DISTRIBUTION AND ABUNDANCE OF EELGRASS (ZOSTERA MARINA) IN NEWPORT BAY

2003-2004 Eelgrass Habitat Mapping Project Bulkhead to Pierhead Line Surveys

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1. INTRODUCTION

1.1 PROJECT PURPOSE

Coastal Resources Management (CRM) conducted underwater habitat surveys in Newport Bay for the City of Newport Beach between December 2003 and August 2004. The purpose of the CRM investigation was to provide a detailed bay-wide map of eelgrass resources within Newport Harbor and Upper Newport Bay intertidal to shallow subtidal bulkhead to pierhead line depths. This data base of information will assist the City in managing the bay's natural resources and obtaining environmental permits from state and local regulatory agencies for projects such as bulkhead repair and dredging. The public will benefit from the data base by being able to determine what environmental constraints and potential costs and options are when applying for individual permits associated with dock repair and individual dredging projects.

In addition to the mapping effort conducted by CRM, the National Marine Fisheries Service (NMFS) conducted additional eelgrass habitat mapping surveys in the open-water federal navigation channels seaward of the pierhead lines to augment the eelgrass habitat mapping surveys conducted by CRM. This mapping effort is reported by NMFS under separate cover. The combination of both surveys provides a full assessment of Newport Bay's eelgrass bed distribution and abundance.

1.2 EELGRASS BIOLOGY AND ECOLOGY

The flowering, marine vascular plant "eelgrass" (Photograph 1) is considered a sensitive marine resource due to its nursery function for invertebrates and fishes, and because it is considered critical foraging habitat for the federal and state listed California least tern (*Sterna albifrons browni*), a seabird that feeds upon juvenile baitfish that congregate in eelgrass meadows. Eelgrass forms meadows on mudflats and subtidal sediment in bays, estuaries, and occasionally in offshore marine sand bottom habitats. The meadows (and subunits referred to as "beds" and "patches") are an important habitat for invertebrates as a source of food and attachment and biological cover, and for marine fishes that seek the shelter of the beds for protection and forage on the invertebrates that colonize the eelgrass blades and sediments in and around eelgrass vegetation.

1.2.1 Physical and Chemical Requirements of Eelgrass

Sediment Type. Eelgrass colonizes a range of sediments varying from firm sand with moderate wave action to soft muds in quiet bays (Phillips 1974). In Newport Bay, eelgrass colonizes subtidal fine sands along the eastern and western shorelines in and near the Entrance Channel. In most other areas of the Bay, eelgrass colonizes silty sediments along Bayshores, Balboa Island, Harbor Island, and Balboa Island North Channel. Typically, the sediments exhibit a decreasing grain size with increasing depth (Ware, pers. observations, Ware 1993, Chambers Group Inc. and Coastal Resources Management 1998, 1999).

Photograph 1. Eelgrass, *Zostera marina*-wide bladed form

Photograph 2. Narrow-bladed form, typical of Newport Bay

Elevational Distribution. The upper elevational range limit of eelgrass on naturally sloped shorelines is primarily regulated by desiccation, sediment stability, and wave shock (Phillips 1974); in Newport Bay this limit appears to be approximately at the Mean Lower Low Water mark (0.0 ft) although it can occur as high as +1 ft (MLLW). However, in many areas of Newport Bay and other modified southern California embayments, its upper range limit is a function of dredging and bulkheading which eliminates natural intertidal eelgrass meadows.

Besides tidal influences, water motion, and sediment parameters, the water column parameters of light, temperature and salinity also control growth and productivity of seagrasses (Thayer et al. 1984, Zimmerman et al. 1991). Of these, light is the factor which often controls the depth, distribution, density, and productivity of seagrass meadows (Backman and Barilotti 1976, Zimmerman et al. 1991).

Light Penetration. In Newport Bay, light penetration is affected by parameters such as time of day, tidal condition, suspended organics and sediment input into the bay from dry-season runoff, winter storms, plankton blooms, shading from docks and boats, and in-bay activities such as dredging and boating activity (ACOE 1998, Merkel and Associates 1996, MBC and SCCWRP 1980, R. Ware, pers. observation). Light penetration is better during the incoming tides compared to outgoing tides which carry higher levels of suspended organics and sediments out of Newport Bay. Zimmerman et al. (1991) estimated that eelgrass in San Francisco Bay required between three and five hours a day of irradiance to maintain carbon balance and growth, and suggested that eelgrass is adapted to extremely low light availability. In general however, higher water turbidity in coastal embayments results in limiting eelgrass depth distribution to intertidal and shallow subtidal environments (Zimmerman et al. 1991). This is reflected in Newport Bay with eelgrass exhibiting a greater depth range nearer the harbor entrance (to a depth of -27 ft MLLW) compared to a maximum of -8 to -10 ft in eelgrass beds located farther back in Newport Harbor such as Harbor Island and Balboa Island where water clarity is poorer and sediments are much finer (R. Ware, pers. observations). Physical effects of dredging in the bay, besides light attenuation, also affects the lower distribution limit of eelgrass in Newport Harbor (R. Ware, pers. observation).

Temperature. Eelgrass is a eurythermal species; its optimum temperature distribution appears to lie between 10 ^{o} C and 20 ^{o} C (50 ^{o} to 68 ^{o} F), and its extreme temperature ranges may vary from -6 C ^{o} in Alaska to 40.5 ^{o} C (21.2 ^{o} F to 104.9 ^{o} F). Therefore, water temperatures in Newport Bay are not a limiting factor for eelgrass growth and distribution. Eelgrass may display some genetic and/or environmental-associated variations in response to water temperature and/or light requirements. For example, wider-bladed meadows of eelgrass occur primarily in the deeper, cooler entrance channel waters of Newport Bay, whereas a narrower bladed form is found throughout the other regions of Newport Bay in shallower, warmer conditions. Seed germination in annual forms of eelgrass is also related to water temperature (Phillips and Watson 1984).

Salinity. Eelgrass is also a eurysaline species and can survive in a wide range of water salinities, including the range of salinities which Newport Harbor experiences. It has been documented to grow at stream mouths when the water is fresh at low tide (Phillips and Watson 1984) but does not grow in persistent freshwater. At the other extreme, eelgrass can grow in waters of extreme salinity (42 parts per thousand [ppt]). In Puget Sound, eelgrass grows best in a salinity of 20 to 32 ppt. Phillips (1972) found that most (70%) eelgrass seed germination occurred at 5 to 10 ppt at all temperatures, although at 10 ppt, seed germination often doubled from 10^{o} C to 15^{o} C but did not do so in full strength seawater (30 ppt).

Oxygen. Under normal growing conditions, oxygen is not a limiting factor for eelgrass. However, during periods of high turbidity which may result in significant light limitation and decreases in photosynthesis and oxygen production, eelgrass root and rhizome tissue may experience periods of anoxia. While eelgrass tissue apparently can withstand periods of 24 hrs of anoxia (Smith 1989), the long-term cumulative effects of prolonged anoxia are not known but it is possible that eelgrass distribution, particularly at its deeper limit, may be negatively affected (Zimmerman et al. 1991).

1.3 HISTORICAL DISTRIBUTION OF EELGRASS IN NEWPORT BAY

Historically, eelgrass has been recorded in the Indian midden (trash areas) remains along the West Bay bluffs dating back to at least 600 A.D. (Weide, 1983). Prior to the mid 1800's, "Newport Harbor", or "Lower Newport Bay" did not exist and the coastline was an open coastal sandy beach and rocky shoreline. Eelgrass was only present in the what is now referred to as "Upper Newport Bay". Following the formation of the sand spit that formed the Balboa Peninsula in the mid-to-late 1800s, conditions in Newport Lagoon were likely conducive for eelgrass colonization due to calmer, bay-like water conditions.

Between the 1950s and the late 1960's, eelgrass persisted between the Coast Highway Bridge and the southern tip of Upper Island near Big Canyon (Barnard and Reish 1958, State Water Quality Control Board 1965, Stevenson and Emery 1958, Posjepal 1969, Hardy 1970, and Allen 1976). Eelgrass beds all but disappeared between the late 1960's and the mid 1970's likely due to heavy sedimentation following the storms of 1969. It has occurred within Lower Newport Bay for at least the past 60 years within beds found along East Balboa Peninsula and around Balboa Island.

Eelgrass acreage in Newport Bay was roughly estimated to be 3 acres in 1993 (Hoffman, pers. comm. in Ware 1993) In 1999, eelgrass was estimated to cover over 18 acres of shallow underwater habitat (Coastal Resources Management, unpublished data). General eelgrass distribution were prepared by Coastal Resources Management and Chambers Group (2003) for the City of Newport Beach Local Plan Update showing the locations of eelgrass in the Bay through 2002 (Coastal Resources Management 2003).

The increase in eelgrass acreage in Newport Bay since 1993 may be the result of several factors –an improvement in water clarity, highly favorable growing conditions during prolonged dry weather years (i.e., La Nina years of low rainfall and low concentration of suspended sediments), better management of dredge and fill projects in the last decade, increased environmental awareness of the importance of eelgrass, and better and more consistent methods of mapping eelgrass vegetation.

With the exception of the general maps prepared for the City's LCP, there have been no definitive, bay-wide investigations to document the extent of eelgrass habitat within Newport Bay that resource managers can use to evaluate environmental impacts on this sensitive marine resource. This study will provide the necessary maps and distribution information for this purpose.

1.4 PROJECT AREA

The project area boundaries include the bay habitat between the bulkhead and pierhead lines of accessible areas of Lower Newport Bay (Newport Harbor) and the southern reach of Upper Newport Bay to Dover Shores and the DeAnza Bayside Marsh Peninsula (Figure 1). However, some areas were not surveyed for one or more of the following reasons: (1) Some areas had been recently surveyed (Linda Isle Lagoon, CRM 2003; Balboa Marina, Tetra Tech 2003); (2) some regions were identified by the Harbor Resources Department as having lower priority during the 1st year of eelgrass habitat mapping (West Newport channels and Rhine Channel), or (3) some areas were deemed too dangerous for divers due to boat traffic and boat basin activity (west end of Mariner's Mile/Lido Reach). Maps of both the Linda Isle Lagoon eelgrass and within the Balboa Marina Channel are available for viewing at the Harbor Resources Department.

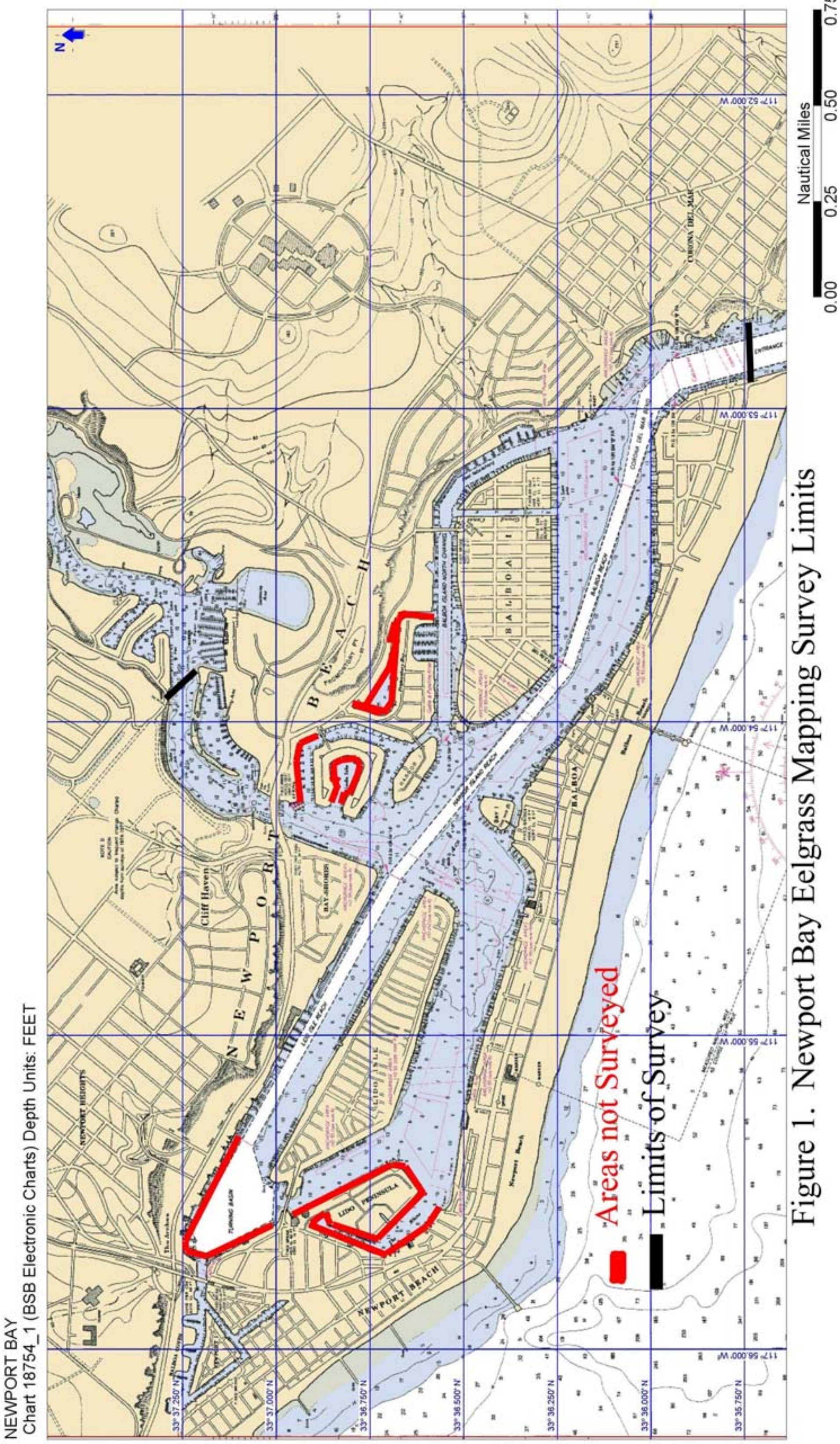


Figure 1. Newport Bay Eelgrass Mapping Survey Limits

2. SURVEY METHODS

Eelgrass vegetation was mapped using a Global Position System (GPS) and a team of Coastal Resources Management biologists consisting of a diver and a surface support biologist. The biologist-diver first located the beginning of an eelgrass bed and marked it with a yellow buoy. The surface support biologist working from a kayak then initiated tracking of the biologist diver using GPS technology as he swam the perimeter of the individual eelgrass bed (See Photographs 1 and 2). Once the diver returned to the beginning point, the GPS track was terminated. Eelgrass patches that were too small to survey or located in difficult areas to obtain a GPS signal (i.e., behind docks/under piers) were referenced as a GPS "point" and a size of the eelgrass patch was estimated by the diver.

The data were initially collected with a Thales Mobile Mapper GPS unit with an accuracy of less than 3 meters (Photograph 3). During the last part of the survey between March and August 2004, the accuracy of the mapping was increased to less than one meter using newly-released differential GPS post-processing software from Thales.

Field data were downloaded into a laptop computer and using Geographic Information Systems Software (Thales Mobile Mapping Software, GPS PRO Tracker, and ARCVIEW 3.2), data files were produced for the City of Newport Beach GIS Division. The results of the mapping surveys were integrated into the City of Newport Beach GIS data base and the City of Newport Beach Harbor Resources Department public accessible website. For presentation and area calculation purposes, 17 eelgrass "regions" were developed. These typically included the area between the bulkhead and pierhead lines, but occasionally included eelgrass patches and small beds immediately seaward of docks. In addition, eelgrass beds that were continuous across channel bottoms separating two islands (i.e., Linda Isle and Harbor Island) were artificially divided down the center to allow for a calculation of eelgrass habitat areas within each region.

We also collected information on eelgrass "turion" density, which provides an indication of habitat cover within the perimeter of the bed. Turions are eelgrass units consisting of the above-sediment portion of the eelgrass consisting of a single shoot and "blades" (leaves) that sprout from each shoot (Photograph 4). Turion density was estimated by the SCUBA-diving biologist counting the number of live, green shoots at the sediment/shoot interface within replicated 0.07 square meter (sq m) quadrats set between the shallow and deep area of each sampling site. Initial standardization of counting methods was conducted to ensure the accuracy of counts between different team members.

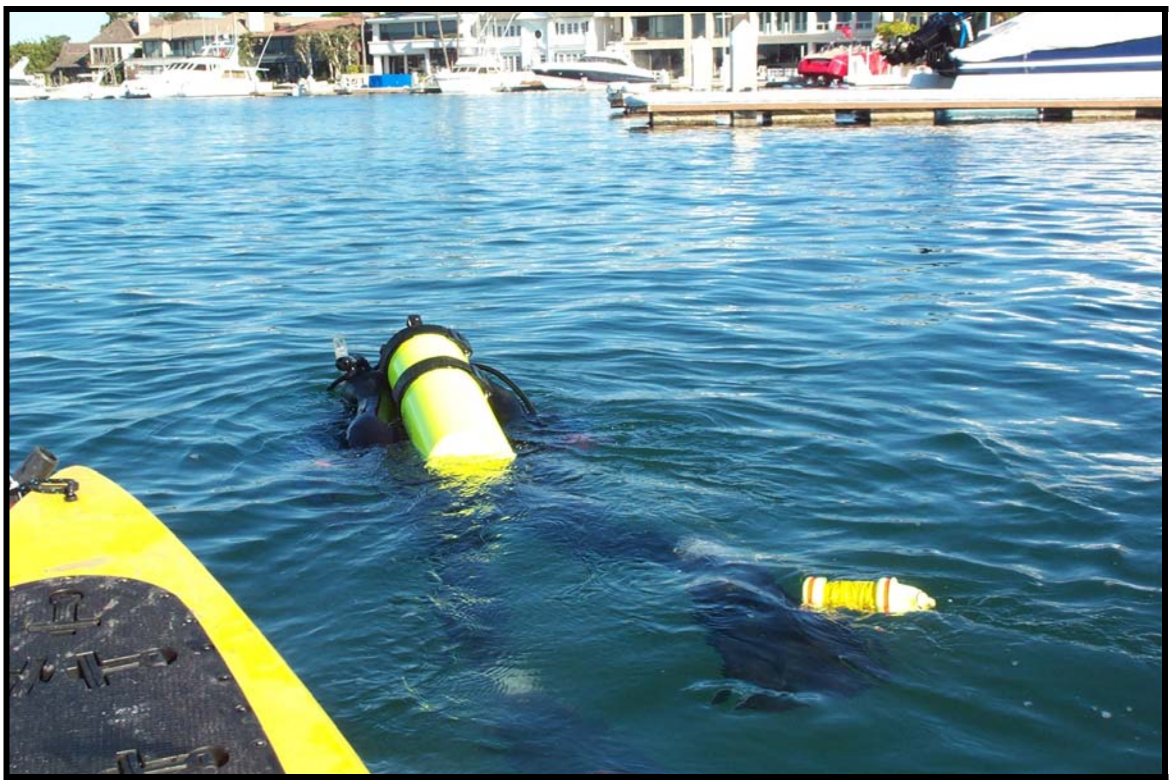
Fourteen areas of Newport Bay were sampled for turion density counts. With one exception, 60 replicate samples were counted along a transect in shallow, mid, and deep areas of the eelgrass bed. Thirty counts were made in the other area (China Cove). The data were then summarized for each area using graphical and statistical methods.

Other background information collected during the survey that is archived for future use includes general sedimentary conditions (sand or silt), water visibility, water depth, and plants and animals observed in the eelgrass beds during the survey.

Data obtained during the eelgrass survey will be available for public view on the Harbor Resources Department website (http://www.city.newport-beach.ca.us/HBR/). This website allows the public to view an aerial photograph of Newport Bay and the mapped locations of eelgrass simultaneously. In addition, users can type in a street address to determine if eelgrass beds or smaller patches area are located near or in front of their property.

The survey team included Mr. Rick Ware, Mr. Stephen Whitaker, Mr. Lein Jenkins, and Mr. Robin Cadiz. Mr. Scott Watson and Mr. Ryan Stadlman of the City of Newport Beach GIS Department were instrumental in providing the final GIS graphics and calculating eelgrass habitat acreages. Mr. Tom Rossmiller and Mr. Chris Miller provide logistical support from the City of Newport Beach.

The procedures we used during the 2003-2004 field survey will be used on regular basis to update the City's eelgrass distribution database to determine trends in eelgrass distribution and density and to assist in the management of the harbor's resources.



Photograph 3. GPS surveying methods using a kayak and diver

Photograph 4. Biologist in kayak follows the diver's buoy, tank, and bubbles

Photograph 5. View of GPS unit and diver below the surface

Photograph 6. Above-sediment morphological features of an eelgrass plant

3. SURVEY RESULTS

The survey was conducted thirty-seven field days between 18 December 2003 and 2 August 2004. Fifteen linear miles of bay shoreline was covered, and the actual length covered by divers and the kayak likely exceeded 30 linear miles of shoreline.

A summary of the survey results are provided in Table 1. A total of 27.746 acres (112,324 square meters) of eelgrass was mapped primarily between 0.0 and -8 feet relative to Mean Lower Low Water (ft, MLLW). Figures 2 shows the general regions in which eelgrass was located. Figure 3 illustrates the distribution of eelgrass beds and Figure 4 illustrates the locations of smaller eelgrass patches. Eelgrass is common to abundant between the bulkhead and pierhead lines throughout the eastern "outer" half of Newport Harbor at depths between 0.0 and -8 ft MLLW. Its distribution in the western "inner" half of Newport Harbor from Bay Island to the Rhine Channel, and in Lido Reach is extremely limited. Within Upper Newport Bay, eelgrass is common to abundant in the lower reach of the main channel between the Coast Highway Bridge and the DeAnza/Bayside marsh peninsula, particularly on a developing shoal on the west side of the marsh peninsula. Five areas of Lower Newport Bay accounted for 78% of the acreage. These areas included the Corona del Mar to Orange County Harbor Patrol region, Balboa and Collins Islands, the channels surrounding Linda Isle, and Harbor Island (Table 1).

Table 1. Results of Eelgrass Habitat Mapping Surveys-Bulkhead to Pierhead Lines

Region #	Survey Region	Area (acres)	% Total	Major Sediment Type
1	Corona del Mar to OCHD	6.886	24.82	sand to silt
5	Balboa and Collins Islands	6.686	24.10	sand to silt
10	Linda Isle (outer channels)	2.916	10.51	silt
9	Harbor Island	2.721	9.81	silt
2	Balboa Channel Marinas/Yacht Basins	2.469	8.90	silt
3	Balboa Peninsula-East of Bay Island	1.672	6.03	silt
15	Bayshores	0.991	3.57	silt
4	Grand Canal	0.898	3.24	silt
13	DeAnza/Bayside Peninsula (Outer)	0.792	2.85	silt
8	N. Balboa Channel/Yacht Basins	0.698	2.52	silt
11*	Linda Isle (Inner basin)	0.281	1.01	silt
16	Mariner's Mile	0.234	0.84	silt
12	DeAnza/Bayside Peninsula (inner side)	0.209	0.75	silt
6	Bay Island	0.132	0.48	silt
14	Castaways to Dover Shores	0.132	0.48	silt
17	Lido Isle	0.025	0.09	silt
7	Balboa Peninsula-West of Bay Island	0.004	0.01	silt
	All Regions	**27.746**	**100.00**	

*does not include 0.21 acres mapped in the inner basin by CRM in 2002 but not during the present survey

FIGURE 2. GENERAL OUTLINE OF REGIONS

Figure 3. AREAL PHOTOGRAPH-MAP

FIGURE 4. EELGRASS PATCHES AERIAL

In addition to these areas mapped by CRM, eelgrass within the Linda Isle Lagoon encompasses a total of 0.21 acres. Tetra Tech (2003) mapped eelgrass in the channel between Linda Isle and the Balboa Marina. Eelgrass habitat found within federal navigation channels is also not reported, but is expected to exceed 100 acres (Bryant Chesney, National Marine Fisheries Service pers. com). Descriptions of the eelgrass within each of the above areas are provided in the following summaries.

3.1 EELGRASS DISTRIBUTION

3.1.1 Entrance Channel Eelgrass (Surveyed by National Marine Fisheries Service)

Although CRM did not survey this feature during the 2004 survey, CRM did a pre-survey of this site in 2002 (CRM and Chambers Group Inc. 2003). National Marine Fisheries Service's open-water eelgrass surveys will include this zone as a companion document to this report.

The harbor entrance channel supports a large eelgrass meadow encompassing over 50 acres of eelgrass (National Marine Fisheries Service, in progress). This large meadow extends into the Corona del Mar Reach, to Balboa Island. Depth range of eelgrass extends between -1 and -27 ft MLLW. Sediments are medium sands to silty sand. A wide-blade variant of eelgrass occurs in the channel (roughly 10 cm wide), and coexists with the more common narrow-bladed form (5 mm wide). Eelgrass blade length extends to over 2 meters (6.6 ft) in length. Photograph 7 and 8 illustrate this wide-bladed form in the entrance channel.

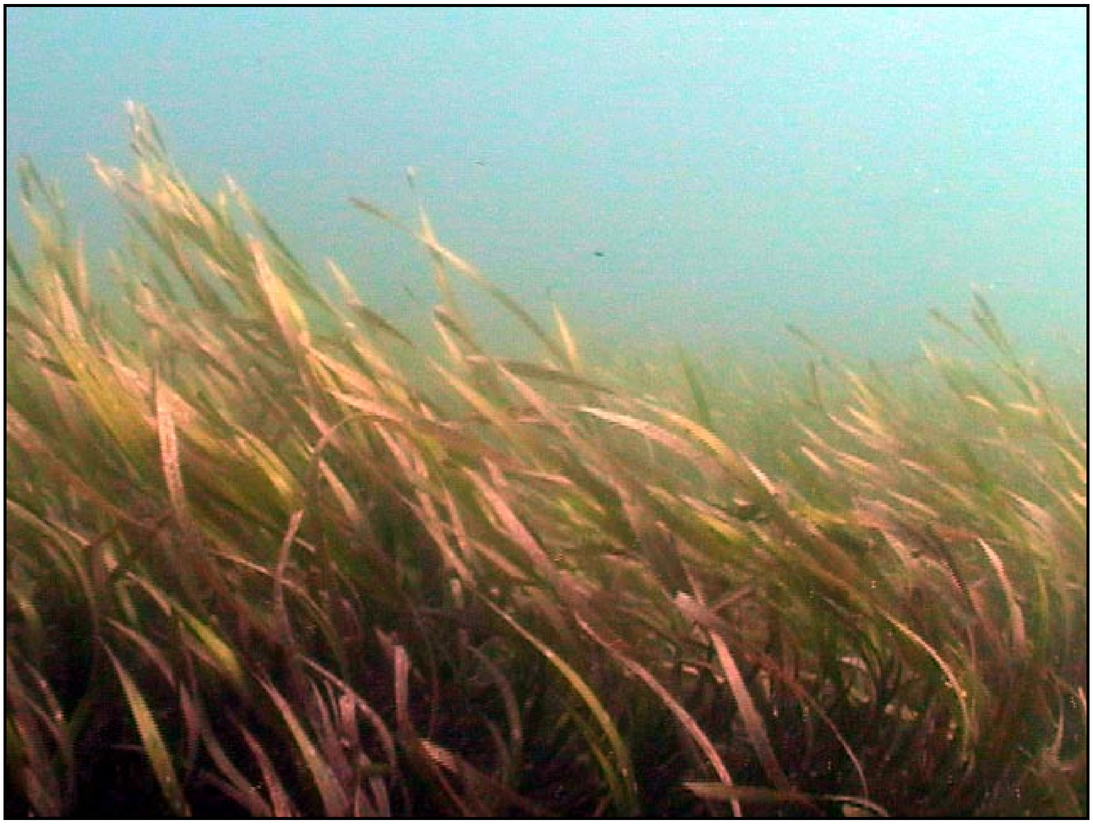
3.1.2 Region 1-Corona del Mar-Bayside Drive including Coast Guard/O.C. Harbor Patrol Facilities (6.886 acres)

Eelgrass is dense and extensive between Bayside Drive and the County Sheriff Harbor Patrol Facilities. The depth range of eelgrass extends between 0.0 and -16 ft MLLW. Unlike many areas in Newport Bay, a substantial portion of the eelgrass meadow is intertidal, occurring at depths up to 0.0 and somewhat higher elevations (Photographs 9 and 10) due to a lack of dredging and channelization in Carnation Cove. The greatest diversity of marine organisms occurs within the eelgrass meadows of this area and the harbor entrance channel. Both narrow and wide blade forms of eelgrass occurs within the region, although most eelgrass is narrow bladed. Sediments tend to range between fine sands and silts. Large concentrations of the speckled scallop (Argopecten aequisulcatus) occur are found in this region, within eelgrass beds. c

3.1.3 Region 2-Yacht Club Basins Between the Orange County Harbor Department and the Balboa Bridge along Bayside Drive (2.469 acres)

The yacht club and marina basins in this region are colonized by moderate eelgrass growth with the greatest concentration of eelgrass within the Bahia Corinthian and Balboa Yacht Club marina basins. Sediments are uniformly fine silts. The shallow water environment, wide basin channels, and proximity to the ocean entrance channel likely enhances the basin habitats as eelgrass habitat.

Photograph 7. Entrance Channel eelgrass meadows at depths of -15 ft MLLW



Photograph 8. Entrance Channel eelgrass meadows

Photograph 9. Intertidal eelgrass meadows in Carnation Cove, Corona del Mar

Photograph 10. Close up of intertidal eelgrass vegetation in Carnation Cove

Photograph 11. Typical eelgrass bed located around the perimeter of a dock along the East Balboa Peninsula

Photograph 12. Shallow water eelgrass habitat shoreward of a dock

3.1.4 Region 3-East Balboa Peninsula (1.672 acres)

The East Balboa Peninsula region encompasses the harbor entrance channel to the beginning of Bay Island (Figure 1). Primarily lined with docks, this region is characterized by many small eelgrass beds and patches that are located between docks, within individuals slips, and shoreward and seaward of docks at depths between -1 and -9 ft MLLW (Photograph 11). In areas where there is a street end and no dock, or where a sand beach is present eelgrass beds are larger. The number of distinct eelgrass beds in this region are substantially less west of Main Street, although small patches are common.

3.1.5 Region 4. Grand Canal (0.898 acre)

The Grand Canal is vegetated with eelgrass along its entire length at depths between 0.0 and -6 ft MLLW. Portions of the Grand Canal were dredged in early 2000 which resulted in some loss of eelgrass habitat. However, significant regrowth through mitigation-mandated transplanting efforts has occurred. Sediments range from sand to silts. The vegetation is the narrow-bladed eelgrass variant. Large concentrations of the speckled scallop (Argopecten aequisulcatus) occur in the Grand Canal eelgrass beds.

3.1.6 Region 5-Balboa and Collins Islands (6.686 acres)

Significant-sized eelgrass meadows line the perimeter of both Balboa and Collins Islands. While Balboa Island is rimmed with sand beaches, Collins Island is bulkheaded and dredged.

Along the Corona del Mar Reach, eelgrass extends seaward into the main channel beyond the pierhead line and is found underneath the boat moorings. The deeper beds coalesce with the meadows that extend into the harbor entrance channel. Most eelgrass occurs at depths between 0.0 and -8 ft MLLW.

The least vegetated region around Balboa Island is along North Bay Front between Apolena and Marine Avenue. However, many small patches occur on this side of the island, whereas the south and east side of the island consists of more larger, uniform meadows. Most of the eelgrass around Collins Island occurs on the south and north sides of the island. Large concentrations of the speckled scallop (Argopecten aequisulcatus) also occur within eelgrass beds in this region, particularly at the corner of East Bay Front and South Bay Front where there is a significant eelgrass bed that extends out several hundred feet.

Sediments within this region tend to be fine sands and silts and the majority of vegetation is the narrow-bladed variant.

3.1.7 Region 6-Bay Island (0.132 acre)

Eelgrass is patchy around Bay Island, with the largest beds occurring along the north eastern side of the Island in front of a sand beach secondly, and in the channel located on the south side of Bay Island. Much of the eelgrass within the narrow channel is new to the area and has colonized since 1999 (Coastal Resources Management 2002). Several patches are located around the east and south perimeter of the island.

3.1.8 Region 7-West Balboa Peninsula (0.004 acre)

The western-most stand of eelgrass along the Balboa Peninsula is found in the Newport Harbor Yacht Club Basin at depths between 0.0 and -3 ft MLLW. No eelgrass patches or beds are located between the Newport Harbor Yacht Club and the Rhine Channel. This bed is small, and one additional patch is located at a depth of -5 ft MLLW within the yacht basin. Sediments are fine silts and the eelgrass is the narrow-bladed form.

3.1.9 Region 8-North Balboa Channel from the Balboa Bridge to Harbor Island (0.698 acre)

The boat docks and yacht basins along the north side of the channel support generally small and narrow but persistent eelgrass beds between the bulkhead and dock headwalks and within the fairways of the marinas and the Balboa Yacht Basin similar to Region 2. Eelgrass has also colonized the blocked-off Bayside Cove, previously open to the channel but now blocked by Belcourt Marina docks. Many, low density small eelgrass patches are located in the fairways of the Balboa Yacht Basin. Sediments are uniformly fine silts and the eelgrass is the narrow-bladed form.

3.1.10 Region 9-Harbor Island (2.721 acres)

Significant eelgrass beds are located around Harbor Island. The vegetation is concentrated in the shallow channel between Beacon Bay and Harbor Island Drive at depths to -3 ft MLLW and is found extensively along the south-facing side of the island between the bulkhead and the pierhead line among and between docks and slips. Another large meadow is located along the west-facing side of the island, where there is a bulkhead but no docks. Along the north side of Harbor Island, eelgrass does not grow between the bulkhead and the pierhead line, likely due to shading effects of the large trees and homes on the north side of the island. However, eelgrass is abundant offshore of the pierhead line in the channel separating Harbor Island and Linda Isle (Figure 3). Sediments are generally silts.

3.1.11 Region 10-Outer Linda Isle Channels (2.916 acres)

The channels surrounding Linda Isle are colonized by moderate cover of eelgrass, particularly in the channel separating Linda and Harbor Island, in the southern-one half of the channel on the east side of Linda Isle, and at the entrance to the Linda Isle basin on the west side of the island. Substantial less eelgrass is found on the north and northeast side of the island. Sediments are uniformly silts. Depth ranges of eelgrass in this region vary between 0.0 to -9 ft MLLW.

3.1.12 Region 11-Linda Isle, Inner (0.281 acre)

A large eelgrass bed is located at the entrance to the Linda Isle basin. In addition, the inner basin also is colonized by eelgrass that takes the shape of both small-to-medium sized beds along the fringes of the boat docks, to a series of small patches that occur throughout the mid-section of the basin. Only the entrance area was surveyed during the current study, which documented a total of 0.28 acre of eelgrass. The amount of eelgrass farther back in the basin is approximately 0.21 acre (Coastal Resources Management 2002).

3.1.13 Region 12-DeAnza/Bayside Peninsula, Inner Area (0.209 acre)

Eelgrass is becoming established at depths between -2 and -5 ft MLLW between the DeAnza Marina and the inshore edge of the DeAnza/Bayside marsh peninsula. This is a relatively recent event, since the area was surveyed in 1999 by Chambers Group and Coastal Resources Management (1999) and no eelgrass was present at that time. Two distinct concentrations of eelgrass are found in the region; one series of small beds at the southern tip of the peninsula, and another located mid channel just south of the mobile home park swimming beach. Small patches are scattered throughout the region. Sediments in this region are fine silts.

3.1.14 Region 13-DeAnza/Bayside Peninsula, Outer Area, Main Channel of Upper Newport Bay (0.792 acre)

The shallow subtidal and intertidal mudflats located on the main channel side of the DeAnza/Bayside Peninsula are colonized by a group of coalescing patches and small eelgrass beds that extend along the southern one-half of the peninsula. The depths range extends between 0.0 ft and -6 ft MLLW, although a majority of the eelgrass is found on a developing shoal at depths between 0.0 and -3 ft MLLW. The beds are dense and consist of the narrow bladed form of eelgrass. Similar to the beds on the east side of the DeAnza peninsula, eelgrass meadows in this region have only recently shown widespread growth since scattered, low density patches were only found during 1999 surveys of this area (Chambers Group, Inc. and Coastal Resources Management 1999). The last time this area exhibited substantial eelgrass meadows was in the late 1960s and early 1970s. The U.S. Army Corps of Engineers is using part of this shoal as a mitigation site for eelgrass habitat loss associated with federal navigation channel dredging in Lower Newport Bay.

3.1.15 Region 14-Castaways to Dover Shores, Upper Newport Bay (0.132 acre)

A small, but persistent eelgrass bed is located immediately north of the Coast Highway Bridge in front of the old Castaways Marina bulkhead at depths between -1 and -5 ft MLLW. This bed was present in the early 1990s, but disappeared following the 1998 El Nino. It was again observed in 2002 (Coastal Resources Management and Chambers Group, 2002). Two small eelgrass beds and several small eelgrass patches occur at shallow depths along shoreline between Castaways and Dover Shores. This region however, is not a significant area of eelgrass concentration compared to the eastern shoreline of the Upper Newport Bay main channel. Sediments in this zone are sandy silt to fine silts.

3.1.16 Region 15-Bayshores (0.991 acre)

Region 15 extends between the Coast Highway Bridge south to the junction of the Lido Reach. Eelgrass is located within two distinct areas- on a shoal in front of the Anchorage Marina extending north to the Coast Highway Bridge and between the bulkhead and docks along the east-facing shoreline. It occurs between the bulkhead and the docks, between adjacent docks, and in wider, open areas near the juncture of the Lido Reach. Sediments are generally fine silts, although they tend to be coarser in front of the Bayshores Community Association beach.

3.1.17 Region 16-Mariner's Mile (0.234 acre)

The Mariner's Mile region within Lido Reach supports a small percentage of eelgrass concentrated between the bulkhead and the headwalks of the residential marina at Bayshores, and secondarily in the Orange Coast College boat basin and the Balboa Bay Club. The western-most location eelgrass location was located was in the Southshores Yacht Club basin.

3.1.18 Region 17-Lido Island (0.025 acre)

With the exception of three small eelgrass beds and several small patches, Lido Island supports the lowest cover of eelgrass of all of the regions surveyed. One small bed is located on the northeast end, several patches occur along the east side, and two small beds are located on the southeast side. Sediments in this region consist of fine silts.

3.1.19 Analysis Based Upon Standardized Shoreline Length

Table 2 provides a standardized comparison of eelgrass acreage for all regions based on a unit area (linear-mile) section of shoreline. The results suggest that some areas, such Region 2 (the Balboa Channel yacht club/marinas) and Region 9 (Harbor Island) with relatively short shoreline perimeters rate higher in eelgrass acreage per linear mile of shoreline than eelgrass habitat within Region 5 (Balboa and Collins Island) and Region 10 (Linda Isle, Outer Channels) which have longer shorelines because more eelgrass is present within a shorter shoreline distance.

Regions 2 and 9 have broader, shallow water habitat similar to Region 1 (Corona del Mar). Consequently, there is greater eelgrass acreage. This analysis provides a method (when combined with eelgrass turion density information and marine biological community association information) to rank the importance of eelgrass bed resources and associated potential environmental consequences of projects to particular locations within Newport Bay.

Table 2. Assessment of Acreage Based Upon Standardized Shoreline Lengths

Region #	Survey Region	Area (acres)	Shoreline (mi)	Acres/Linear Mile	% Total
1	Corona del Mar to OCHD	6.886	0.85	8.07	24.59
2	Balboa Channel Marinas/Yacht Basins	2.469	0.58	4.22	12.86
9	Harbor Island	2.721	0.67	4.09	12.45
5	Balboa and Collins Islands	6.686	2.03	3.29	10.03
15	Bayshores	0.991	0.33	2.97	9.05
10	Linda Isle (outer channels)	2.916	1.20	2.43	7.40
13	DeAnza/Bayside Peninsula (Outer)	0.792	0.37	2.14	6.52
4	Grand Canal	0.898	0.61	1.47	4.47
3	Balboa Peninsula-East of Bay Island	1.672	1.58	1.06	3.22
8	N. Balboa Channel/Yacht Basins	0.698	0.69	1.01	3.09
11	Linda Isle (Inner basin)	0.281	0.48	0.59	1.78
12	DeAnza/Bayside Peninsula (inner side)	0.209	0.37	0.57	1.74
6	Bay Island	0.132	0.34	0.39	1.18
16	Mariner's Mile	0.234	0.84	0.28	0.85
14	Castaways to Dover Shores	0.132	0.56	0.24	0.72
17	Lido Isle	0.025	2.23	0.01	0.03
7	Balboa Peninsula-West of Bay Island	0.004	1.09	0.004	0.01
	All Regions	**27.746**	**14.82**	**1.87**	**100**

3.2 EELGRASS TURION DENSITY

3.2.1 Density Relationships between Sampling Sites and Depth

Mean turion density in Newport Bay eelgrass meadows during late-spring to summer 2004 periods was 231.2 per sq m (n=600). Figure 4 illustrates the mean turion density counts at each sampling site. By sampling area, turion density ranged between 102.3 (Orange Coast College Boat Basin) to 323.4 per sq m (Outer DeAnza Peninsula). Turion counts were conducted between early spring to mid summer, representative of the maximum periods of growth and vegetative spread.

In most areas of Newport Bay, eelgrass turion density exhibited a significant negative correlation to sampling depth (t=2.8, 12 deg freedom, $r^2 = 0.72$) indicating the number of eelgrass turions decrease with increasing depth. This correlation is dependent upon a decrease in submarine light levels with increasing depth (Zimmerman 1991). While this is true for most areas, deeper areas with better water clarity near the ocean entrance channel support higher density eelgrass beds than regions farther back in the harbor at similar depths (i.e., Lido Yacht Club and the OCC boat basin). Four density “site groupings” were present (Figure 5). These included Site Group 1, consisting of deeper-depth sampling sites with moderate to high densities near the ocean entrance channel (China Cove, Harbor Entrance Channel, and Balboa Island); Site Group 2 that consisted of Lower Harbor boat basins with dredged, uniform depths and low densities (OCC Boat Basin, Lido Yacht Club), Site Group 3 of shallower sites with low densities (Linda Isle and Inner DeAnza) and Site Group 4 consisting of sites with a gradient of elevations, but overall shallow water sites with very high densities (Outer DeAnza, C Street, Grand Canal, Bay Isle, Harbor Island, PCH Bridge, and Bayshores).

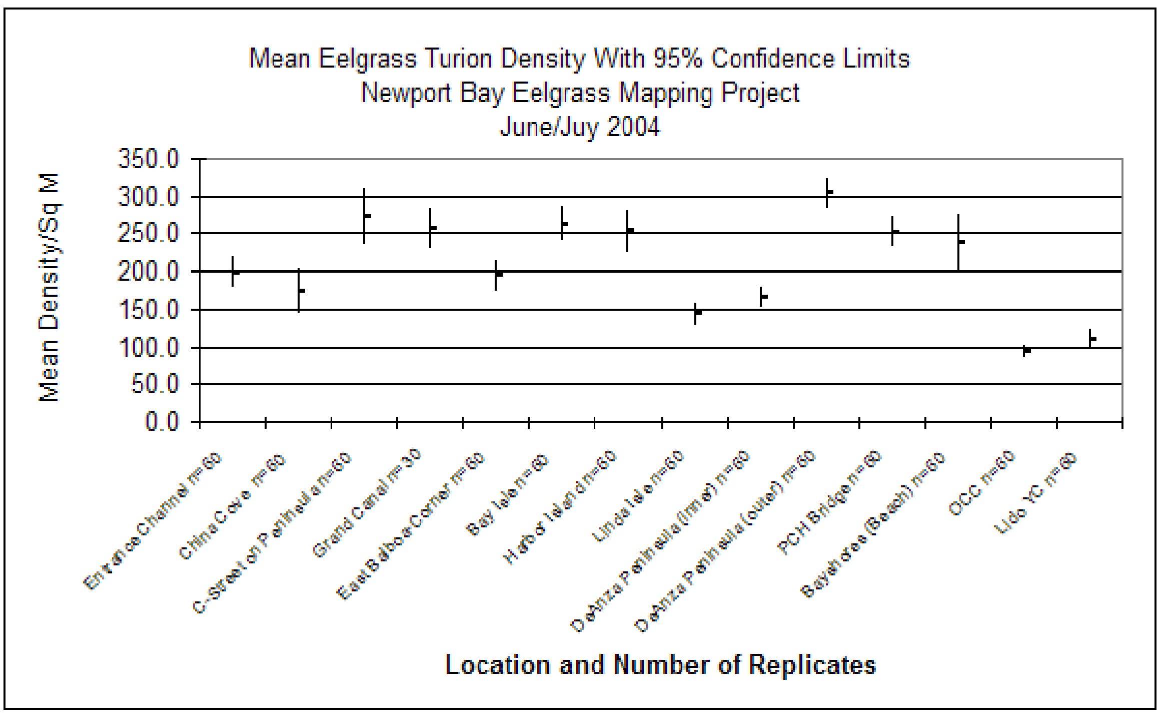


Figure 5. Eelgrass turion density at each of the sampling sites

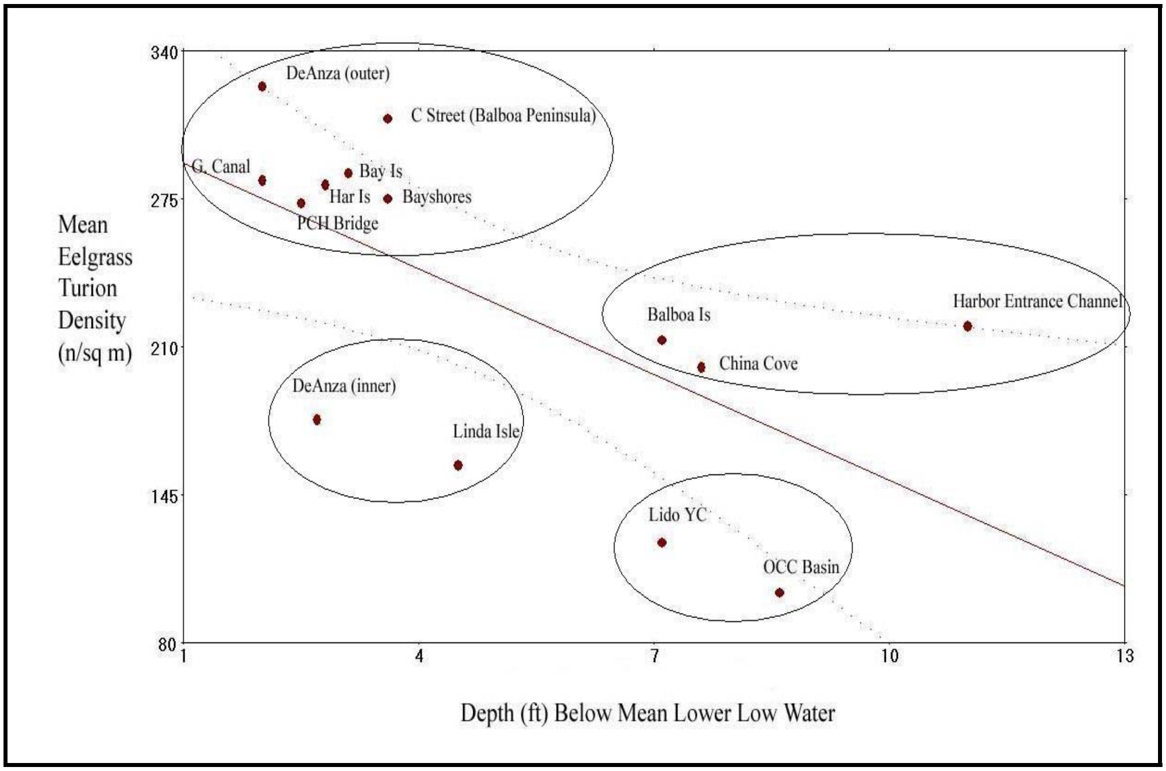


Figure 6. Eelgrass Turion Density Site Groups
95% confidence limits around the correlation regression line are shown in dotted lines)

3.3 MARINE ORGANISMS OBSERVED DURING THE SURVEYS

Table 2 lists the plants and animals observed within eelgrass beds or immediately nearby eelgrass beds during December 2003 through August 2004 surveys. While not comprehensive or quantitative, the list of organisms observed includes a total of 63 species of plants and animals. Of these, 1 was a bacterium, 9 were algae species, two were seagrasses, 31 were invertebrates, and 20 were fishes. During eelgrass surveys conducted in July 1999, 28 species of macro invertebrates were observed living on eelgrass or in sediments of eelgrass beds. The most common forms were speckled scallops (*Argopecten aequisulcatus)*, anemones (*Pachycerianthus fimbriatus*), snails and sea slugs (*Bulla*, *Chelidonera*) and nudibranchs (*Anisodoris nobilis*). During both the 2003-2004 and 1999 surveys, commonly encountered fish were topsmelt (*Atherinops affinis*), spotted sand bass (*Paralabrax maculatofasciatus*), barred sand bass (*P. nebulifer*) and round string ray (*Urolophus halleri*). Fourteen of 16 species of fish observed during July 1999 eelgrass bed surveys were associated with eelgrass habitat (Chambers Group Inc. and Coastal Resources Management 1999.

Table 2.
Species List of Organisms Observed During the Eelgrass Habitat Mapping Surveys
Dec 2003 to August 2004

Common Name	***Scientific Name***
Bacteria	
white sulphur bacteria?	Bacillariophyceae
Algae	
green algae	*Colpomenia sinuosa*
green algae	*Enteromorpha sp*
green algae	*Ulva latuca*
feather boa kelp	*Egregia menziesii*
brown seaweed	*Cystoseira osmundacea*
sargassum weed	*Sargassum muticum*
red algae	*Acrosorium uncinatum*
red algae	*Gracilariopsis sjoestedtii*
red algae	unid. red leafy algae
Seagrasses	
ditchgrass	*Ruppia maritima*
eelgrass	*Zostera marina*
Sponges	
yellow sponge	*Haliclona* sp.
Cnidarians	
moon jelly	*Aurelia aurita*
hydroid	*Corymorpha palma*
anemone	*Diadumene*
burrowing anemone	*Pachycerianthus fimbriatus*
Annelid worms	
ornate tube worm	*Diopatra ornata*
Mollusks-Gastropods	
lemon nudibranch	*Anisodoris nobilis*
Gould's bubble snail	*Bulla gouldiana*
predatory sea slug	*Chelidonera inermis*
California cone snail	*Conus californicus*
ringed dorid nudibranch	*Dialula sandiegensis*
Spanish shawl nudibranch	*Flabellinopsis iodinea*
wavy top snail	*Lithopoma undosa*
octopus	*Octopus bimaculatus*
Mollusks-Pelecypods	
speckled scallop	*Argopecten aequisulcatus*
wavy chione	*Chione undatella*
bay mussel	*Mytilus galloprovincialis*

Arthropods

cancer crab	Cancer sp.
sheep crab	Loxorhynchus grandis
mysid shrimp	Mysidacea, unid,.
California lobster	*Panulirus interuptus*
southern kelp crab	*Pugettia producta*

Echinoderms

bat star	*Asterina miniata*
sand star	*Astropecten armatus*
sand dollar	*Dendraster excentricus*
sea cucumber	*Parastichopus parvimensis*
short-spined sea star	*Pisaster brevispinus*
ochre sea star	*Pisaster ochraceus*
purple sea urchin	*Strongylocentrotus purpuratus*

Ectoprocts

stoloniferan ectoproct	*Zoobotryon verticillatum*

Fish

top smelt	*Atherinops affinis*
kelp surfperch	*Brachyistius frenatus*
pile surfperch	*Damalicthys vacca*
black surfperch	*Embiotoca jacksoni*
opaleye	*Girella nigricans*
goby	Gobiidae, unid.
giant kelpfish	*Heterostichus rostratus*
rainbow surfperch	*Hypsurus caryi*
California garibaldi	*Hypsypops rubicundus*
bat ray	*Myliobatis californicus*
senorita	*Oxyjulius californicus*
kelp bass	*Paralabrax clathratus*
spotted sand bass	*Paralabrax maculatofasciatus*
sand bass	*Paralabrax nebulifer*
California halibut	*Paralichthys californicus*
white surfperch	*Phanerodon furcatus*
horny head turbot	*Pleuronichthys verticalis*
turbot, unid.	Pleuronichthys, unid
rubberlip surfperch	*Rhacochilus toxotes*
round stingray	*Urolophus halleri*

4.0 SUMMARY AND CONCLUSIONS

- Eelgrass is widely distributed in Lower Newport Bay between bulkhead and pierhead lines. Eelgrass is particularly prevalent in the eastern half of the harbor from Bay Island to the ocean entrance channel. It occurs between approximately 0.0 ft MLLW to depths beyond the pierhead lines into the federal navigation channel limits.

- Areas of greatest eelgrass abundance in Lower Newport Bay include the Corona del Mar region, Balboa Channel yacht and marina basins, Balboa Island, Harbor Island/Beacon Bay, and the channels that surround Linda Isle.

- Eelgrass is substantially less abundant around the western half of Lower Newport Bay (i.e., Mariner's Mile, Lido Island, and along the shoreline of the Balboa Peninsula west of Bay Island).

- Upper Newport Bay has a developing eelgrass meadow around southern one-half of the DeAnza/Bayside marsh peninsula. Comparatively, the western shoreline of Upper Newport Bay in the vicinity of Castaways and Dover Shores is colonized by substantially less eelgrass.

- Within the 14 sites where density counts were obtained, four distinct depth groups were ascertained. These included a site group of moderately deep stations located close to the channel entrance with moderately high densities; a site group of moderately deep, dredged boating areas with low densities; a site group of relatively shallow stations with high densities; and a site group of relatively shallow stations with moderate densities.

- Turion density-depth relationships indicate a strong negative correlation between turion density and increasing depth in most areas of Newport Bay and is an indication of the relationship between increasing depth and decreasing light levels necessary for eelgrass to survive. Where light is sufficient at deeper depths in the relatively clearer waters of the ocean entrance channel and Corona del Mar beds, ambient light levels at depth can sustain a productive eelgrass habitat. Alternatively, light levels are less in more turbid waters farther back in Newport Bay at comparable depths can are less able to sustain high eelgrass productivity.

- With further refinement, the delineation of specific regional rankings of eelgrass acreage and density site group rankings, trends in eelgrass distribution can be used as a management tool to assign ecological values to various areas of Newport Bay.

- Additional emphasis should be placed on evaluating the abundance and diversity of marine life within eelgrass meadows to assist in the assignment of ecological values to various regions of Newport Harbor and Upper Newport Bay.

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