September 1, 2005

From: Michael DeLapa, Central Coast Project Manager, MLPA Initiative
To: Central Coast Regional Stakeholder Group (CCRSG)
Re: Responses to your requests for information

The staff of the MLPA Initiative, the Department of Fish and Game, and members of the MLPA Science Sub-Team have prepared a second set of responses to requests for information from members of the CCRSG. Because we were not able to obtain the necessary information, we have not prepared responses to several requests. We are currently conducting additional research and hope to have further information at a later meeting. If you have additional questions or comments about the responses, please contact Mike Weber, Senior Policy Analyst with the MLPA Initiative, at mleoweber@aol.com.

RSG-1: *What are the historic and recent population trends (spatial and temporal) of marine mammals, specifically sea lions, harbor seals, and sea otters? What are their diets? What is the impact of their feeding on commercially and recreationally important species?*

The following responses emphasize information from central California over information from other regions. Little to no information on historical abundances was available for California sea lions, harbor seals, and southern sea otters, although some early estimates are included for the purposes of comparison with later systematic censuses.

California sea lions: The range of California sea lions extends from the Pacific coast of Baja California to southern British Columbia. These animals breed primarily in the southern part of their range from the Gulf of California to San Miguel Island. Commercial hunting in the 19th and early 20th centuries likely reduced California sea lion populations. In the late 1920s, only 1,000-1,500 California sea lions were counted on the shores of California. Since a general moratorium on hunting marine mammals was imposed with passage of the Marine Mammal Protection Act (MMPA) in 1972, the population has grown substantially to a current estimate of 237,000-244,000 animals. Between 1975 and 2001, the population grew at an average annual rate of 5.4%.

California sea lions are plastic specialist predators—that is, they feed on specific species of prey, which change as different species become more abundant seasonally or from year to year. In the case of California sea lions, these species include Pacific hake, northern anchovy, Pacific sardine, spiny dogfish, and squid. In a recent study at Año Nuevo Island, sea lions were found to feed on rockfishes, Pacific whiting, market squid, Pacific sardine, northern anchovy, spiny dogfish shark, and salmonids (Weise and Harvey 2005). Based on this research, Weise and Harvey estimated sea lions in central California consumed 8,406 - 8,447 tons of prey species in 2001-2002, of which 450 tons-1,525 tons were salmonids.

In recent years, salmon fishermen have increasingly complained about damage to gear and catches by California sea lions. Between 1997 and 1999, Monterey Bay commercial fishermen suffered estimated losses that ranged from $18,031 to $60,570 for gear and $225,833 to $498,076 in salmon (Weise and Harvey *in press*). For the same period, Weise and Harvey estimated that sea lions fed upon hooked salmon at rates that ranged from 8.5% to 28.6% in the commercial fishery, 2.2% to 18.36% in the CPFV fishery, and 4.0% to 17.5% in the personal skiff fishery. Predation rates were highest in the El Niño year of 1998 when the abundance of other prey was reduced.

Harbor Seals: Harbor seals in the eastern Pacific range from the Pribilof Islands in Alaska to Isla San Martin off Baja. Between the Mexican and Canadian borders, harbor seals have been managed as three separate stocks, of which one is the stock off California. After passage of the MMPA in 1972, harbor seal abundance grew rapidly until 1990, when stocks leveled off. There has been no net population growth in California since 1990 (Caretta *et al.* 2004). In 2002, the population was estimated at 27,863 animals.

Harbor seals eat a wide variety of pelagic and benthic prey, including small schooling fishes such as northern anchovy, many species of flatfishes, rockfishes, and cephalopods (Antonelis and Fiscus 1980, Weise and Harvey 2001 and references therein). Diet studies of harbor seals in central California did not find evidence of predation on ocean-swimming salmonids, though they were found to eat small salmonids returning to spawning streams in central and northern California (NMFS 1997; Weise and Harvey 2001).

Southern Sea Otters: Once ranging from northern California to Punta Abreojos in Baja California Sur, with few exceptions, southern sea otters are now found only from Pt Año Nuevo in Santa Cruz County to Purisima Pt in Santa Barbara County (USFWS 1995, 2003). Commercial hunting severely reduced sea otter populations in the 18th and 19th centuries. By 1914, the California population of sea otters may have numbered as few as 50 animals. Between 1983 and 1994, the sea otter population grew at an average annual rate of 5-6%, and reached a maximum observed population size of 2,377 individuals in the spring of 1995. Sea otter numbers have fluctuated since then. Since 1998, the population has increased at a rate of 0.9%, based on the three-year running average. Though recent estimates indicate that the population is growing, recovery is still inhibited by a variety of factors that contribute to otter mortality including: incidental drowning in gill and trammel nets, oil spills, toxic contaminants, other human impacts, and disease (Hanni *et al.* 2003, Miller *et al.* 2004, USFWS 2003).

Otters have been shown to be a keystone species, exerting strong top-down control on their prey species (Estes and Palmisano 1974, Estes and Duggins 1995). Their predation on sea urchins has been shown to limit urchin abundance, allowing for the growth of kelp forests and associated species (Estes and Palmisano 1974, Estes and Duggins 1995). Sea otters have a varied diet consisting of benthic invertebrates such as red sea urchins (*Strongylocentrotus franciscanus*), red (*Haliotis rufescens*) and black abalone (*H. cracherodii*), kelp crabs (*Pugettia producta*), clams (*Gari californica*), and cancer crabs (*Cancer spp.*) (Ostfeld 1982). Expansion of sea otter populations, following protection from harvest, resulted in conflicts with commercial and recreational abalone fisheries that had developed when otter numbers were depressed and abalone were abundant (Estes and VanBlaricom 1985). In some locations, predation by otters may have a larger effect on red abalone populations than current human harvest rates (Fanshawe *et al.* 2003).

RSG-2: *What are the relationships between kelp abundance and climate variation?*

Kelp biomass and persistence have been correlated with El Niño events in southern California: kelp biomass and recovery decreases after marked increases in sea surface temperature. Data are available to conduct a similar analysis for the central coast study region. For instance, MLPA Initiative staff has assembled maps of the sensitivity of sea surface temperature changes due to El Niño events in the region. Since temperature stress, among other factors, has been linked to declines in kelp biomass elsewhere, it is expected that kelp beds in central coast areas with strong temperature changes will be less stable than those in comparable locations with more consistent sea surface temperatures. (See also B-27 below.)

B-19: *Current recommendations are that reserves should be 3-12 miles long and spaced no more than 30-60 miles apart. How does this apply to complex coastlines such as Carmel Bay and South Monastery Bay and the headlands between Cypress Point to Point Pinos?*

Existing estimates of larval dispersal distances, upon which the current SAT recommendations are based, generally do not take into account the effects of heterogeneity in the coastline such as embayments and headlands. (See studies cited in the larval dispersal presentation and the Design Guidelines section of the Draft Management Plan prepared by the SAT). Thus, it is not clear how these coastal features will influence the distance larvae disperse along the coastline. However, much evidence suggests that currents along the up-current side of headlands (e.g., Pt. Reyes) move water farther offshore (referred to as advection) and likely carry larvae from and along the coast. In contrast, on the down-current side of headlands and within embayments (e.g., the south side of Pt. Reyes and the northeast corner of Monterey Bay), currents form eddies and gyres that retain water near the coast (referred to as retention areas), and likely reduce the distance that larvae disperse. Both of these features are clearly visible in images of sea surface temperature (SST) along the central coast. Thus, it is likely that the heterogeneous coastline along the coast south of Monterey Bay reduces larval dispersal distances compared to less heterogeneous coastlines, but this depends very much on where the eggs and larvae are produced and how long they exist in the plankton. Eggs and larvae produced (spawned) in deeper water offshore of these features are less likely to be influenced by inshore current features. Larvae that exist for longer durations in the plankton, like many rockfishes, are also likely to eventually be dispersed greater distances despite such coastal features. Because these traits (location and depth of spawning, duration in the plankton) vary among species, the effect of complex coastlines will differ greatly among species, which is the basis for very general recommendations on MPA design based on larval dispersal.

B-20: *Please describe the currents and back eddies within Carmel and Monterey Bay and discuss the implications for larval dispersal.*

Available information on currents and other oceanographic features in the study region will be made available to the CCRSG in the coming weeks.

B-21: *Please discuss the advantages of locating MPAs in high larval retention areas, such as coves and bays, and fish nursery areas. Please discuss the advantages of locating MPAs in current swept/high larval dispersal areas.*

There are pros and cons to situating MPAs in areas that will lead either to a greater likelihood of larval transport (i.e. high-current areas) or to a lower likelihood of larval transport (i.e. retention areas). High rates of egg and larval transport from sites exposed to high currents, referred to as advection or export, enhance the role of an MPA in contributing to the replenishment of populations outside the MPA as well as other MPAs. However, it also reduces the likelihood that populations within the MPA will replenish themselves and increases the dependency of protected populations on replenishment from populations outside the MPA. Conversely, MPAs located at sites of larval retention are more likely to replenish themselves and are less dependent on replenishment from outside the MPA, but also will contribute less to the replenishment of populations outside the MPA.

B-22: *Is there data since the 1960s on water quality parameters for Carmel and South Monterey Bays? Data on nitrogen compounds, pH, O_2 saturation, turbidity/Secchi disk? Is there evidence of decreasing water quality or measuring eutrophication?*

The MLPA Initiative staff is compiling information on water quality issues for inclusion in the regional profile. Map 6 portrays land uses that may have water quality impacts, while Map 7 indicates impaired water bodies and discharges in the region. The regional profile also includes links to information on water quality in specific areas.

B-23: *What species have produced an unnaturally low amount of larvae and how do we know of those occurrences? Is there any existing scientific evidence that some species' populations currently have lower than natural larval output?*

Clarification has been requested regarding this question.

B-24: *What factors are depressing clam populations and why do whole areas of previously very productive clam habitat not show recovered clam populations? What factors are similarly depressing abalone and sea otter populations? What is the interrelationship among these three species? What steps could be taken which might benefit populations for all three species?*

The question can be answered only by assuming that it is directed at Pismo clams and red abalone specifically, not other clam or abalone species. Other species (e.g., black abalone) have exhibited recent declines and persistent reductions for reasons other than predation by sea otters.

The establishment of four State Marine Conservation Areas (MCAs) at Atascadero Beach, Morro Beach, Pismo, and Pismo-Oceano Beach, provide the best information available to answer this question. The four MCAs were established prior to the expansion of sea otters into the Morro Bay region for the purpose of excluding fishing and for maintaining populations of adults as spawners. Limited surveys within these MCAs by the Department of Fish and Game prior to and subsequent to the immigration of sea otters suggest that clam populations declined coincident with the arrival of sea otters. Because the MCAs exclude fishing, decline of the clams within these MCAs is likely attributable to predation by sea otters. Persistent reductions in Pismo clam populations in these MCAs are associated with the continued presence of otters in the region. Whether these reduced clam populations reflect population sizes comparable to those that existed prior to the extirpation of sea otters in the region is unknown. The patterns of Pismo clam decline within MCAs coincident with the immigration and continued presence of sea otters suggest that abundances that supported fisheries prior to the return of otters are unlikely to return under existing environmental conditions, including current sea otter abundances.

The lower abundance of red abalone within the range of the sea otter relative to areas to the north and south of their range also suggests that otter predation contributes to lower population sizes of red abalone. These numbers are considered too low to support a commercial fishery (CDF&G Abalone Recovery Plan 2004). To what extent the size of existing red abalone populations is attributable to sea otters or recreational fishing is unclear. Comparison of population sizes in and out of the existing MPAs at Hopkins, Pt Lobos and Big Creek might help answer this question. The only surveys of red abalone abundance in and outside of these MPAs that we are aware of were recently conducted by Dr. Fiorenza Micheli's lab at Stanford University; the results are unpublished. Red abalone surveys at sites that had been protected for varying lengths of time (5-71 years), including Hopkins, Pt Lobos, Pt Pinos, Carmel Pt, Mal Paso Creek, and Pescadero Pt. did not detect a significant relationship between the age of the protected area and abundance of red abalone. However, there was significantly more and larger abalone in some of these no-take reserves (e.g., Hopkins and Point Lobos) than in sites of comparable habitat outside of the MPAs that had a history of limited take prior to the ban on abalone collecting in 1997.

Protecting sea otters will continue their predation on these two prey species where they co-occur. Monitoring studies of the red abalone population at Hopkins Marine Station by John Pearse and Fiorenza Micheli indicate that abalone populations have been at low, but stable population levels for 30+ years.

No ecological relationship between Pismo clams and abalone is known. How their numbers contribute to or detract from otter predation on one another is unknown. It is possible that they reduce predation on one another by detracting otter predation from one another, but they may also help sustain larger otter populations that maintain a higher level of predation on each species. Because these indirect relationships among the three species—sea otters, Pismo clams, red abalone—are unclear, only the direct interactions between sea otters and their prey can be predicted with some confidence.

B-25: *What baseline or other factors would influence any increase or decrease in economic value for non-consumptive uses due to the establishment of new MPAs?*

The value of the improvement is always relative to the "what if" baseline. The "what if" baseline is not the baseline today, but the level of amenities that would have been present without an MPA. The results of current research by LeFranchi and conventional wisdom also suggest that simply restricting certain kinds of users from an area can increase the value of that area for other users. For instance, an MPA restriction that prohibits personal motorized watercraft would probably increase the area's value for kayaking.

The following are other factors that might be affected by MPAs and would increase the non-consumptive value of wildlife encounters:

1) Increased frequency of encounter;
2) Increased abundance of organisms per encounter;
3) Increased ease of encounter (i.e. if species were closer to access points);
4) Increased combinations of wildlife encounters (i.e. multiple encounters with different species of wildlife);
5) Increased combinations of wildlife encounters with other physical attributes (e.g. seeing a shark swimming by dramatic underwater rock formations); and
6) Increasing experience of users.

In addition, the overall non-consumptive value of wildlife encounters would increase simply because more people participate in these activities. This could be due to increased avidity or participation in wildlife viewing or increases in population.

B-26: *Is it possible to map patches of kelp persisting for more than two years? That is, through El Nino cycles or other long-term events?*

Aerial kelp harvester surveys provided kelp data for the central coast region for the period 1990-2002. MLPA Initiative staff will be making this information available as a GIS data layer, which will allow year-to-year comparisons of kelp distribution. Scientists have linked persistence with the size of kelp patches: larger kelp beds persist longer (Graham 2003). A recent model based on the aerial surveys just mentioned also makes it possible to determine the probability of recolonization vs. extinction of a kelp bed.

B-27: *Are there maps of locations for persistent kelp patches and upwelling centers?*

See previous question for locations of persistent kelp beds. Research is underway to identify persistent oceanographic features at a scale relevant to MPA design.

B-28: *Do we have evidence that sea otters limit the fishery for Dungeness crab?*

There is no conclusive evidence one way or the other on this matter in California. Both published and unpublished reports document sharp declines in Dungeness crab abundance in Glacier Bay, Dundus Bay, and Prince William Sound upon the arrival of sea otters in southeast Alaska (Garshelis, Garshelis, Kimker 1986).

B-29: *What can you tell us about how to select sites for MPAs so as to optimize its value and maximize its socio-economic benefits?*

Minimizing negative impacts requires taking several considerations into account. First, in order to minimize negative impacts, you must set a goal such as protection of some percentage of habitat. You can then try to design an MPA to achieve that goal at the least cost to users, such as fishermen. If you were to set a goal of minimizing negative impacts, you would end up locating MPAs only where there are no people.

The options for locating and designing MPAs lie on a spectrum from MPAs that restrict no activities to MPAs that restrict all activities. From the extractive users' point of view, minimizing negative impacts means creating MPAs that minimize restrictions and potential costs. The key question for an extractive user is, how can a given level of protection be achieved with the least impact on extractors? For non-extractive users, MPAs that fail to restrict extractive users may generate adverse impacts and thus costs to non-extractive users, either by reducing the value of non-extractive uses now or in the future. The only way to minimize impacts on non-extractors is by reducing extraction. The key question for a non-extractive user then is, how much extraction can be permitted with the least impact on non-extractors?

Designing MPAs to maximize the net benefits to everyone integrates both of the above approaches, but the goal is to make everyone better off overall. This does not mean that every individual is better off because of an MPA. Someone who incurs a cost represents a “negative” net benefit. In order to maximize total net benefit, we need to make sure that any net benefit to one party is greater than any cost (net negative benefit) that an MPA may impose on another party. In general, since we are going to be working only with very rough estimates of values, the net benefit to one party should be reasonably large.

These calculations have to do with values and preferences. If, for instance, kayakers prefer areas that don’t have personal motorized watercraft, we need to determine whether the degree of preference is such that it makes sense to restrict personal watercraft. In some cases, the impact on kayakers may be so great as to justify doing so. If, however, kayakers rarely see a personal watercraft in an area, restrictions on personal watercraft probably don’t make sense, although kayakers might prefer that there be no personal watercraft in an area.

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