# California MLPA Master Plan Science Advisory Team Draft Supporting Text for Proposed Levels of Protection for the MLPA North Coast Study Region

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# Clams (all methods of hand collection in the intertidal)

**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 (non-scuba hand collection):

*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):**

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 collection):

**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, hand nets):

**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, spear, 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 (all methods of hand collection):**

**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 (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 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

#### **Urchin (hand collection):**

**Direct impacts:** Hand collection of urchins causes some habitat disturbance (divers may move rocks to better remove the urchins) but these disturbances are not substantial.

Several species of sea urchins inhabit the northeast Pacific Ocean. The two most abundant species on shallow rocky reefs along the coast of California are the red and purple sea urchins (*Strongylocentrotus franciscanus* and *S. purpuratus*, respectively). The red urchin is the only species taken commercially in California waters. This species is relatively sedentary, so 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. 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 algae available and the presence of predators, red sea urchins restrict their distribution to cracks 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 (e.g. 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*, sunflower sea star, *Pycnopodia helianthoides*, and other species. Small sea urchins are eaten by a number of other, smaller predators (e.g., other sea stars, crabs and other species).

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 also 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).

Since they are important prey, key herbivores, and interact with other species in a range of different ways, removal of urchins by urchin harvest is likely to have impacts on community structure within an MPA.

Level of protection: Moderate-low

#### Coonstripe shrimp and spot prawns (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 (hand collection):

**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 (all methods):

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)

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