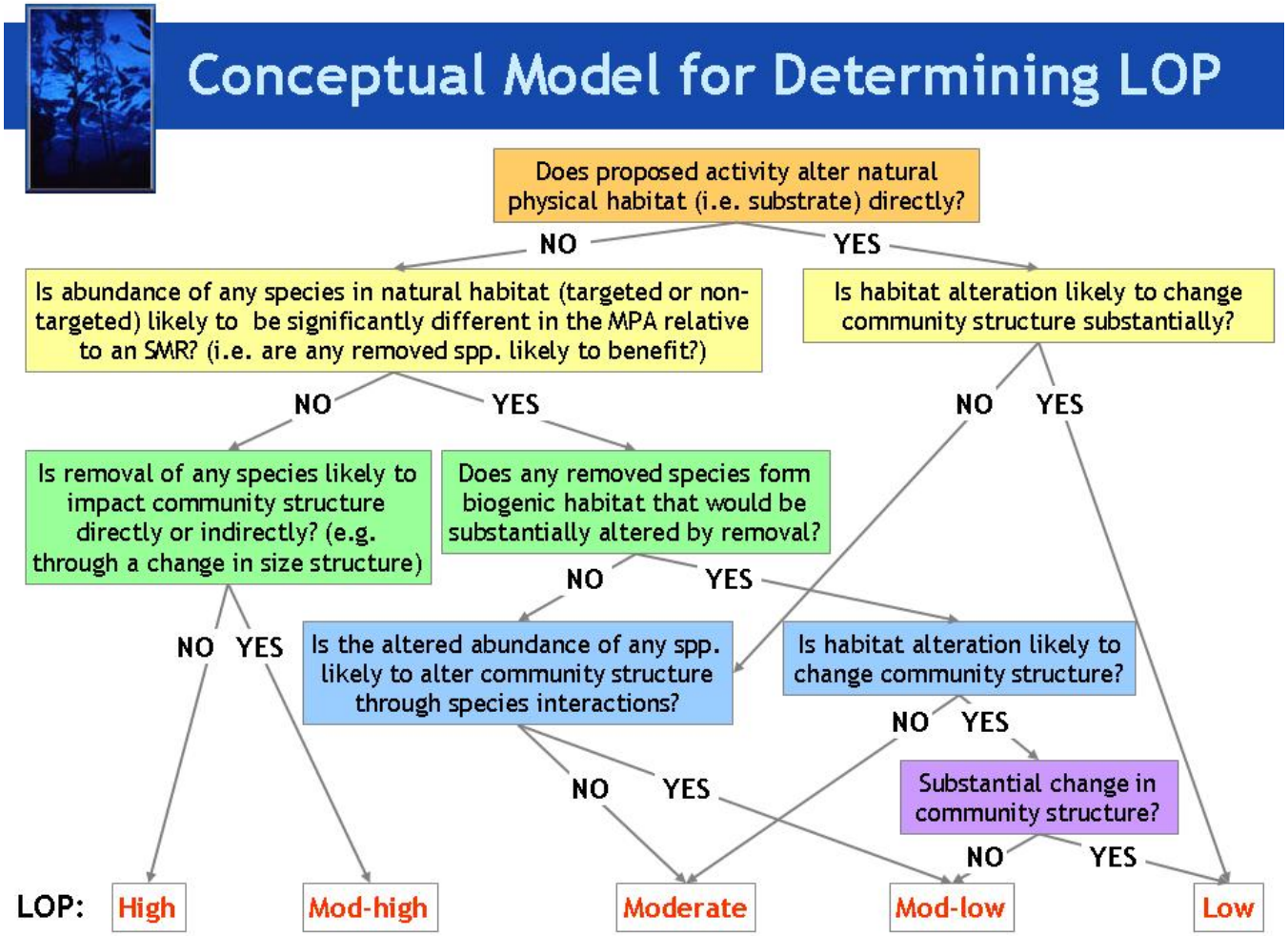
Levels of protection are based upon the likely impacts of proposed activities to the ecosystems within the MPA. Conceptually, the SAT seeks to answer the following question in assigning levels of protection: "How much will an ecosystem differ from an unfished ecosystem if one or more proposed activities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

SMRs are, by definition, unfished ecosystems, therefore we ascribe to them the highest protection level, "very high." MPAs that allow extractive activities are asigned 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 an 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).

Levels of Protection for the North Coast Study Region

The levels of protection as they apply to the north 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 damage to substrate or removal of habitat-forming organisms received this low level of protection.

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

	Level of Protection	MPA Types	Activities Associated with this Protection Level
	Very high	**SMR**	**No take**
	High	**SMCA SMP**	**Salmon** (H&L or troll in waters >50m depth); **coastal pelagic finfish**[1] (H&L, round-haul net, dip net);
	Mod-high	**SMCA SMP**	**Dungeness crab** (trap, hoop-net, diving)**; salmon** (troll in water <50m depth);
	Moderate	**SMCA SMP**	**smelts** (H&L, dip net); **redtail surfperch** (H&L from shore); **California halibut** (H&L); **coonstripe shrimp and spot prawn** (trap)**; clams** (intertidal hand harvest); **turf algae**[2] (intertidal hand harvest); **salmon** (H&L in waters <50m depth)
	Mod-low	**SMCA SMP**	**Pacific halibut** (H&L); **lingcod, cabezon, and rockfishes, and greenlings** (H&L, spearfishing, trap); **red abalone** (free-diving); **urchin** (diving)
	Low	**SMCA SMP**	**Rock scallop** (diving); **mussels** (hand harvest); **bull kelp** (hand harvest); **ghost shrimp** (hand harvest); **sea palm** (intertidal hand harvest); **canopy-forming algae**[3] (intertidal hand harvest)

Levels of protection (LOPs) for uses in plain text were approved by the SAT at its December 16-17, 2009 meeting. Underlined text indicates new additions to the LOP table for consideration at the SAT's January 20-21, 2010 meeting.

1 The grouping "coastal pelagic finfish" includes: Northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), and Pacific sardine (*Sardinops sagax*).

2 The grouping "turf algae" includes the following harvested groups: *Porphyra* spp. (Nori, Laver), *Ulva* spp. (Sea Lettuce), *Chondrocanthus/Gigartina exasperata* (Turkish Towel), and *Mastocarpus* spp. (Mendocino Grapestone).

3 The grouping "canopy-forming algae" includes the following harvested groups: *Alaria* spp. (Wakame), *Lessonioposis littoralis* (Ocean Ribbons), *Laminaria* spp. (Kombu), *Saccharina/Hedophyllum sessile* ('Sweet' Kombu), *Egregia menzeisii* (Feather Boa), and *Fucus* spp. (Bladder wrack or Rockweed).

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 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 SAT 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.

[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.

Clams (intertidal 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**

Abalone (free-diving hand harvest):

Direct impacts: Take of abalone (*Haliotis* spp.) using hand collection techniques is unlikely to damage habitat. Abalone are relatively sedentary organisms, so their local abundance will likely be altered by take relative to an SMR. 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 (Schaegger et al. 1999), and the same may be true for free-divers. Divers may also cause behavioral responses in mobile species (Parsons and Eggleston 2006).

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. Abalone are important grazers and could have localized impacts on algal abundance in the nearshore environment. Although abalone have deep-water refugia generally beyond free-diving depths, localized depletion of shallow adult spawning stocks within an MPA, combined with short larval dispersal distances, could reduce the local availability of young abalone as prey to small predators. 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-low**

Dungeness crab (trap, hoop net, diving):

Direct impacts: Traps used to catch Dungeness crab (*Cancer magister*) contact the bottom, but they likely cause little habitat disturbance. Dungeness crab are a moderately mobile species, showing potential movement on the order of 10-15 km Smith and Jamieson 1991).

Though commercial fishing can dramatically reduce the ecosystem-wide abundance of Dungeness crabs, their local abundance is not likely to be altered by take relative to an SMR. 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 (Taggart et al. 2004). 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). However, the oceanography, bathymetry and large size of the spatial closure were likely key factors in determining that outcome, and the applicability of those results to the north coast study region is probably limited.

Indirect impacts: Dungeness crabs are key predators in the benthic environment and their abundant larvae provide food for a variety of pelagic species. Crabs consume large numbers of sessile and sedentary benthic invertebrates, and the removal of the largest male crabs could decrease predation pressure, which may have an effect on the invertebrate populations in an area.

Level of protection: **Moderate-high**

Mussels (hand harvest):

Direct impacts: Take of mussels (*Mytilus californianus*, *M. galloprovincialis, and M. trossulus*) 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 (e.g. 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**

Smelts (hook and line, dip net):

Direct impacts: Take of smelts (*Atherinops affinis, A. californiensis, Hypomesus pretiosus, Spirinchus starksi*) by hook and line or hand nets is unlikely to damage habitat. However, fishing for smelt neat the shore targets the fish during the spawning season, and associated catch includes benthic resident species that would otherwise be protected in an MPA.

Indirect impacts: Though smelts and their eggs provide food for a wide variety of species, their removal from the ecosystem is unlikely to have a substantial impact on community structure.

Level of protection: **Moderate**

Cabezon, rockfish, greenling and lingcod (hook and line, spearfishing, trap):

Direct impacts: Cabezon (*Scorpaenichthys marmoratus*), rockfish (many species, *Sebastes* spp.), greenlings (*Hexagrammos decagrammus* and *Oxylebius pictus*), 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. Fishing with hook and line gear (including longlines) could involve bottom contact and traps contact the bottom, but these methods likely cause little habitat disturbance. It is important to note that a level of protection was determined for cabezon, rockfish, greenling, and lingcod individually. Since all four groups received the same level of protection for the same reasons, they are being presented here as a group.

Indirect impacts: Cabezon, rockfish, greenling, 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**

Ghost shrimp (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**

Rock scallop (diving hand harvest)

Direct impacts: Hand collection of rock scallops (*Crassadoma gigantea*) is done in one of two ways. Either the diver cuts the scallop from its 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**

Coonstripe shrimp and spot prawn (trap):

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

Spot prawns and coonstripe shrimp are moderately mobile species (Boutillier and Bond 2000) which may benefit directly from MPAs within state waters. Tagging studies of spot prawns 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. Though no movement studies have been conducted on coonstripe shrimp, they are ecologically similar to spot prawns, so they could be reasonably assumed to have similar adult movement distances. No data on associated catch for the spot prawn fishery were examined, but data from other trap fisheries (e.g. Dungeness crab) 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 and coonstripe shrimp are micro-predators, feeding on other shrimp, plankton, small mollusks, worms, sponges, and fish carcasses. In turn, these species are one of many available prey items for fishes and marine mammals. Any change to ecological interactions caused by reduced abundance of spot prawns or coonstripe shrimp is likely to have only minor impacts on community structure within an MPA.

Level of protection: **Moderate**

Sea palm (intertidal hand harvest):

Direct impacts: Take of sea palms (*Postelsia palmaeformis*) by hand is unlikely to cause habitat damage. However, sea palms are sessile and their abundance is likely to be altered by take relative to an SMR. Commercial hand harvesters tend to only take fronds, but this reduces canopy cover and will reduce spore production if done after June or more than once per year (Thompson et al. *submitted*), which in turn can reduce population size in subsequent years (Nielsen & Knoll *in prep*). In addition, complete removal of all plants in a population prior to the onset of spore production can lead to localized extinction if the population is > 5 m from an adjacent population (Nielsen & Knoll *in prep*).

Indirect impacts: Sea palms form extensive canopy in the high intertidal zone; the presence of algal canopy is well known to ameliorate high temperatures, high light levels and desiccation for understory species in the high intertidal, providing a refuge from these stressful physical conditions for some organisms. Therefore, removal of plants, thinning of plants, and removal of fronds have effects on other species and habitat availability below the sea palm canopy. These effects include: reducing the amount of bare space or available habitat for colonization (created when sea palms are dislodged by waves), altering the abundances of several common understory macroalgae (in the genera: *Corallina, Microcladia* and *Hymenina*), and increasing the diversity of understory species (Blanchette 1994). Some of these changes persist even after take has ceased, including reduced abundance of sea palms due to spore limitation (Blanchette 1994; Thompson et al. *submitted*; Nielsen & Knoll *in prep*).

Level of protection: **Low**

Marine algae other than bull kelp and sea palm (intertidal hand harvest):

The current focus of commercial, recreational and cultural take in northern California is on ‘edible’ seaweeds. However, many species of marine macroalgae are also harvested from wild populations internationally and nationally for industrial applications as they are the primary sources of alginates, agar, and caregeenans. There is also interest in exploring the use of macroalgae (especially kelps or members of the order Laminariales) for the production of biofuels. Neither Oregon nor Washington currently allow commercial take of benthic marine macroalgae, making California the most likely location for growth in commercial take.

Current regulations on method and amount of commercial take in California are minimal; they do not reflect well established, biological knowledge of benthic marine macroalge and plants nor do they adequately distinguish among species creating the potential for masking the effects of human take (i.e., serial depletion of species). Benthic marine macroalgae and plants include species from 4 major divisions (= phyla) with a large diversity of growth forms and life histories making generalizations challenging. In defining levels of protection for the commercial and recreational take of benthic marine macrolage and plants the focus is on ecological roles and functions. Two species have individual levels of protection, reflecting their

important ecological role, current commercial importance and/or availability of data on the impacts of commercial take (the kelp forest-forming species *Nereocystis luetkeana* and the intertidal sea palm *Postelsia palmaeformis*).

Direct impacts: Take of marine algae (for species lists, see LOP designations below) is unlikely to damage the non-biogenic habitat. However, all algae are sessile, so their abundance is likely to be altered by take relative to an SMR, and the dispersal shadows of spores and seeds are very limited in spatial extent, typically less than 1 km (e.g. Kinlan and Gaines 2003).

Indirect impacts: Benthic macroalgae and plants form biogenic habitat. Habitat can take the form of large kelp forests in subtidal habitats (typically formed by *Nereocystis luetkeana* in northern California), surfgrass meadows, and canopy- and turf-forming algal beds in the intertidal zone. Additionally, all macrophytes serve as food either directly or indirectly (as drift, wrack or particulates) for a wide range of herbivores (such as abalone and urchins), suspension feeders (such as mussels and barnacles) and detritivores (such as wrack-associated amphipods and insects).

Thus the removal of any benthic macroalgae will remove biogenic habitat. However, whether or not the removal of that habitat leads to substantial changes in community structure depends on the nature of the species being removed. The removal of canopy forming species substantially changes community structure. Canopy forming intertidal algae ameliorate high temperatures, high light levels and desiccation for a diverse assemblage of understory species providing a refuge from adverse physical conditions outside of the canopy for many of these organisms (Dayton 1975a,b; Duggins and Dethier 1985; Blanchette 1994; Bertness et al. 1999; Burnaford 2004). Algal canopies may also 'whiplash' the surfaces underneath them as they are tossed around by waves, removing some organisms (Ojeda and Santelices 1984; Kiirikki 1996). Algal canopies are formed primarily by large, brown macroalgae in the orders Laminariales and Fucales.

Commercially collected **canopy forming algae** include: *Alaria spp.* (Wakame), *Lessonioposis littoralis* (Ocean Ribbons), *Laminaria spp.* (Kombu), *Saccharina/Hedophyllum sessile* ('Sweet' Kombu), *Egregia menzeisii* (Feather Boa), and *Fucus spp.* (Bladder wrack or Rockweed). *Postelsia palmaeformis* (Sea Palm) is also collected commercially, but has its own level of protection designation.

The removal of turf forming algae is not likely to substantially alter community structure, since they provide less habitat and do not dramatically reduce the effects of abiotic factors like canopy forming algae do. Commercially collected **turf forming algae** include: *Porphyra spp.* (Nori, Laver), *Ulva spp.* (Sea Lettuce), *Chondrocanthus/Gigartina exasperata* (Turkish Towel), and *Mastocarpus spp.* (Mendocino Grapestone).

Level of protection: **Low** for canopy forming algae [*Alaria spp.* (Wakame), *Lessonioposis littoralis* (Ocean Ribbons), *Laminaria spp.* (Kombu), *Saccharina/Hedophyllum sessile* ('Sweet' Kombu), *Egregia menzeisii* (Feather Boa), and *Fucus spp.* (Bladder wrack or Rockweed)]

Moderate for turf forming algae [*Porphyra spp.* (Nori, Laver), *Ulva spp.*

(Sea Lettuce), *Chondrocanthus/Gigartina exasperata* (Turkish Towel), and *Mastocarpus spp.* (Mendocino Grapestone)

Redtail surfperch (hook and line from shore):

Direct impacts: Fishing for redtail surfperch (Amphistichus rhodoterus) from shore using hook and line gear may cause some disturbance to the intertidal, but is unlikely to significantly alter habitat. Redtail surfperch occur in a narrow band of shallow waters along the coast, primarily over soft bottoms, and give birth to live young. Their limited range of habitats and viviparous reproduction indicate that their abundance is likely to be altered by take relative to an SMR.

Indirect impacts: Redtail surfperch are a key component of the commercial fishery of the north coast study region, and they compose approximately 73% of the commercial surfperch catch in California (Love 1996). Although they eat a wide variety of prey and are eaten by a number of predators, several other surfperch species play a similar ecosystem role and thus their removal is unlikely to alter the community structure of the nearshore sandy bottom habitat.

Level of protection: **Moderate**

California halibut (hook and line):

Direct impacts: Take of California halibut (Paralichthys californicus) by hook and line is unlikely to alter habitat. California halibut are a moderately mobile species that inhabit 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). Additionally, California halibut are rare in the north coast study region, occurring in the region almost exclusively in Humboldt Bay. Due to their limited distribution in the region and their potential to move only short distances, the abundance of California halibut may be altered by take relative to an SMR.

Associated catch on trips targeting California halibut in the north coast is primarily composed of bait fish and estuarine and soft bottom associated species, but does include a number of rocky reef species, (totaling ~6% of total catch). In addition to altering the abundance of halibut, fishing for this species may alter the abundance of associated catch species including demersal sharks, skates and rays and a variety of reef fish including rockfish, lingcod, and greenlings.

Indirect impacts: California halibut are important predators in the benthic ecosystem, feeding on a variety of schooling fish and benthic organisms (Cailliet et al. 2000). However, there are a variety of other important benthic predators present in estuarine habitats in the north coast study region, so the removal of California halibut is unlikely to significantly alter community structure.

Level of protection: **Moderate**

Pacific halibut (hook and line):

Direct impacts: Take of Pacific halibut (Hippoglossus stenolepis) by hook and line is unlikely to damage habitat, though some bottom contact may occur. Movement studies on Pacific halibut are very limited, but their movement patterns appear to be similar to those of California halibut. For example, Thompson and Herrington (1930) tagged Pacific halibut in Alaska and British Columbia and found that the majority of fish move less than ten miles, though a few individuals move great distances. Given their potential to move only short distances, the abundance of Pacific halibut may be altered by take relative to an SMR.

Associated catch on trips targeting Pacific halibut in the north coast includes a variety of soft bottom and rocky reef-associated species. The relatively high associated catch of rocky reef species (nearly 40% of total catch) may be due to the practice of targeting this species in cobble-bottom habitats. Unfortunately, the available catch records do not allow distinction between incidental take and secondary targeting of rockfish or other reef species. In addition to altering the abundance of Pacific halibut, fishing for this species may alter the abundance of associated catch species including reef fish such as rockfish, lingcod, and cabezon, and demersal sharks, skates and rays.

Indirect impacts: Pacific halibut are important predators in the benthic ecosystem. Furthermore, Pacific halibut occur over both sandy and rocky bottoms, and fishing over rocky bottoms increases the likelihood of associated catch of resident rocky reef species. Therefore, fishing for Pacific halibut has the potential to alter the benthic community structure in an area, giving it a level of protection of moderate-low.

Level of protection: **Moderate-Low**

Sea urchin (diving hand harvest):

Direct impacts: Commercial red sea urchin fishing uses hand rakes to fish urchins. Rake collection of urchins may cause some rocky habitat damage (divers may also 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 north coast of California are the red and purple sea urchin (*Strongylocentrotus franciscanus* and *S. purpuratus*, respectively). The red urchin is the only species taken commercially in California waters. Both red and purple sea urchins are relatively sedentary. Thus, the abundance of red sea urchins within an area may be altered by take relative to an SMR, depending on the rates of predation by other sea urchin predators. Divers harvest sea urchins selectively so there is little or no take of non-target species.

Indirect impacts: Urchins are ecologically important species in most shallow rocky ecosystems (Lawrence 1975, Harrold and Pearse 1987, Rogers-Bennett 2007). They are important herbivores, prey, competitors and facilitators of other species in nearshore rocky habitats. In many parts of 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). However, in the north coast study region, there is little evidence to suggest that unfished urchin populations create "urchin barrens" with no kelp, devoid of fleshy algae and dominated by encrusting coralline algae (L. Rogers-Bennett, in prep).

Adult sea urchins are eaten by several predators on shallow rocky reefs in the north coast study region, including the wolf eel, Anarrhichthys ocellatus, 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). In particular, predation by the sunflower sea star has been shown to be important in controlling sea urchin populations in cold water ecosystems similar to those founding the north coast study region (Duggins 1983). For example, predation rates on tethered purple sea urchins at 10 sites spanning the warm and cold water kelp forest ecosystems of the Channel Islands National Marine Sanctuary revealed that urchin mortality was in fact greatest at cold water sites (San Miguel and Santa Rosa) where sunflower sea stars were observed to be the dominant urchin predator, relative to the warm water sites (Anacapa and Santa Cruz) where spiny lobster (Panulirus interruptus) and sheephead (Semicossyphus pulcher) were the dominant urchin predators (Salomon et al. 2009). In the colder water kelp forest ecosystems off British Columbia, Canada, similar sea urchin predation studies suggest that Pycnopodia is the dominant red sea urchin predator on these subtidal rocky reefs (Salomon pers com 2010).Furthermore, sunflower sea stars are not a fishery target, so their natural populations likely remain high in areas with sufficient prey resources. In addition, at high densities, sea urchins in southern California may experience high mortality from disease (Behrens and Lafferty 2004), which can reduce local sea urchin abundance, however, this has not been observed in the north coast study region.

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 may compete with adult 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 (Rogers-Bennett and Pearse 2001). Red sea urchins act as habitat for juvenile red sea urchin and a suite of other small invertebrates including snails, crabs and invertebrates particularly in shallow habitats in northern California (Rogers-Bennett et al. 1995) and elsewhere in the world. The protection afforded by red sea urchin spines might be even more important for abalone recruits and other invertebrates in the north coast study region, due to the stronger storms and overall shallower rocky reefs of the region, particularly in comparison to other study regions.

These life history features can be used to determine the level of protection for sea urchin harvest in the north coast study region. The lack of evidence that unfished sea urchin

populations will form "urchin barrens" in the north coast study region, the sedentary lifestyle of sea urchins, the abundance of important sea urchin predators that are not themselves fishery targets, and sea urchins acting as biogenic structure result in the level of protection for sea urchin harvest in the north coast study region being Moderate-low.

Level of protection: **Moderate-Low**

Coastal pelagic finfish (hook and line, round haul net, dip-net):

Direct impacts: The term "coastal pelagic finfish" includes northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel *(Scomber japonicus*), and Pacific sardine (*Sardinops sagax*). Coastal pelagic finfish are highly mobile pelagic species that are unlikely to benefit directly from MPAs within state waters. Hook and line gear, dip-nets and round haul nets do not typically contact the seafloor, however, round haul nets have the potential to damage rocky reef habitats and associated structure forming invertebrates if they come in contact with the bottom. Catch records collected by the Pacific Fisheries Management Council, (PFMC 2009) indicate that bottom contact is infrequent (an average of 6% of hauls contained some benthic algae or invertebrates), and incidental take is low and comprised almost entirely of other highly mobile schooling fish. The mobile nature of the target species and low incidental take of resident species indicate that take of coastal pelagic finfish is likely to have little impact on the resident ecosystem.

Indirect impacts: Coastal pelagic finfish feed on a variety of planktonic organisms and smaller fish. Both coastal pelagic finfish and their prey are highly mobile and incidental catch is low and comprised mainly of other highly mobile species, thus the indirect ecosystem impacts of take are predicted to be low.

Level of protection: **High**

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