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June 18, 2014
M&A# 05-024-32

Mr. Justin Denelsbeck
U.S. Army Corps of Engineers
Los Angeles District
Regional Planning Section
915 Wilshire Blvd. Suite 930
Los Angeles, CA 90501-3401

Final Canopy Kelp and Subtidal Reefs Survey Report In Support of the Morro Bay 2014 Maintenance Dredging Project W912PL-14-P-0014

Dear Mr. Denelsbeck:

This letter report serves to transmit information regarding the canopy kelp and subtidal reef survey completed for the Morro Bay 2014 Maintenance Dredging Project.

PURPOSE AND INTRODUCTION

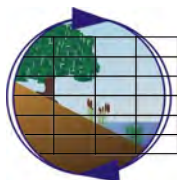
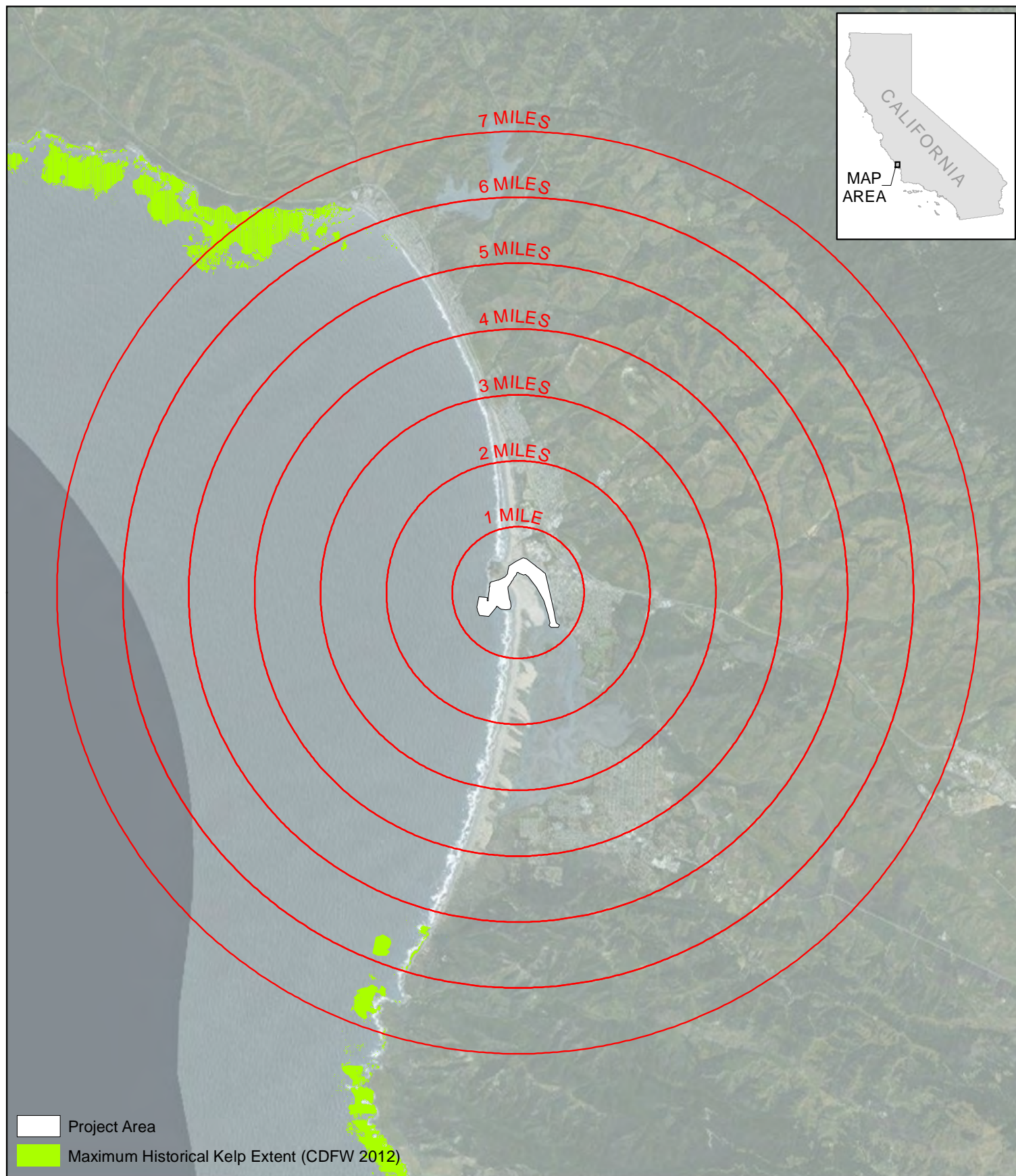
Merkel & Associates Inc. (M&A) was retained by the U.S. Army Corps of Engineers, Los Angeles District (Corps) to conduct a focused pre-dredge canopy kelp and subtidal reef survey in the Federal navigation channel, which includes the entrance channel, transition area, sand trap, main channel, Navy channel, and Morro channel and vicinity (Figure 1). The purpose of this survey was to accurately map and characterize the existing kelp and subtidal reefs within this area.

STUDY AREA LOCATION

The study area is the northern portion of Morro Bay surrounding the Federal navigation channel (Figure 1). Canopy kelp habitat has been mapped on the open coast by the California Department of Fish & Wildlife (CDFW) through regional monitoring efforts. The most proximate mapped canopy kelp beds in the area are found approximately 6 miles from Morro Bay on coastal rocks of the headlands off Cayucos to the north of the study area and off of Montana de Oro State Park south of Los Osos in the vicinity of Spooner's Cove. The sandy shoreline between these two rocky headland areas is typically not conducive to supporting offshore kelp communities.

SURVEY METHODOLOGY

The kelp and subtidal reef investigation was conducted from May 2-4, 2014. Prior to initiation of work, a search of the regional kelp mapping data prepared by the CDFW was investigated for any offshore kelp beds located within the vicinity of Morro Bay. Data were acquired for this effort through queries of ftp://ftp.dfg.ca.gov/R7_MR/BIOLOGICAL/Kelp/, the Department's data server. However, regional kelp data layers had not been updated since 2012 surveys; and as such, the regional kelp maps have not changed since the prior report (M&A 2013b). The project scope called for identification of offshore kelp beds within 1 mile of the mouth of Morro Bay; however, since no kelp beds were found in



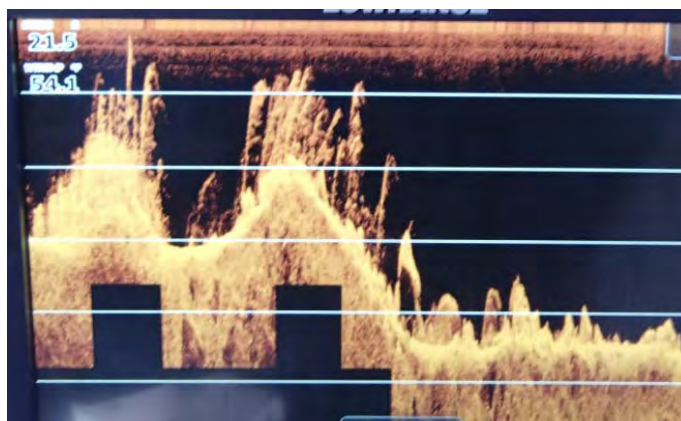
Project Vicinity Map with Regional Kelp Distribution
Morro Bay 2014 Maintenance Dredging

Figure 1

the immediate vicinity, the mapped area was expanded radially from the mouth of Morro Bay until canopy kelp beds were identified both north and south of the study area. This kelp canopy is mapped by CDFW and its contractors using aerial overflight surveys that are subsequently digitally interpreted to plot kelp canopy. The beds identified are typically dominated by giant kelp (*Macrocystis pyrifera*).

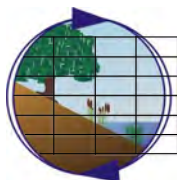
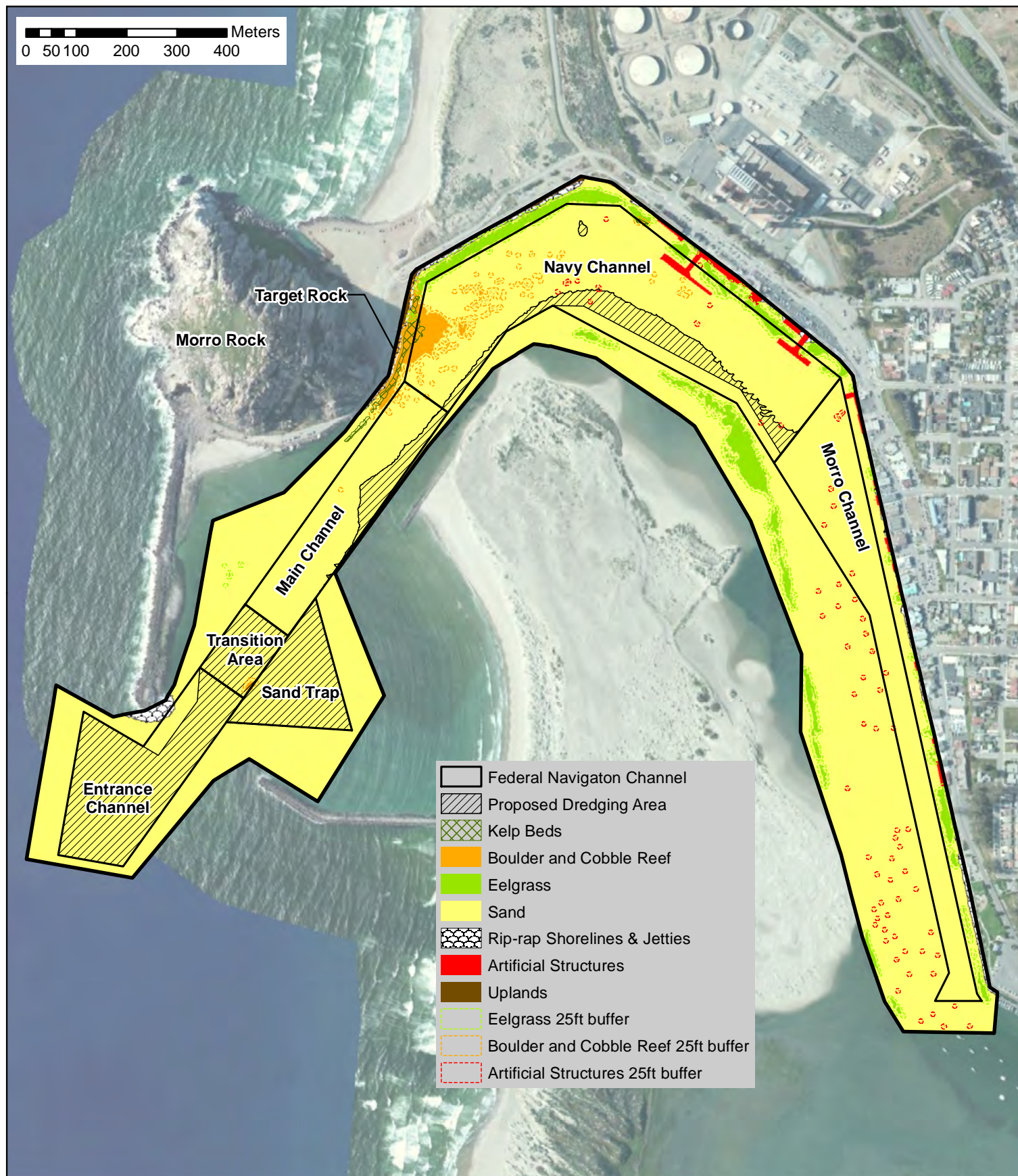
Within the Morro Bay study area, surveys were conducted using multiple methods including interferometric sidescan sonar to locate and map hard bottom habitat features and kelp beds. Visual observations were made during low tide to identify kelp and macroalgal species and to photograph habitats. A drop camera and a remotely operated vehicle (ROV) were used to verify characteristics of the reefs and to identify additional algal species characterizing the kelp communities.

Reef and kelp distribution data were collected using an interferometric sidescan sonar operating at 486 kHz scanning out 35 meters on both the starboard and port channels for a 70-m wide swath. Interpretation of the data allowed for an assessment of the distribution of the hard bottom habitat as well as kelp, identified by air filled stipes and pneumatocysts that have high acoustic reflectivity in the water. The survey was conducted by running parallel transects that were spaced to allow for overlap between adjoining sidescan swaths. Parallel transects were performed until the entirety of the survey area was captured in the survey report. All data were collected in latitude and longitude using the North American Datum of 1983 (NAD 83) and reprojected to NAD 1983 State Plane. Data were then plotted on a geo-rectified aerial image of the project site. The same transect surveys completed for the FY 2014 pre-dredging eelgrass surveys were interpreted for mapping reefs and kelp habitats. During surveys, a single-beam fathometer was also operated in a non-recording mode and provided information on the bottom characteristics and the presence of kelp within the vessel tracks. This information was useful in the interpretation of sidescan sonar data. One of the important observations from the single-beam fathometer was that a substantial portion of the canopy kelp within the survey area had not reached the surface at the time of the May 2014 survey. To map the edge of the surface canopy, the survey vessel was navigated along the edge of the canopy such that the main GPS antenna was positioned directly above the edge of the surface canopy. The vessel track lines were logged at 1Hz position refresh rate creating a boundary map that was subsequently digitized for canopy mapping. Where individual outlier plants were noted on the surface, these were recorded by GPS as points. Multiple photographs were used to characterize the scale of plants on the surface at points, and to assist in identifying shapes of the termination of kelp canopies along the shoreline.



Sub-surface giant kelp on rocky bottom near Target Rock

Following completion of the survey, sidescan sonar traces were joined together and geographically registered. Features were then digitized as a theme over the aerial image. In order to provide spatial context to the reefs and kelp habitat, other habitat features were mapped on the overall sand bottom mosaic (Figure 2). This included mapping of riprap shoreline and jetties, and artificial structures that supports macroalgal communities and can support canopy and understory kelp during various years and



Federal Navigation Channel
Kelp and Reef Habitat Map - May 2014
 Morro Bay 2014 Maintenance Dredging

Figure 2

under various environmental conditions. Because several of the features are extremely small, a 25-foot buffer was placed around habitat features in order to aid in visual detection on the graphics.

Sand was mapped as the base habitat in the survey area. Because sand exhibits patterns of dynamic distribution within the inlet area, it can overrun and scour or bury hard substrate the influence the availability of reefs to support algal beds, including kelp. The distribution of eelgrass can also be affected by the shading of canopy kelp, while eelgrass stabilizes sediment allowing it to build to higher elevations locally where it can overrun hard substrate. As a result, these habitats can affect each other where they co-occur. Within Morro Bay, this is particularly true along the interface of kelp and eelgrass at the northwestern portion of the Navy Channel and near the Morro Bay Power Plant, cooling water intake at the southerly end of Coleman Beach.

During the field investigations, reef areas were visited during high and low tides, and photographs were taken of the reefs and exposed algal communities. For examination of the subtidal reef environments, a combination of drop camera and ROV tools were used. The drop camera was drifted over the reef environments and allowed to settle occasionally to capture photo images and to document reef conditions. The ROV was maneuvered through the reef areas and was used to inspect bottom conditions on a broad scale. Using the visual and camera observations, an inventory of algae observed was developed. While the inventory is not expected to be exhaustive, it did capture all of the dominant species observed within the intertidal environments and encountered within subtidal camera and ROV surveys.

Sidescan survey control was provided by a dual antennae submeter differential GPS with positioning surveyed to the vessel. The accuracy of the antenna was verified using a local benchmark located on the waterfront in Morro Bay near the head of the bay. The identification and location of the benchmark is as follows:

| | |
|---------------|---------------------|
| NOS | 2298 C 1978 |
| ELEVATION | 4.698 M |
| LATITUDE: | 35° 22' 16.5634" N |
| LONGITUDE: | 120° 51' 26.9807" W |
| | NAD 83 epoch |
| HORIZ. DATUM: | 2004.0 |
| VERT. DATUM: | MLLW epoch 83-01 |

Prior to initiation of survey on May 2, the survey vessel was trailered so the boat was positioned adjacent to survey monument NOS 2298 C, a 3½" brass disk located in the center concrete median of Embarcadero Street. This monument was also used for verification of GPS at each subsequent survey period on May 3 and 4. The results of the GPS verification are as follows:

| DATE | BM STATION | STATION POSITION | DGPS POSITION | CALCULATED ERROR (FT) |
|--------------|------------|---|---------------------------------------|-----------------------|
| 5/02/14_1213 | NOS 2298 C | 35° 22' 16.5634" N; 120° 51' 26.9807" W | 35° 22' 16.585" N; 120° 51' 26.980" W | 2.2 |
| 5/02/14_2037 | NOS 2298 C | 35° 22' 16.5634" N; 120° 51' 26.9807" W | 35° 22' 16.591" N; 120° 51' 26.971" W | 2.9 |
| 5/03/14_0934 | NOS 2298 C | 35° 22' 16.5634" N; 120° 51' 26.9807" W | 35° 22' 16.588" N; 120° 51' 26.981" W | 2.5 |
| 5/03/14_1636 | NOS 2298 C | 35° 22' 16.5634" N; 120° 51' 26.9807" W | 35° 22' 16.580" N; 120° 51' 27.040" W | 5.2 |
| 5/04/14_0850 | NOS 2298 C | 35° 22' 16.5634" N; 120° 51' 26.9807" W | 35° 22' 16.592" N; 120° 51' 26.980" W | 2.9 |
| 5/04/14_1723 | NOS 2298 C | 35° 22' 16.5634" N; 120° 51' 26.9807" W | 35° 22' 16.580" N; 120° 51' 26.983" W | 1.7 |

SURVEY RESULTS

At the time of the May 2014 survey, five substrates and three vegetation based habitats were identified and mapped. Vegetated habitats are developed on physical substrates and thus are not exclusive in area. The substrate mapped include: sand bottom, boulder and cobble reef, riprap shorelines and jetties, artificial structures, and uplands (Figure 2). The vegetated habitats mapped include canopy kelp beds and eelgrass habitats. Hard bottom substrates within Morro Bay support non-canopy macroalgal dominated habitat on surfaces below approximately mean sea level. These features were not mapped as they are easier to characterize by substrate type and elevation ranges.

Algal species observed during the investigations are summarized in Table 2. The individual habitat areas are discussed below.

Table 2. Algal species observed during the May 2014 field investigations

| Chlorophyta (green algae) | Phaeophyceae (brown algae) | Rhodophyta (red algae) |
|---|--|--|
| <i>Ulva lobata</i> <i>Enteromorpha</i> sp. <i>Chaetomorpha</i> sp. <i>Bryopsis corticulans</i> | <i>Cystoseira osmundacea</i> <i>Egregia menziesii</i> <i>Macrocystis pyrifera</i> <i>Nereocystis luetkeana</i> <i>Desmarestia ligulata</i> <i>Dictyopteris</i> sp. <i>Giffordia</i> sp. (<i>grandulosa</i> ?) <i>Fucus gardneri</i> <i>Hesperophycus californicus</i> | <i>Prionitis lanceolata</i> <i>Rhodymenia pacifica</i> <i>Rhodymenia californica</i> <i>Endocladia muricata</i> <i>Chondracanthus exasperatus</i> <i>Gigartina californica</i> <i>Gigartina agardhii</i> <i>Gigartina tepida</i> <i>Ceramium eatonianum</i> <i>Cystoseira osmundacea</i> <i>Botryoglossum farlowianum</i> <i>Bossiella chiloensis</i> <i>Calliarthron tuberculosum</i> <i>Corallina officinalis</i> <i>Lithothamnion</i> spp. <i>Lithophyllum</i> spp. <i>Erythrophyllum</i> sp. <i>Farlowia conferta</i> <i>Hildenbrandia occidentalis</i> <i>Mazzaella flaccida</i> (Iridaea f.) <i>Halosaccion glandiforme</i> <i>Laurencia spectabilis</i> <i>Odonthalia</i> sp. <i>Gracilaria verrucosa</i> <i>Sargassum muticum</i> <i>Smithora naiadum</i> <i>Porphyra perforata</i> <i>Polysiphonia acuminata</i> |

Sand Bottom

The dominant habitat within northern Morro Bay is soft sand bottom. The nature of the sand varies within the Bay due principally to the energy environment. Within the shallow portions of the north Bay, there are a number of beaches and sand flats that support both littoral sands as well as wind-deposited

dune sands. These are very clean granular sands with low silt content. In addition, the entrance channel, sand trap, transition area, main channel and portions of the Navy channel support highly mobile clean littoral sand on the surface. In more quiescent portions of the northern Morro Bay, sand bottom is characterized as a silty-sand or sandy-silt substrate. These areas exhibit no flow driven surface features, but rather support evidence of biological activities including burrows, fish foraging pits, and invertebrate tracks over the sediment.

Areas of sand bottom, both within partially stabilized channel areas, as well as outside of the higher velocity channels, are generally unvegetated. There are several areas that support intermittent high-density beds of small sand dollars (*Dendraster excentricus*). Where macroalgae is found, it is typically mobile or restricted to eddy areas that serve as algal traps. Macroalgae in these areas is predominantly ephemeral in nature and dominated by such opportunistic species as the green algae *Ulva lobata*, *Enteromorpha* and *Cheatomorpha* species. Also found on the soft bottom environments are red algae including *Gracilaria verrucosa* and *Porphyra perforata*. The brown alga, *Desmarestia ligulata* was also observed as a common algal constituent on the sand bottom. This species was typically associated with shells and small rock rubble found in the sand.

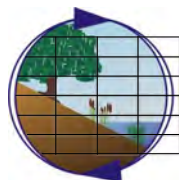
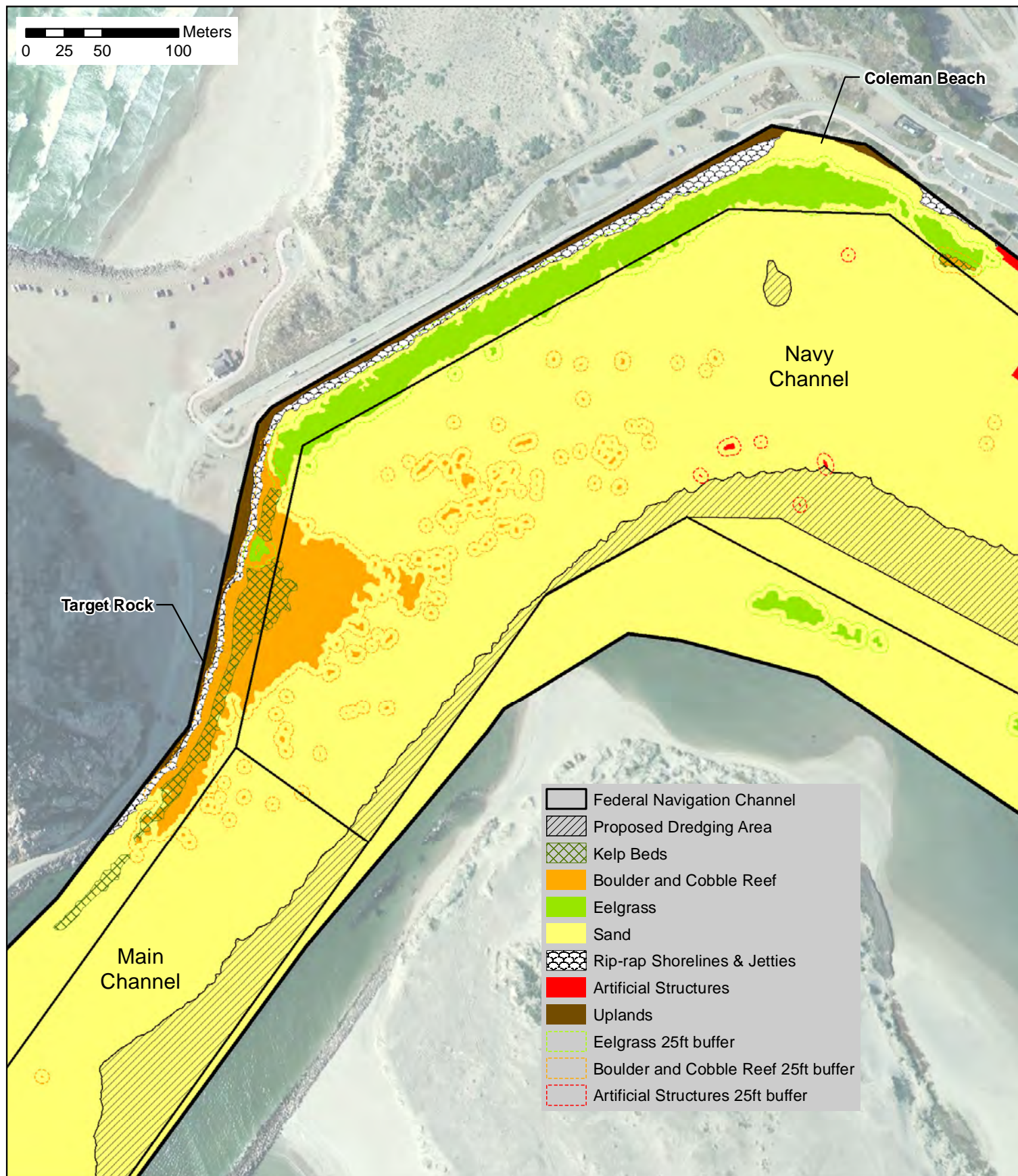
Eelgrass Beds

On the sand bottom, eelgrass beds are the only persistent vegetated habitat. The distribution of eelgrass in the northern portion of Morro Bay has been discussed extensively in previous survey reports (M&A 2011, 2013). Eelgrass is located within the shallower subtidal and low intertidal portions of Morro Bay within stabilized and partially stabilized soft bottom habitats. In northern Morro Bay, this habitat is found in a small population of a few individual plants located in the outer Morro Bay north of the Federal channel at approximately the dividing line between the transition area and the main channel (Figure 2). Further into the bay, eelgrass is found as fringing beds on both sides of the Navy channel segment of the Federal channel. Eelgrass continues to occur intermittently between docks and other piers along the shoulders and outside of the Federal channel along the Morro Bay Embarcadero, both along the Navy channel and the Morro Channel. To the west, eelgrass occurs on the shallow sand flats extending from intertidal to shallow subtidal depths.

Eelgrass habitat interdigitated with kelp beds at the south end of Coleman Beach near the Morro Bay Power Plant cooling water intakes where sand partially covers a small rock pile supporting kelp. Eelgrass is also found integrating with the kelp beds to the east of Target Rock north of the Navy Channel. At this site, the soft bottom habitat that supports eelgrass to the east extends into the revetted shoreline where sand fills pockets around the boulders. This eelgrass bed is very dynamic varying in extent with the scale of the overhanging kelp canopy.

Boulder and Cobble Reef

Boulder and cobble reef is principally located in the vicinity of Morro Rock and suggests a geologic feature extending eastward from Morro Rock into the Bay (Figures 2 and 3). Other small rock piles are found scattered to the south of Morro Rock; however, the various rocks in this portion of the Bay tend to be isolated and less definitively distributed as a natural formation. The reef is characterized by a combination of large and small rock that ranges from a continuous boulder field in the shadow of Morro Rock to widely scattered boulders within the Navy channel. Along the upper edge of the boulder and cobble reef, the natural stone has been supplemented by the placement of additional site-native rock to create a revetted shoreline along Coleman Drive as it extends out to Morro Rock. The transition between natural reef and revetted shoreline in this area is principally a matter of slope with little to no difference in algal community characteristics.



Morro Bay Kelp Beds - May 2014
Morro Bay 2014 Maintenance Dredging

Figure 3

The boulder cobble reefs present within Morro Bay support a mix of algae dominated strongly by *Dictyopteris* sp. but also including *Gigartina tepida* near Target Rock, and *Desmarestia lingulata* as the visual dominants. Within shallow areas of the rocky subtidal *Bryopsis corticulans* was observed. This species was not noted in the prior 2013 surveys. Uncommon in 2014, was *Halosaccion glandifome*, a species that was more common during the prior year's surveys. In sand scoured lower portions of the reef, various coralline algal species are present including species of *Corallina*, *Calliarthron*, and *Bossiella*. In highly scoured areas near the sand/boulder interface encrusting coralline algae including *Lithothamnion* and *Lithophyllum* spp. were observed.

The reefs support populations of the corallimorph strawberry anemone *Corynactis californica* as well as scattered cup corals *Balanophyllia elegans*. Also visibly dominant on the rock are various encrusting bryozoa, with multiple stalked tunicates dominated by *Steyla clava* being present. Bat star (*Patiria miniata*), pink sea star (*Pisaster brevispinus*), and giant sea star (*Pisaster giganteus*) were common on the cobble reef near Target Rock and to the east.

Canopy kelp beds are found on the boulder and cobble reef as discussed below.

Canopy Kelp Beds

Canopy forming kelp beds within Morro Bay are found attached to the boulder and cobble reef rock located in the vicinity of Target Rock and near the Morro Bay Power Plant intake structure (Figure 3). The defining feature of this habitat is the presence of sporophyte giant kelp (*Macrocystis pyrifera*) that forms a surface reaching canopy structure. In 2013, annual bull kelp (*Nereocystis luetkeana*) was observed as a single decaying stipe of floating in the Bay near the Target Rock kelp bed. During 2014, bull kelp was noted to exist along the outer margins of the giant kelp bed near Target Rock. The presence of bull kelp appears to be very low compared to the more dominant perennial giant kelp. Understory algal communities within the kelp bed are described in the boulder cobble reef discussion.

While the extent of kelp beds in Morro Bay have been fairly restricted in both 2013 and 2014, a July 30, 2007 aerial photo available in the Google Earth historic images shows the canopy kelp extended over a much greater extent of the reef, well out into the western portion of the Navy channel. This observation suggests that the kelp bed may be highly dynamic from year to year and is capable of covering much of the available reef rock. In 2014, it was noted that much of the giant kelp had not reached the surface at the time of the May survey, although it was present well beyond the outer extent of observed surface canopy.

The small kelp bed located on rocky outcrop near the Morro Bay Power Plant intake has not changed substantively between 2013 and 2014, and there is no expectation of substantial expansion or contraction given the limited availability of rocky substrate in this area.

The canopy kelp beds provide a unique resource to the resident population of sea otters (*Enhydra lutris nereis*), which uses the algal canopy as moorings to hold position in Morro Bay while resting. The expanding otter population has made this species one of the most visible resources associated with the kelp canopy. Otters have been noted to utilize both the larger kelp bed along the northern shoreline of bay, as well as the small kelp bed near the power plant.

Riprap Shoreline and Jetties

Outer Morro Bay is protected by two large jetty fingers that extend from Morro Rock on the north to the entrance channel and from the dune system on the south to the entrance channel (Figure 2). These

jetties provide wave protection to outer Morro Bay and create a wave refraction pattern that maintains a broad crescent beach on the south side of the basin. An additional small rock groin is located at the northern end of the crescent beach, just outside of the study area and southeast of the main channel. A semi-linear strip of revetment stone is present to the southeast, and riprap shoreline is located along the shoreline east of the break between the main channel and Navy channel segments of the Federal channel (Figure 2 and 3). This rock alignment suggests the presence of a revetted channel bank now buried in sand from littoral accretion and dune blown sand origins. Further into the bay, rock revetment has been used to armor the peninsula extending out to Morro Rock along the edge of Coleman Drive back to Coleman Beach. Revetment also extends slightly north of the intake structure of the Morro Bay Power Plant. Revetment then extends from the southern edge of intake structures extending southward along the eastern shoreline of the Bay, often overshadowed by artificial structures that overhang or are constructed on the water.

The riprap revetment and more exposed jetty structures support variable communities of encrusting organisms and non-canopy macroalgae. Above elevations of approximately mean sea level, the rock is principally barren with limited mobile invertebrate use. Below mean sea level typical intertidal zonation of barnacles and mussels occur with a transition to a macroalgal dominated habitat near the mean low tide elevation. Within this algal community, turf like species, including *Endocladia muricata* and *Odonthalia* sp. dominate the upper portions of the algal beds. At increasingly lower elevations, turf algae gives way to more foliose species including *Mazzeella flacida*, *Chondracanthus exasperatus*, *Gigartina* spp. *Fucus gardneri* and *Hesperophycus californicus* are also present in these areas. Within low intertidal and subtidal zones on the outer jetties, feather boa kelp (*Egregia menziesii*) is common. Also common, mostly within the shallow subtidal, is lazy edges (*Botryoglossum farlowianum*) and *Cystoseira osmundacea*. The encrusting *Hildenbrandia occidentalis* coats the faces of some of the low intertidal rock where foliose algae are less dense. Coralline algae, including *Corallina*, *Calliarthron*, and *Lithophyllum*, were observed on the lower portions of the exposed jetty where high surf and sand scour occurs on a regular basis.

Away from the higher wave energy on the lower revetment stone along Coleman Drive, the most common subtidal alga is *Dictyopteris*. Also present within this area is *Desmarestia ligulata*, a species that is very common within drift algae in the outer portions of the bay north of the transition area. Along the Embarcadero shoreline, the invasive species *Sargassum muticum* is the dominant algal species on the rock. Also present are opportunistic chlorophytes including *Ulva lobata*, *Enteromorpha* sp., and *Bryopsis corticulans*.

Artificial Structures

Artificial substrate consists of manufactured hard materials including concrete, metal, fiberglass, and other objects within the Bay. The majority of these structures are associated with the development along the embarcadero and include piles, docks, and debris on the bay bottom. Other artificial structures include mooring blocks that are found along the A-1 anchorage within the vicinity of the Morro channel, along the main channel where channel marker buoys are located, and within and adjacent to the sand trap near the entrance. For the most part, macroalgal communities are limited on the artificial structures as a result of depth or the generally vertical surfaces or prior existing encrusting epifaunal growth.

Uplands

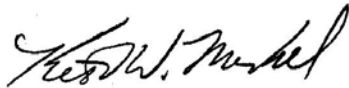
A few areas of upland habitat were captured in defining the study area. Because the study area was intended to be within the areas of tidal influence, these areas are limited and are generally unvegetated, or vegetated by upland invasive species such as hottentot-fig iceplant (*Carpobrotus edulis*).

DISCUSSION

This project memorandum serves to transmit the pre-dredging focused canopy kelp and subtidal reefs survey results and is intended to satisfy the pre-construction report deliverable requirements of contract W912PL-14-P-0014. The document reveals a typical environment for protected and semiprotected environments. The general paucity of hard substrate restricts the potential for development of expansive kelp beds within northern Morro Bay. The work was conducted as an information document to assist the Corps of Engineers in planning and preparation of environmental documents. No specific action is being evaluated with respect to the data presented and therefore no recommendations are provided.

If you have any questions regarding these data, please do not hesitate to contact me.

Sincerely,



Keith W. Merkel
Principal Consultant

REFERENCES

- California Department of Fish & Wildlife 2012. Marine Region Canopy Kelp Habitat Mapping on the Open Coast 2012. ftp://ftp.dfg.ca.gov/R7_MR/BIOLOGICAL/Kelp/.
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- Merkel & Associates. 2013a. Final Post-Dredge Eelgrass Survey Report in Support of the 2012 Cycle of the Morro Bay Maintenance Dredging Project, Morro Bay, California. Prepared for U.S. Army Corps of Engineers Los Angeles District. February 2013.
- Merkel & Associates. 2013b. Final Canopy Kelp and Subtidal Reefs Survey Report in Support of the FY 2013-2014 Cycle of the Morro Bay Maintenance Dredging Project, Morro Bay, California. Prepared for U.S. Army Corps of Engineers Los Angeles District. June 2013.
- Merkel & Associates. 2013c. Final Post-Dredge Eelgrass Survey Report in Support of the 2013 Morro Bay Maintenance Dredging Project, Morro Bay, California. Prepared for U.S. Army Corps of Engineers Los Angeles District. July 2013.

ATTACHMENT 1: PHOTO PAGES



Photo Point 1a. Tip of the northern jetty exhibiting turf algae above scoured areas of coralline algae.



Photo 1b. Inside southern jetty illustrating the fairly barren rock of the splash zone above turf and foliose algal zones.



Photo 2a. Narrow giant kelp canopy located along northern shoreline east of Morro Rock.



Photo 2b. Giant kelp in front of Target Rock along with *Enteromorpha* mat growing in the shallows.



Photo 3a. Cobble beds intermixed with boulders at the western end of the Navy Channel.



Photo 3b. Drift kelp and eelgrass debris trapped in active sand deposits to the north of the transition area of the channel inside the outer jetties.



Photo 4a. Target Rock shoreline area with surface slicks on wave rippled water revealing canopy kelp presence.



Photo 4b. Minor occurrences of bull kelp were noted on the outer perimeter of the giant kelp bed within the western portion of the Navy Channel.



Photo 5a. Low tide exposed eelgrass bed at Coleman Beach.



Photo 5b. Sand dollar beds (*Dendraster excentricus*) have become more expansive in the northern portions of the Bay over the past few years. These beds are located on the building shoal along the west side of the Navy Channel.