RESULTS OF THE THIRD NEWPORT BAY EELGRASS (*ZOSTERA MARINA*) BAY-WIDE HABITAT MAPPING SURVEY: STATUS AND DISTRIBUTION BETWEEN 2009 AND 2010 WITH ADDITIONAL OBSERVERVATIONS IN 2011

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1. INTRODUCTION

This report presents the results of eelgrass habitat mapping investigations in Newport Bay between July 2009 and March 2011, and is the third is a series of investigations in support of the City of Newport Beach Harbor Area Management Plan (HAMP). Previous studies included eelgrass habitat mapping surveys in 2003-2004 (Coastal Resources Management, Inc. 2005) and 2006-2008 along with oceanographic surveys in Newport Harbor between July 2008 and May 2009 (Coastal Resources Management, Inc. 2010).

1.1 PROJECT PURPOSE

The purpose of this investigation is to provide the City of Newport Beach with detailed information on the distribution and abundance of eelgrass within Newport Harbor and Upper Newport Bay, and physical and chemical abiotic factors that may influence the distribution of eelgrass. This data base of information will assist the City in managing the bay's eelgrass resources. The public will benefit from the data base by being able to determine what environmental constraints dealing with eelgrass may be associated with infrastructure improvement projects such as bulkhead repair/maintenance, beach nourishment, harbor dredging, and dock and pier construction and maintenance.

1.2 BACKGROUND

Year 1 Survey Summary. A total of 30.4 acres of eelgrass were mapped in shallow water at depths between 0 and -12 ft Mean Lower Low Water (MLLW). Mean station density averaged 212.8 turions per square meter, ranged between 94 and 273.8 per square meter (15 stations). The shallow water nearshore CRM study was augmented by a National Marine Fisheries Service (NMFS) survey of eelgrass that mapped 93 acres of eelgrass in the deeper navigational channels between Corona del Mar and Balboa Island (NMFS, 2003).

Year 2 Survey Summary. During the second shallow water eelgrass habitat mapping survey, a total of 23.1 acres of eelgrass was mapped between +0.7 and -12 ft MLLW. Turion density averaged 130.7 turions per square meter and varied between 67.1 and 221.9 turions per square meter (10 stations). Eelgrass was absent at five of the stations sampled during the Year 2 Survey, previously sampled in 2004.

CRM also conducted deepwater eelgrass habitat mapping surveys using side scan sonar and mapped 45.4 acres of deepwater eelgrass to depths of -28 ft MLLW. The difference between the amount mapped by NMFS in 2003 and CRM in 2008 was likely due to differences in survey methodology. Additional information on eelgrass blade length/width, relationships to underwater light irradiance, and tidal residence times were presented. Oceanographic surveys were added to the project during July-August 2008, Nov-Dec 2009, and March-May 2009 at 18 stations throughout the harbor extending into Upper Newport Bay, and included data on water temperature, dissolved oxygen, pH, salinity, water transparency (secchi depth), underwater luminance based upon both light intensity (lumens/sq ft) and light energy (Photosynthetic Photon Flux, micro mol m^2 sec^1).

Based upon the patterns of eelgrass distribution and turion density during the first and second years of eelgrass habitat mapping surveys, three eelgrass stability zones were identified in Newport Bay: (1) a stable eelgrass zone, where eelgrass distribution and density are relatively constant and underwater light levels are highest; a transitional eelgrass zone where eelgrass acreages are highly variable and underwater light levels exhibit high variation; and an unvegetated eelgrass zone, where eelgrass was not documented during the 2003-2008 surveys.

1.3 PROJECT SETTING

Newport Bay is located within the city limits of Newport Beach, California (Figure 1). The City is bordered by the coastal cities of Huntington Beach to the northwest and Laguna Beach to the southeast.

Newport Bay is a combination of two geologically distinct bodies of water- Newport Harbor (Lower Newport Bay) and Upper Newport Bay. In recent history, Newport Harbor was a coastal lagoon. It was initially formed between 1824 and 1862 as a consequence of down current sand deposition from the Santa Ana River that formed a sand spit across the mouth of Upper Bay. This sand spit eventually developed into the present-day Balboa Peninsula (Stevenson and Emery 1958), Lower Newport Bay is four miles long and oriented in a northwest-to-southeast direction (Figure 1) parallel to the coastline. Today, the Harbor is a multi-user system. It is: a wildlife habitat that is transitional in nature between the tidal channel and marsh ecosystem of Upper Newport Bay and the open coastal marine environment; a major navigational harbor and anchorage for 9,000 small boats and larger vessels; and a center of business for marine-related activities and tourism (http://www.newportbeach.com/california). The federal navigational channel in Newport Bay is maintained by the U.S. Army Corps of Engineers (USACOE). A June 2008 survey of the channel conducted by the USACOE suggested that approximately 1 million cubic meters of sediment has accumulated above the authorized Operations and Maintenance (O&M) depths within actively maintained portions of the bay and therefore needs to be dredged (Anchor QEA, 2009). Some areas that need to be dredged however consist of sediments contaminated by historical releases from industrial sources and storm drains adjacent to the bay as well as ongoing runoff from the surrounding watershed. Consequently, studies are being conducted to determine where and how contaminated sediments within the bay should be dealt with (Anchor QEA 2009a, 2009b).

Upper Newport Bay is a drowned river valley and geologically much older than the Lower Bay. It extends in a north-to-northeasterly direction from the Pacific Coast Highway Bridge for a distance of about 3.5 miles and is bounded by the bluffs of the Newport Mesa on the west and the San Joaquin Terrace on the east. The Bay veers east at the "Dike" and extends to the Jamboree Road bridge, where the San Diego Creek empties into the Bay. The Central Orange County Water Management Area encompasses an area of approximately 154 square miles with overland flows draining toward the Pacific Coast into Newport Bay http://www.ocwatersheds.com/wma_CentralOC.aspx. This watershed is the major contributor of suspended sediments, nutrients, and other pollutants to the Newport Bay ecosystem.

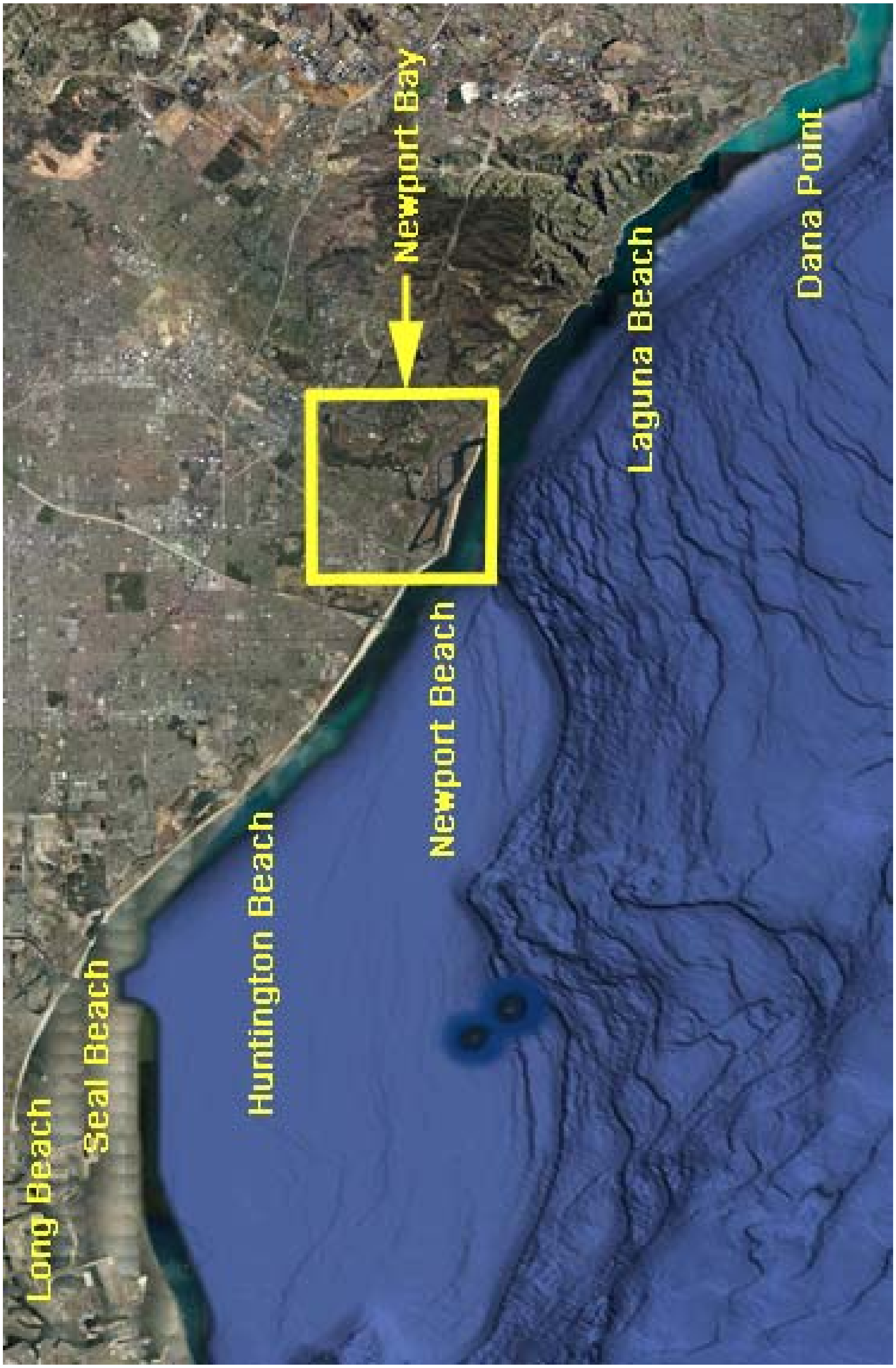


Figure 1. Regional Setting

Upper Newport Bay is characterized by mudflat, salt marsh, freshwater marsh, riparian, and upland habitats, and sediment control basins that are protected within the 752-acre State of California Upper Newport Bay Ecological Reserve (UNBER). Part of the Upper Bay (140 acres) is under the control of the County of Orange, and is designated as Orange County Regional Park. While the majority of Upper Newport Bay is primarily a salt marsh system with freshwater influence, the lower one-third below Shellmaker Island and the UNBER has been dredged and filled since the early 1900's for housing development, recreational swimming, marinas, and a boat launch ramp.

Upper Bay sediment basins and channels were dredged as part of the U.S. Army Corps of Engineers Ecological Restoration Project led by the US Army Corps of Engineers. While planning for the project began in 1993, actual in-bay work was started in 2006 and completed in 2010. The project involved extensive dredging of sediment, especially to maintain two major in-Bay sediment retention basins (near Jamboree Road and near the Salt Dike). A primary objective of this project was to effect management of sediments deposited within the bay, with the objective of reducing the frequency of dredging projects while also enhancing habitat values within the upper bay and slowing the detrimental impacts of sediment accumulation on the fish and wildlife habitats. These basins keep some sediment from reaching the remainder of the Upper Bay and from the Lower Bay. The dredging also expanded channels that surrounded various islands in the Upper Bay, including Middle Island. New marsh islands and wetland channel habitat were also constructed. A large portion of the dredge material was barged from Upper Newport Bay to the EPA approved offshore disposal site, LA-3, located six miles offshore of Newport Beach. Scows and tugs were moored in Lower Newport Bay west of Harbor Island. With the restoration of better tidal flow in Upper Newport Bay and the creation of new wetland channels, there is some expectation that eelgrass may be able to recolonize areas of the Upper Newport Bay where it once grew more prolifically.

1.4 SUMMARY OF EELGRASS BIOLOGY

The genus *Zostera* (eelgrass) is a marine angiosperm (flowering plant) and one of 12 genera of marine seagrasses world-wide (Hartog and Kuo, 2006; Phillips and Menez, 1988). It grows at depths between the mid-to-low intertidal zone and offshore subtidal depths of 30 meters in Southern California (Phillips and Menez, 1988; Phillips and Echeverria, 1990; Mason, 1957; Coyer et. al, 2007). Both *Z. pacifica* (previously described as *Z. asiatica* by Phillips and Echeverria, 1990) and *Z. marina* are found offshore in the Channel Islands and along the coast of Santa Barbara County (Coyer et. al, 2007), although recently, the results of the Coyer et al. study regarding *Zostera* speciation may be in question (Bryant Chesney, National Marine Fisheries Service, pers. com. with R. Ware, 6 June, 2010). In mainland bays, estuaries, and harbors, *Zostera marina* is more commonly found between the low intertidal zone and depths of eight meters. A third species found along the west coast (*Zostera japonica*, "dwarf eelgrass") is an invasive from Asia (Posey, 1988). While its presence in the Pacific Northwest has been known since the early 1900s (Phillips, 1984) its presence in California has only recently been established (Humboldt Bay, Foss et al., 2007). However, *Z. japonica* is not known to occur in Newport Bay.

Zostera marina has historically grown in both Lower Newport Bay and Upper Newport Bay, although its distribution and abundance has varied greatly over time (Coastal Resources Management, Inc., 2009). Eelgrass beds are extremely valuable as a fishery habitat and nursery area for marine organisms. The importance of this fishery habitat periodically conflicts with the need for the City of Newport Beach to maintain and sustain a viable commercial and recreational harbor and for residents to maintain the integrity of their boat docks and piers. Consequently, there is a need for the City to document the distribution and abundance of eelgrass- spatially and temporarily-in order to (1) identify harbor project impacts on eelgrass, (2) to mitigate eelgrass habitat losses according to local, state, and federal environmental policy, and (3) to make informed harbor area management policy decisions.

Photograph 1. Eelgrass, *Zostera marina.*
Source Photo: R. Ware, Coastal Resources Management, Inc.

1.5 EELGRASS REGULATORY SETTING

While eelgrass does not have a formal listing as a state-or-federal endangered, rare, or sensitive species, the California Department of Fish and Game, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service recognize its important as a protected resource and have defined measures to mitigate potential eelgrass habitat losses in the Southern California Eelgrass Mitigation Policy (National Marine Fisheries Service 1991 as amended).

As vegetated shallow water habitat, eelgrass is protected under the Clean Water Act, 1972 (as amended), section 404(b)(1), “Guidelines for Specification of Disposal Sites for Dredged or Fill Material”, subpart E, “Potential Impacts on Special Aquatic Sites”. This area includes sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, riffle, and pool complexes. Environmental legislation under the National Environmental Policy Act (NEPA) and State of California Environmental Quality Act (CEQA) dictates that project designs for coastal projects (1) make all possible attempts to avoid impacts to eelgrass, (2) minimize the degree or magnitude of impacts, (3) rectify, or compensate for unavoidable eelgrass habitat losses by restoring soft bottom habitat with eelgrass using transplant techniques, and (4) reduce or eliminate impacts to eelgrass over time by preservation and maintaining eelgrass over the life of the project.

The fishery value of Newport Harbor and Upper Newport Bay's eelgrass habitat and the need for its protection are also defined in the Essential Fish Habitat (EFH) provisions of the 1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act (FR 62, 244, December 19, 1997. Eelgrass habitats are considered habitat areas of particular concern (HAPC) for various federally-managed fish species within the Pacific Groundfish Fisheries Management Plan (FMP), (i.e., rockfishes). Designated HAPC, including eelgrass, are not afforded any additional regulatory protection under the Magnuson-Stevens Fishery Management and Conservation Act. However, federally permitted projects with potential adverse impacts to HAPC are more carefully scrutinized during the consultation process (National Marine Fisheries Service, 2008a).

The City of Newport Beach, within its adopted Land Use Plan (City of Newport Beach, 2009) acknowledges the importance of eelgrass in Newport Harbor as well as the *"need to maintain and develop coastal-dependent uses in Newport Harbor that may result in impacts to eelgrass" and "Avoid impacts to eelgrass (Zostera marina) to the greatest extent possible. Mitigate losses of eelgrass at 1.2 to 1 mitigation ratio and in accordance with the Southern California Eelgrass Mitigation Policy. Encourage the restoration of eelgrass throughout Newport Harbor where feasible"* (LUP Policy 4.2.5-1).

2.0 METHODS AND MATERIALS

2.1 PROJECT STAFF

The eelgrass survey team included CRM Senior Marine Biologist Rick Ware (Principal Investigator, M.S Biology), Stephen Whitaker, Marine Biologist, (Field team leader, M.S., Biology), Tom Gerlinger, Marine Biologist, (M.S., Biology), Robin Kohler, Marine Technician, and Amanda Bird (Marine Technician, B.S., Biology). Rick Hollar (Senior Hydrographic Engineer, Nearshore and Wetland Surveys, M.S., Engineering) was the principal investigator for side scan sonar surveys. Mr. Ryan Stadlman (City of Newport Beach GIS Department) assisted CRM in GIS presentations and made the GIS data available to the public by uploading the maps to the City's website. Chris Miller and Tom Rossmiller (Harbor Resources Division, Retired) managed the project for the City of Newport Beach and provided logistical support.

2.2 PROJECT LOCATION

Studies were conducted in Newport Bay, located within Newport Beach, Orange County, California (Figures 1 and 2). The project area included the intertidal and subtidal soft bottom habitats between Lower Newport Bay (Newport Harbor) and the southern reach of Upper Newport Bay between the Coast Highway Bridge and Dover Shores (Figure 2) Two regions within Upper Newport Bay were not surveyed for eelgrass during this study because they are managed by different agencies (California Department of Fish and Game and the County of Orange). However, these regions have been surveyed by other groups (MBC Applied Environmental Sciences for the Army Corps of Engineers in 2004 and 2006; Chambers Group, Inc. for the County of Orange Dunes Marina Dredge Project (2006); and Coastal Resources Management, Inc. for the Dunes Marina Dredge Project (2007) and the Dover Shores Community Association Dredge Project (2008b). The surveys excluded the Rhine Channel and the harbor's channels west of Newport Blvd.

2.3 SURVEY DATES

Eelgrass surveys were conducted between July 2009 and October 2010. Eelgrass turion density studies were conducted in early March 2011 to compare previously collected summer turion density data during the first and second surveys with early eelgrass season turion density. Navigational channel side scan sonar surveys were conducted in Linda Isle and Upper Newport Bay in July and August 2009 which were ground truthed by divers and remote underwater video in follow up surveys during August 2009.

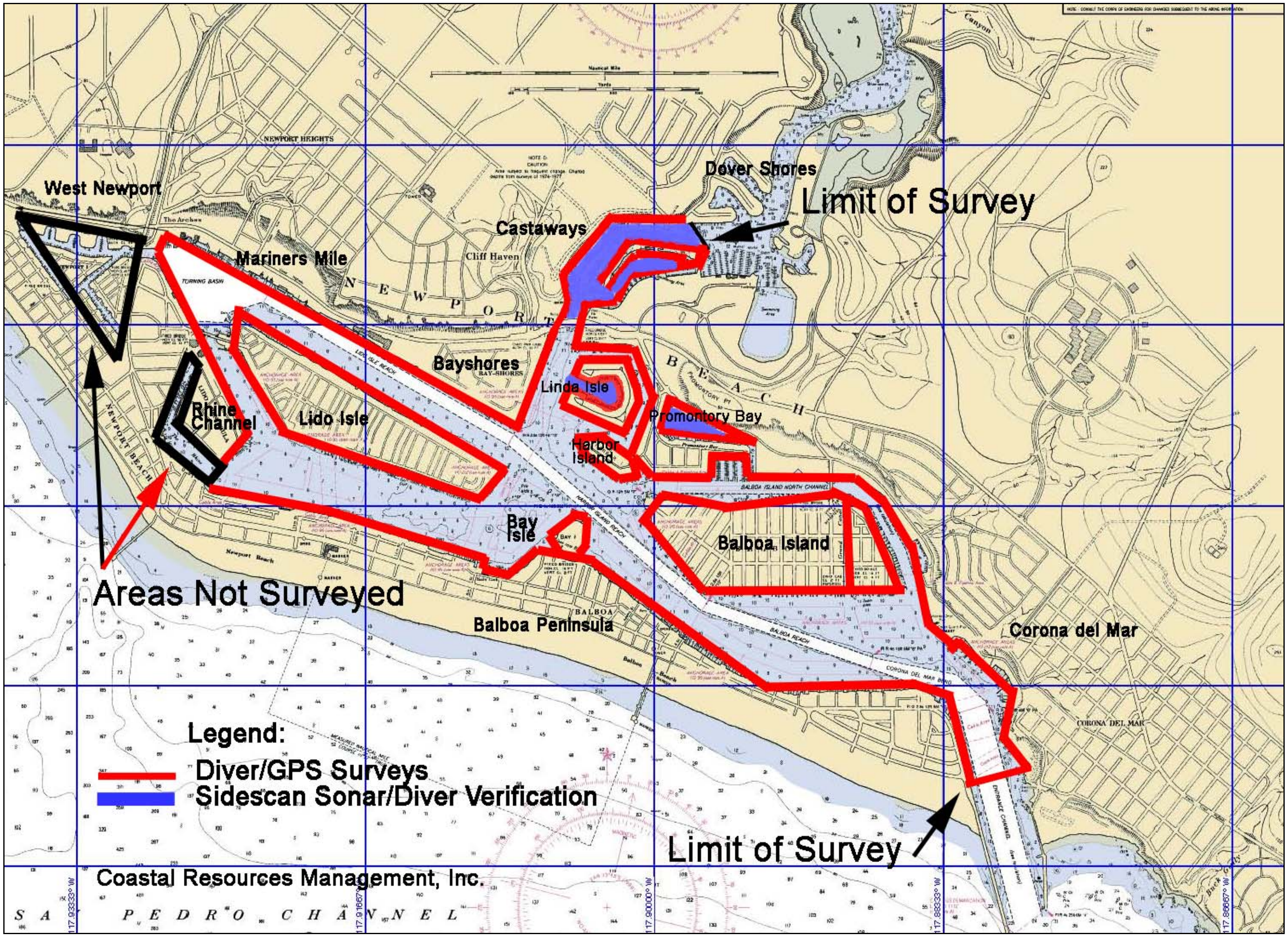


Figure 2 Location and Boundaries of Eelgrass Habitat Surveys, 2009-2010. Refer to Figure 2 for locations of water quality and sediment quality sampling stations.

2.4 EELGRASS MAPPING SURVEY METHODS

Two methods were used to map eelgrass during the 2009-2010 shallow water survey (generally defined as between the intertidal zone to a depth of -10 ft MLLW). The primary method used to map eelgrass was diver mapping with GPS. In most cases, diver surveys included the bayfloor 30 feet past the end of docks and piers, except where the pierhead line was irregular, such as along Carnation and China Cove. Divers also surveyed shallow water side channels between and around Linda Isle and Harbor Island, all marina basins, inlets (Inner Linda Isle and Promontory Cove), in Upper Newport Bay from the Coast Highway Bridge to Dover Shores (west side), and around the perimeter of DeAnza Marsh Peninsula. It also included depths to -15 ft MLLW in the Entrance Channel in front of China Cove and Pirate Cove, since the shallow water bed was connected to the deeper Navigational Channel eelgrass bed.

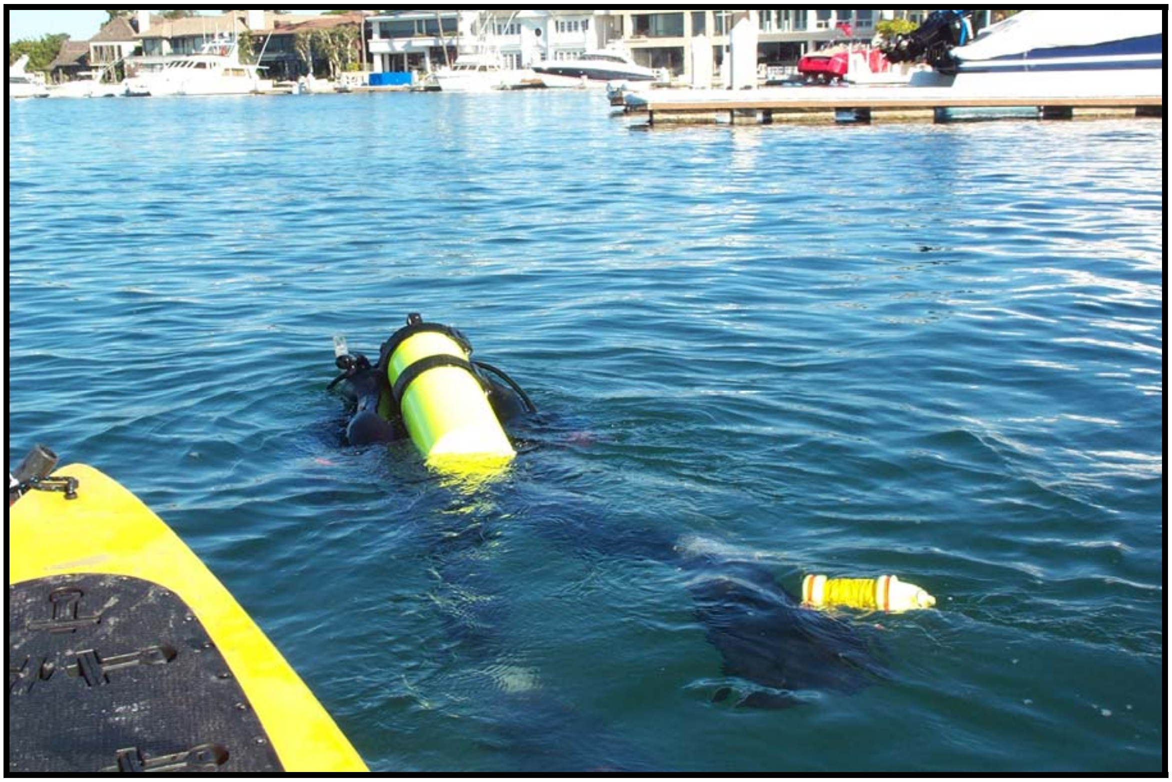
We also employed remote sensing techniques (side scan sonar and remote underwater video) to survey the bottom habitat for eelgrass. These surveys were conducted in Upper Newport Bay between the PCH Bridge to Dover Shores, in Linda Isle Inlet, in Promontory Bay, and north and west around Harbor Island (Figure 2). Other areas (Balboa Island and Corona del Mar) were also surveyed using side scan but not under this contract, and these data are on file with CRM.

2.4.1 Diver-GPS Mapping

Eelgrass vegetation was mapped using a Global Position System (GPS) and a team of Coastal Resources Management, Inc. biologists consisting of a diver and a surface support biologist in a kayak. To assist in the mapping process, an Ocean Technology Systems (OTS) surface-to-diver communications system was employed. Eelgrass depth ranges were recorded during this phase of the field operations. A Thales Mobile Mapper Wide-Area Augmentation System (WAAS) GPS/GIS Unit was employed to map eelgrass beds and small eelgrass patches. The estimated GPS error of the Thales Mobile Mapper unit, with post-processing differential correction is less than 1 meter with clear open skies; however, in some instances, the error was higher because the team was working near bulkheads, underneath piers, and between docks where a clear view of the sky was not always possible. In these instances, the error was estimated to be 1 to 3 meters. 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 with the GPS as the diver swam the perimeter of the individual eelgrass bed (See Photographs 2 to 4). Once the diver returned to the beginning point, the GPS polygon area mapping 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.

2.4.2 Eelgrass Turion Density

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 5). In order to assess eelgrass habitat vegetation cover, thirty



Photograph 2. GPS surveying methods using a kayak and diver

Photograph 3. Biologist in kayak follows the diver's buoy, tank, and bubbles

Photograph 4. View of GPS unit and diver below the surface. Source: CRM, 2005

Photograph 5. Above-sediment morphological features of an eelgrass plant.
Source: CRM, 2005

(30) eelgrass turion counts were made at each of 15 stations throughout the study area by SCUBA-diving biologists that counted the number of live, green shoots at the sediment/shoot interface within replicated 0.07 square meter (sq m) quadrats. These counts were conducted along an underwater transect between the shallow-and-deep edges of eelgrass at each sampling site. Prior to conducting the survey, the team standardized their counting methods to ensure the accuracy of counts between different team members.

2.4.3 Extralimital Observations

Other background information collected during eelgrass habitat mapping surveys included water visibility, water depth, and plants and animals observed in the eelgrass beds during the survey.

2.4.4 Side Scan Sonar and Remote Video Mapping Surveys

Coastal Resources Management, Inc. and Nearshore and Wetlands Surveys (NWS) conducted side scan sonar/remote video surveys in and around Linda Isle, Promontory Bay, and Upper Newport Bay. The bottom survey method is based on the use of an Imagenex 881 Sportscan side scan sonar "fish" (Photograph 6). It is light weight and deployed and operated from a small vessel. The electronics are housed in the compact towfish, which is towed with a Kevlar signal cable. The system is powered from a 12-VDC power source. All of the functions of the side scan system are controlled from a computer.

The equipment was installed on the research vessel *Wetland Surveyor*. A Leica 12-channel marine Professional DGPS receiver and side scan sonar were connected to the data acquisition computer, which ran the Hypack Data Acquisition software. The Hypack 6.2b Hydrographic Data Acquisition and Processing Software is an integrated marine survey package. It allows for the collection and processing of data from a wide variety of instrumentation including GPS and side scan sonar. All input data were accurately time-tagged to provide precise correlation between the various instruments. The output signal from the GPS receiver was also output to the remote-video camera system so that the video was annotated with coordinates. The side scan sonar towfish was flown from the port bow of the survey vessel to avoid contamination of the signal with noise from the propeller wash.

The side scan sonar information was linked to Coastal Resources Management, Inc.'s high-resolution underwater color video camera (Ocean Systems, Inc Deep Blue Professional Grade Color Underwater Video Camera) that integrated GPS data and time on the underwater video (Photograph 7). After the equipment had been installed, integrated, and tested, the data collection began. Position, side scan, and video data were collected simultaneously while steering the survey vessel down Newport Harbor's main channel. The video camera was lowered from a point immediately astern of the towfish.

Field personnel viewed the bayfloor in real- time as the side scan sonar produced bottom-profile information. The real-time information was simultaneously recorded on a Digital Video Recorder (DVR) that was used in the office/laboratory to verify the side scan sonar

Photograph 6. Imagenex 881 Sportscan Side scan Sonar Towfish

Photograph 7. CRM's Ocean Systems Deep Blue High-resolution
Underwater Video Camera

locations of eelgrass, and additional information of the types of fish and marine life present. Many targets were positively identified by plotting video targets on the geo-referenced photo-mosaics. However, many areas of interest-apparent on the post-processed mosaics- were not visible in the video record because of the expanded coverage afforded by the side scan sonar system. Therefore, an additional field day was used to locate and identify the side scan sonar targets by CRM diver-biologists, and an additional day was used to re-survey targets using the GPS and video camera system and the geo-referenced photo-mosaics. Using the Hypack map display, the survey vessel was navigated to a target of interest visible on a mosaic. The video camera was lowered and the area was examined until the target was identified. Each target was located and identified in turn as an eelgrass or non-eelgrass record.

2.5 DATA PROCESSING

2.5.1 Eelgrass Habitat Maps

Diver-collected field and side scan sonar data were downloaded into a laptop computer and using Geographic Information Systems Software (Thales Mobile Mapping Software, GPS PRO Tracker, and ArcView 10.0). Eelgrass bed polygons and patches were projected on City of Newport Beach (CNB) geo-referenced files. All survey data were standardized to City GIS formats and presented in California State Plane Coordinate System Zone VI FIPS 0406 (feet). Results were integrated into the CNB GIS data base and the CNB Harbor Resources Department public accessible website. For presentation and area calculation purposes, 18 eelgrass "regions" (Figure 3) were developed. The areas surveyed were generally between the shoreline and 10 meters past the end of dock structures with the exception of the Carnation Cove/China Cove shoreline, where beds extended farther into the channel. Continuous beds across channels separating Linda Isle and Harbor Island were artificially divided down the center to allow for a calculation of eelgrass habitat areas within each region. Eelgrass areal cover, by region, was calculated with the assistance of the CNB GIS department staff based upon the combined areas of eelgrass polygons and eelgrass patches within each region.

2.5.2 Eelgrass Turion Density

Field-collected turion density counts (per 0.07 square meter) were entered into an Excel spreadsheet by station and depth, and converted to density per square meter. Summary statistics were then calculated (mean, standard deviation, and 95% confidence intervals) for each station and depth, and summarized in tabular and graphic format.

Two-way classification analysis using hierarchical clustering techniques (SAS, 2009) was used to visually display relationships between the attributes (eelgrass acreages and eelgrass turion density) and each of 18 survey regions within and between each of the three survey periods. Graphics and statistics were prepared with Excel 2003, and SAS JMP 8 Statistical Discovery Graphics and Statistics Package software.

2.5.3 Remote Video and Side scan Sonar Data

Video tapes taken during the side scan sonar survey were reviewed by observing the recorded data on a laptop computer at 1/3 the speed at which the data were collected. This information was used to ground-truth the side scan sonar data, observe the health of eelgrass, and obtain targets of interest along with the latitude and longitude positions obtained from the GPS annotation on the video. The video surveys were also used to determine if invasive algae (*Caulerpa taxifolia*) was present within each of the survey areas. Once the video and diver survey targets were verified as either eelgrass or non-eelgrass, side scan sonar data were processing using the Hyscan Processing module of the Hypack software. Geo-referenced photo-mosaic TIFF files were created by digitally overlaying data from overlapping sonar passes. These photomosaics were then imported into ArcView 10.0. Eelgrass polygons were developed based upon the identifiable eelgrass locations observed within the photomosaics.

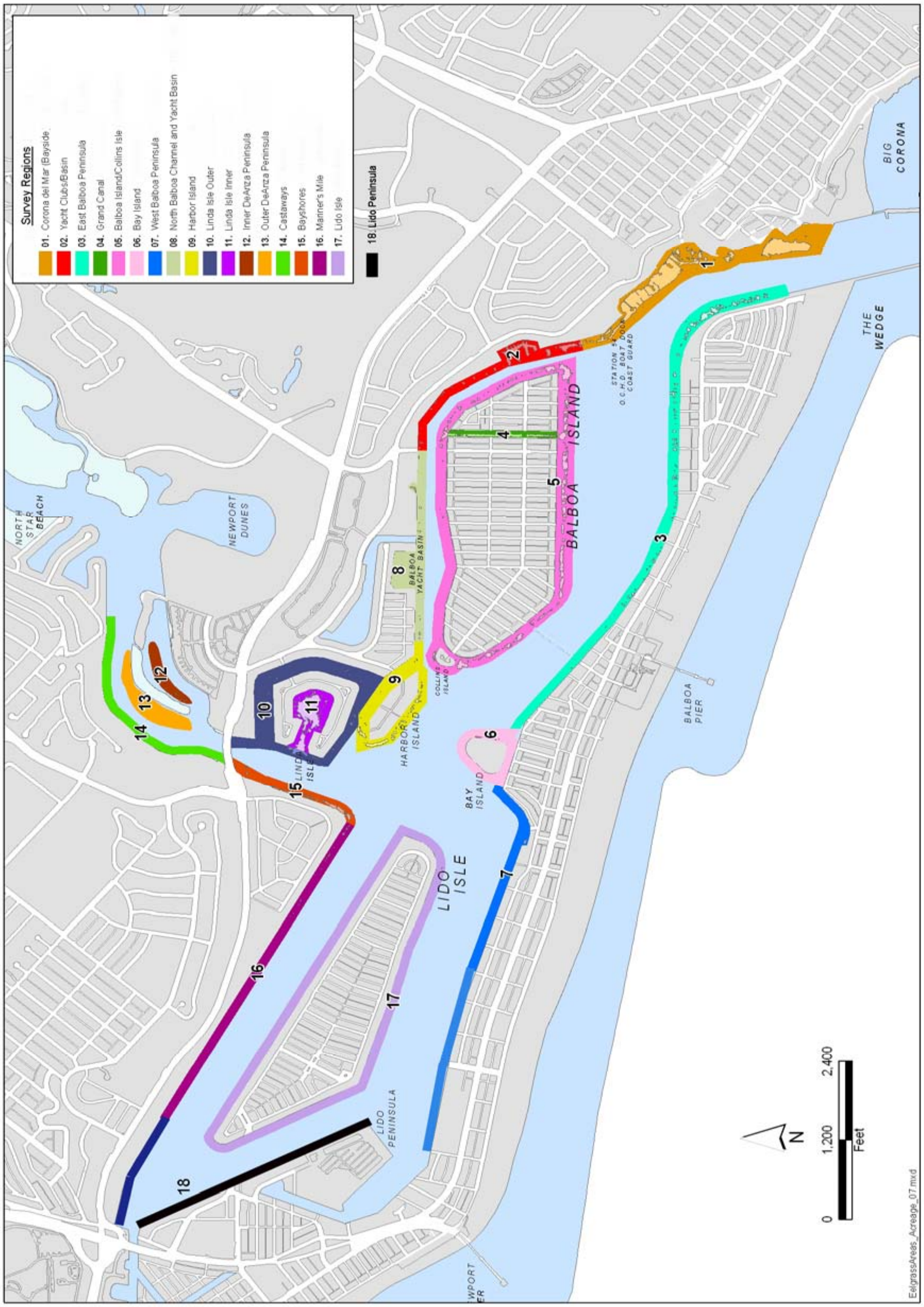


Figure 3. Eelgrass Survey Regions

3.0 EELGRASS HABITAT MAPPING SURVEY RESULTS

Eelgrass habitat mapping surveys were conducted during 42 field days between July 17th 2009 and December 9th, 2010 and included diver/GPS and shallow-water remote side scan sonar surveys. Nearly 17 linear miles of bay shoreline were surveyed, and the actual length covered by divers and the kayak exceeded 36 linear miles of shoreline. Eelgrass turion density surveys were conducted between March 3 and March 9, 2011. Public-accessible habitat survey maps for all eelgrass habitat mapping surveys between 2003 and 2010 are available online at the City of Newport Beach's website at:

http://www.city.newport-beach.ca.us/gis/gis_main.html
http://www.city.newport-beach.ca.us/GIS/GIS_interactive_2.html

3.1 DIVER SURVEY UNDERWATER VISIBILITY MEASUREMENTS DURING EELGRASS SURVEYS

Under water visibility (horizontal measurements) were recorded by CRM diver-biologists between 2003 and 2010 (Figure 4). Average bottom water visibility during the 2010-2011 survey was 4.0 +/2.9 ft (n=70 measurements), compared to 2003-2004 (5.5+/2.9 ft) and 2006-2008 (3.3 +/- 3.0 ft). A slight, baywide improvement in underwater visibility was observed at the Entrance Channel, along Bayside Drive, Harbor Island and DeAnza, but decreases in diver-visibility occurred along Balboa Island, Mariner's Mile, Linda Isle/Balboa Marina, and Lido Isle.

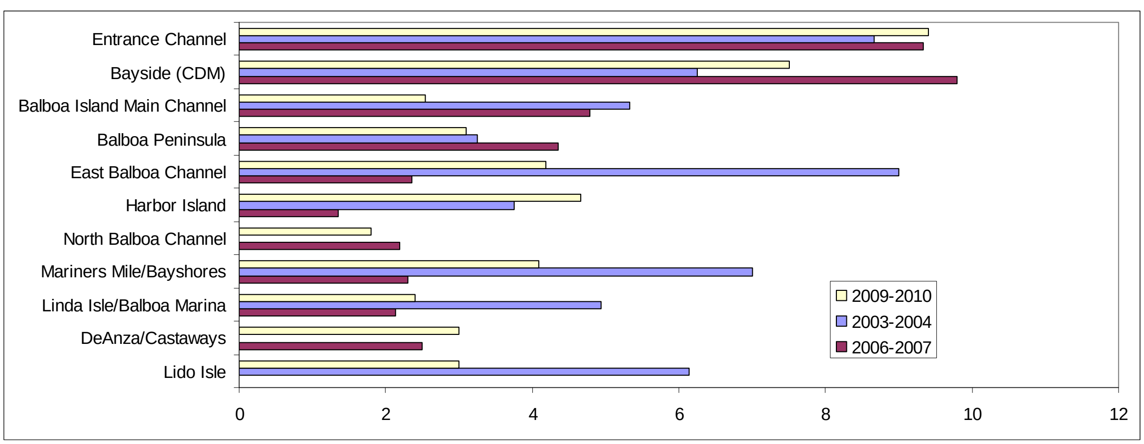


Figure 4 .
Comparison of Underwater Visibility for Various Survey Regions of Newport Bay.
2003-2004, 2006-2007, 2009-2010

3.2 EELGRASS DISTRIBUTION AND ABUNDANCE

A total of 19.92 acres (8.06 hectares) of shallow water eelgrass was mapped bay-wide between 2009 and 2010 (Table 1), representing 2.3 % of the 884.9 acres (358.1 hectares) of soft bottom habitat within the Lower Newport Bay and Upper Newport Bay survey area. Eelgrass habitat accounted for 3.4 % of the soft amount of bottom habitat in the survey area during the 2003-2004 survey, when a total of 30.4 acres of eelgrass were mapped within the shallow water habitat, and 2.6% of the soft bottom habitat in 2006-2007 (Figure 5). The amount of eelgrass present in 2009-2010 represents a decline of 10.49 acres (34%) of shallow water eelgrass compared to 2003-2004, and a decline of 1.39 acres (13.7%) compared to 2006-2007.

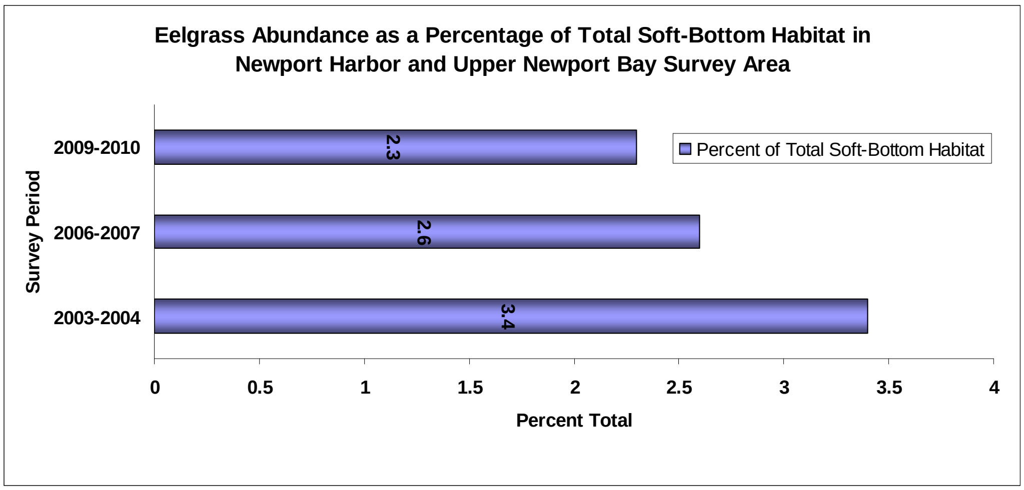


Figure 5.

Eelgrass was mapped at depths between +0.5 and -15 feet Mean Lower Low Water (MLLW). An overview of eelgrass distribution is presented in Figure 6.

As observed during previous surveys, shallow water eelgrass was common-to-abundant in the “forebay” between Corona del Mar and Balboa Island (Corona del Mar Reach and the Balboa Reach) extending to Bay Isle at depths between 0.0 and -15 ft MLLW (Table 1, Figure 6). Most eelgrass occurred at depths of -8 ft or less. Eelgrass was also abundant “midbay” within Linda Isle Inlet. These regions accounted for 93 % of all of the shallow water eelgrass in Newport Bay (Table 1). Eelgrass acreages were low in other “midbay” areas (North Balboa Channel, the side channels around Harbor and Linda Isle, Lido Reach/Mariners Mile, and Upper Newport Bay), and absent in “West Newport Bay” west of the Newport Harbor Yacht Club, on the east-facing side of Bayshores across from Linda and Harbor Island; and along the Lido Peninsula (Table 1).

Table 2 and Figure 7 summarize the distribution of eelgrass, by region, during all survey years. Figures 8-15 super-impose eelgrass distribution on City of Newport Beach GIS maps of the bay. Figure 16 presents deepwater channel eelgrass habitat surveys conducted in 2003 and 2008 (NMFS, 1993; Coastal Resources Management, Inc. 2005 and 2010).

Table 1. Results of 2009-2010 Eelgrass Habitat Mapping Surveys Shallow Water Eelgrass Habitat*

Region #	Survey Region	2009-2010 (acres)	% of Shallow Water Eelgrass Habitat	Sediment Type Source: (CRM 2010)
1	**Corona del Mar/Bayside Drive to OCHD**	10.363	52.0	Coarse Silt to Medium Sand
5	**Balboa and Collins Islands**	3.052	15.3	Fine Sand
11	**Linda Isle (Inner basin)**	1.974	9.9	Very Fine Silt
2	**Balboa Channel Yacht Basins**	1.758	8.8	Silt to Fine Sand
3	**Balboa Peninsula-East of Bay Island**	1.391	7.0	Fine Sand to Medium Sand
4	**Grand Canal**	0.623	3.1	Fine Sand
9	**Harbor Island**	0.446	2.2	Fine to Coarse Silt
8	**North Balboa Channel and Yacht Basins**	0.119	0.6	Coarse Silt to Fine Sand
16	**Mariner's Mile**	0.070	0.4	Coarse Silt to Fine Sand
10	**Linda Isle (outer channels)**	0.068	0.3	Fine to Coarse Silt
6	**Bay Island**	0.041	0.2	Coarse Silt to Fine Sand
7	**Balboa Peninsula-West of Bay Island**	0.014	0.1	Fine Silt to Medium Sand
13	**DeAnza/Bayside Peninsula (Outer)**	0.001	0.0	Medium Silt
12	**DeAnza/Bayside Peninsula (inner side)**	0.000	0.0	Medium Silt
14	**Castaways to Dover Shores**	0.000	0.0	Medium Silt
15	**Bayshores**	0.000	0.0	Very Fine Sand
17	**Lido Isle**	0.000	0.0	Coarse Silt to Medium Sand
18	**Lido Peninsula**	0	0.0	Medium Silt
	All Regions	19.920	100.0	

Note: No deep water eelgrass surveys were conducted in navigational channels during the 2009-2010 survey

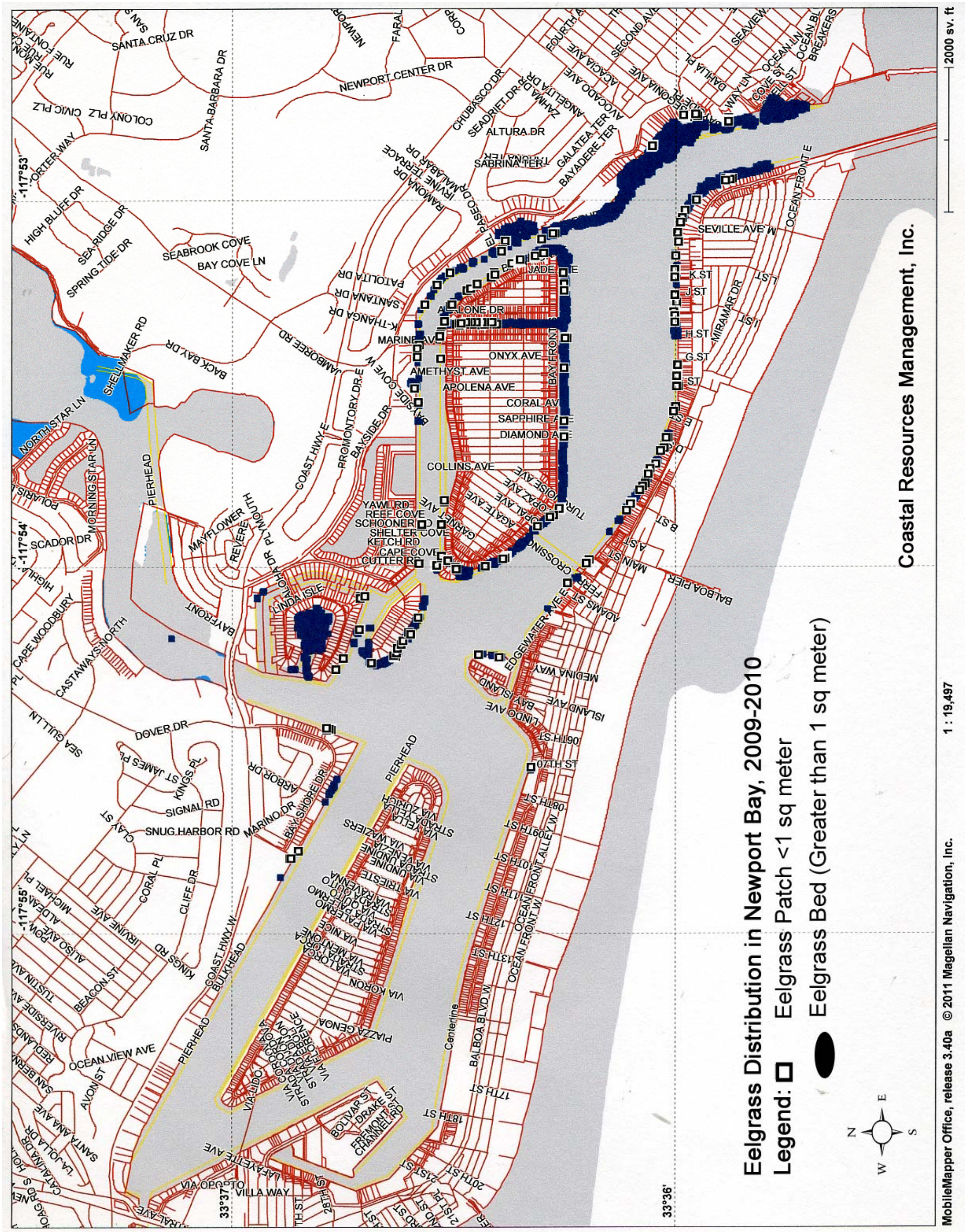


Figure 6. Overview of Eelgrass Distribution in Newport Bay, 2009-2010
Note: No side scan sonar habitat mapping surveys were conducted in the entrance channel. Refer to Figure 17 for previous mapping survey results.

Table 2. Summary of Distribution and Acreage. 2003-2010

Region	Description	2003-2004 (acres)	2006-2008 (acres)	2009-2010 (acres)	Mean (acres) (2003-2010)	Difference (acres) Between 2003 and 2010
A*	Newport Harbor Deepwater Navigational Channels*	90.3[a]	45.86[b]	no survey		no comparison; surveyed by different sonar methods
	Shallow Water Habitat					
1	Corona del Mar/Bayside Drive to OCHD	9.521	9.075	10.363	9.653	0.842
2	Balboa Channel Yacht Basins	2.469	1.539	1.758	1.922	-0.711
3	Balboa Peninsula-East of Bay Island	1.672	1.557	1.391	1.540	-0.281
4	Grand Canal	0.898	1.143	0.623	0.888	-0.275
5	Balboa and Collins Islands	6.686	4.554	3.052	4.764	-3.634
6	Bay Island	0.132	0.051	0.041	0.075	-0.091
7	Balboa Peninsula-West of Bay Island	0.034	0.03	0.014	0.026	-0.020
8	North Balboa Channel and Yacht Basins	0.698	0.115	0.119	0.311	-0.579
9	Harbor Island	2.721	0.712	0.446	1.293	-2.275
10	Linda Isle (outer channels)	2.916	0.328	0.068	1.104	-2.848
11	Linda Isle (Inner basin)	0.281**	3.218	1.974	1.824	1.693
12	DeAnza/Bayside Peninsula (inner side)	0.209	0.009	0.000	0.073	-0.209
13	DeAnza/Bayside Peninsula (Outer)	0.792	0	0.001	0.264	-0.791
14	Castaways to Dover Shores	0.132	0	0.000	0.044	-0.132
15	Bayshores	0.991	0.664	0.000	0.552	-0.991
16	Mariner's Mile	0.234	0.066	0.070	0.123	-0.164
17	Lido Isle	0.025	0.004	0.000	0.010	-0.025
18	Lido Peninsula	not surveyed	0	0.0	0.0	
	*Deepwater and Shallow Water Regions	**120.711**	**68.925**	**no deepwater survey**		
	Shallow Water Regions Only	**30.411**	**23.065**	**19.920**	**24.547**	**-10.491**

[a] National Marine Fisheries Service, 2003

[b] Coastal Resources Management, Inc., 2010

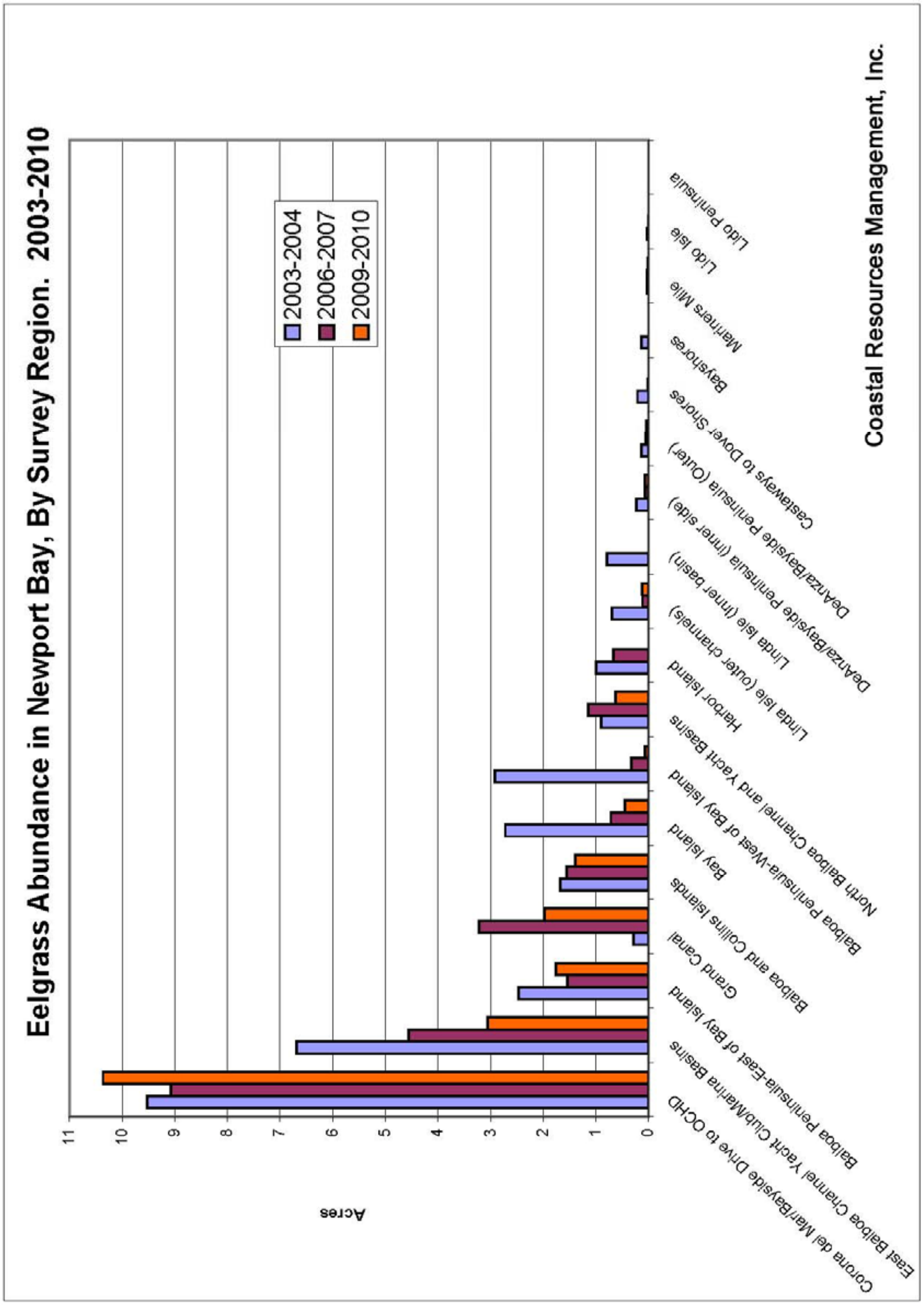

Eelgrass Abundance in Newport Bay, By Survey Region. 2003-2010
Acres
0
1
2
3
4
5
6
7
8
9
10
11
2003-2004
2006-2007
2009-2010
Corona del Mar/Bayside Drive to OCHD
East Balboa Channel Yacht Club/Marina Basins
Balboa Peninsula-East of Bay Island
Grand Canal
Balboa and Collins Islands
Bay Island
Balboa Peninsula-West of Bay Island
North Balboa Channel and Yacht Basins
Harbor Island
Linda Isle (outer channels)
Linda Isle (inner basin)
DeAnza/Bayside Peninsula (inner side)
DeAnza/Bayside Peninsula (Outer)
Castaways to Dover Shores
Bayshores
Mariners Mile
Lido Isle
Lido Peninsula
Coastal Resources Management, Inc.

Figure 7.

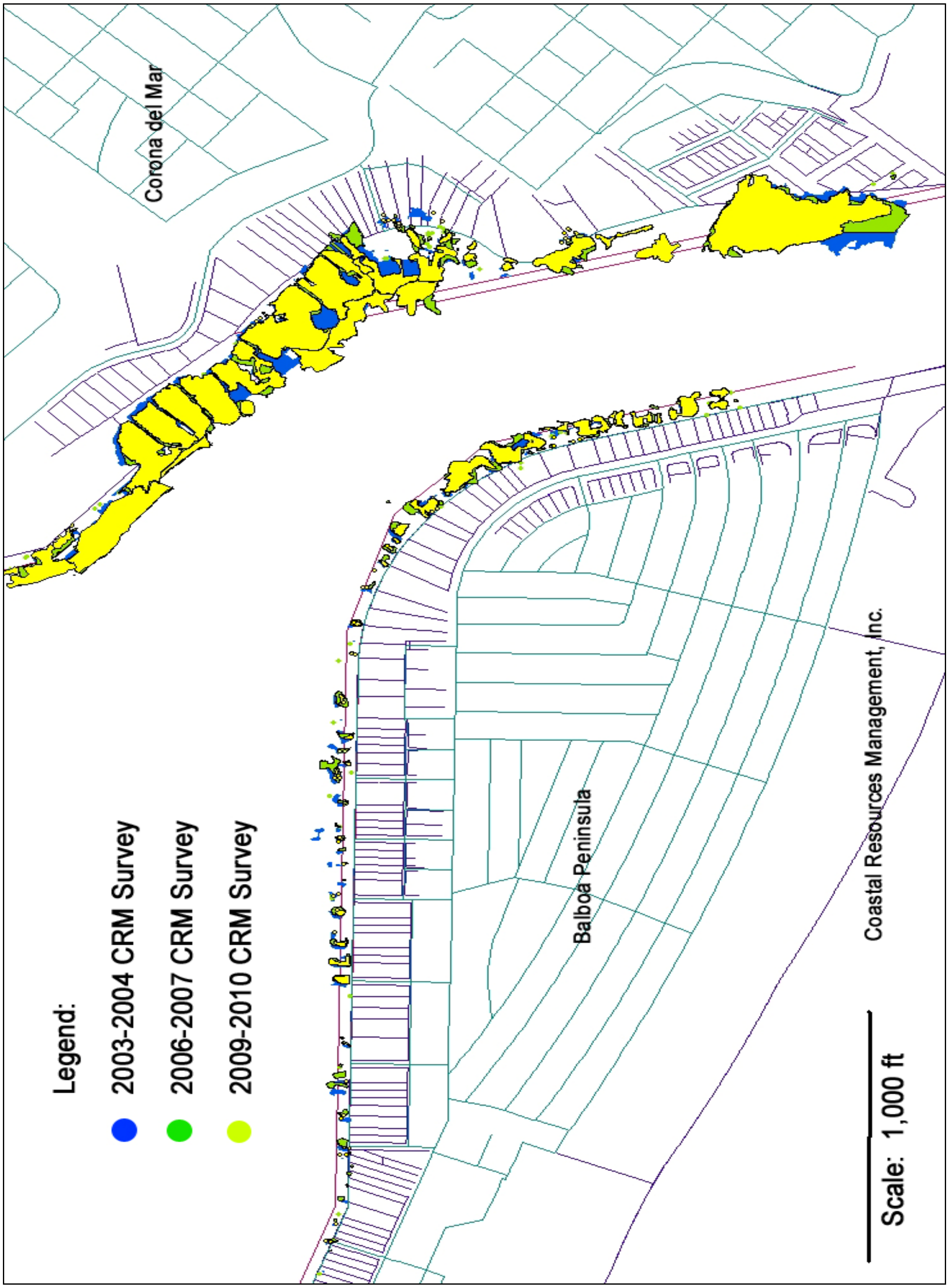


Figure 8. 2003-2004, 2006-2007, and 2009-2010 Eelgrass Habitat Maps. Corona del Mar Bend and Balboa Reach

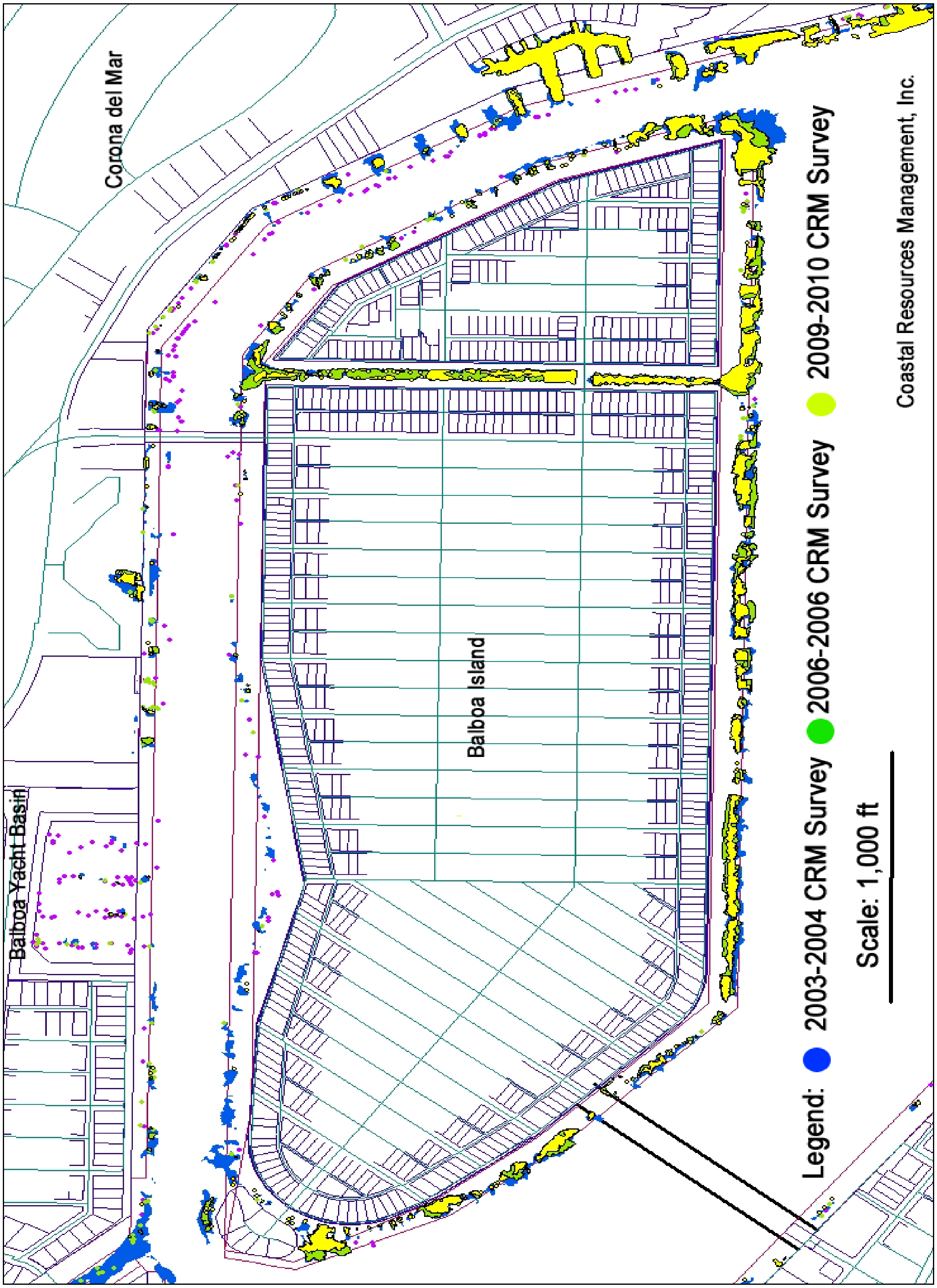


Figure 9. 2003-2004, 2006-2007, and 2009-2010 Eelgrass Habitat Maps. Balboa Reach and Harbor Island Reach

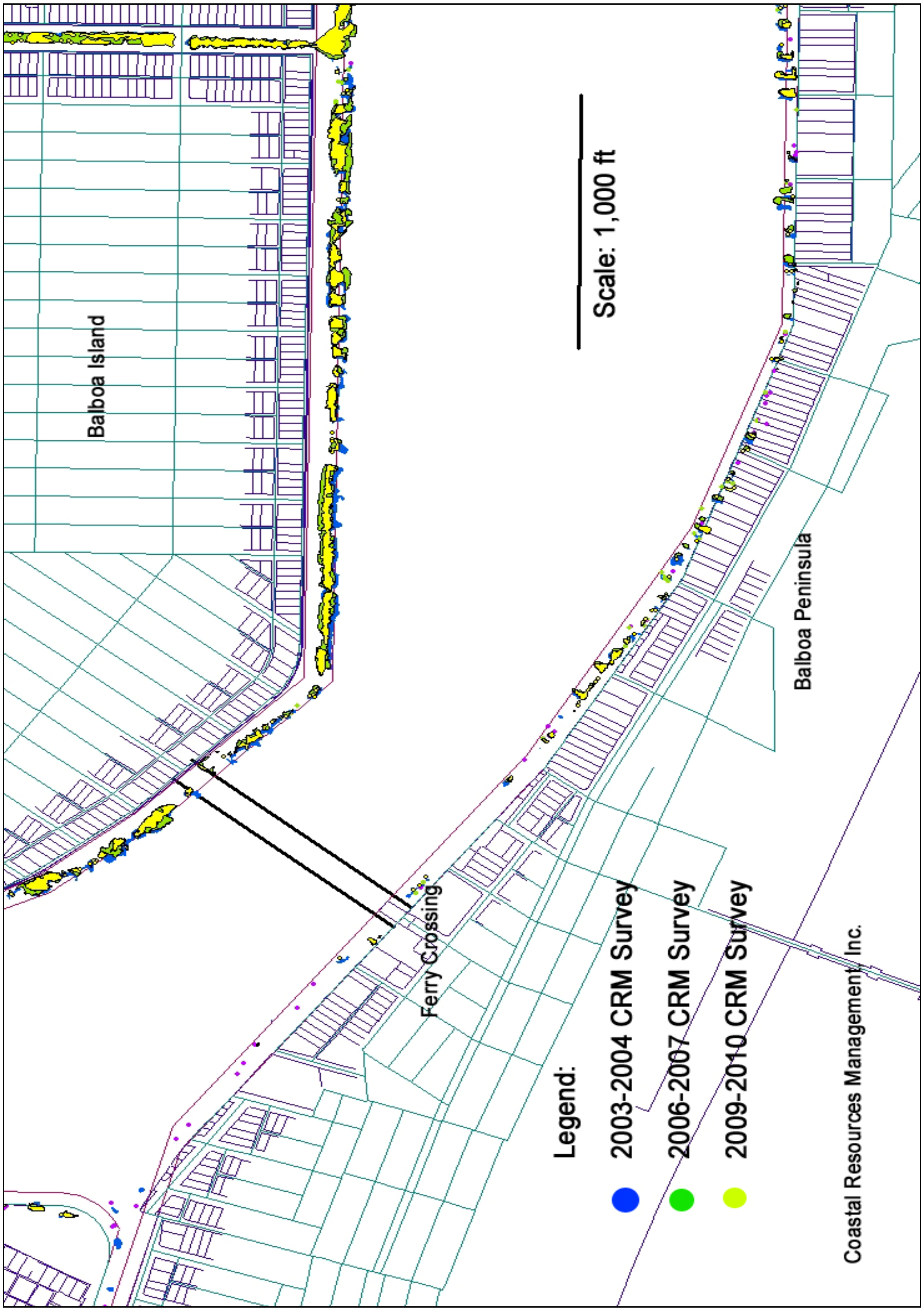


Figure 10. 2003-2004, 2006-2007, and 2009-2010 Eelgrass Habitat Maps. Mid Balboa Peninsula

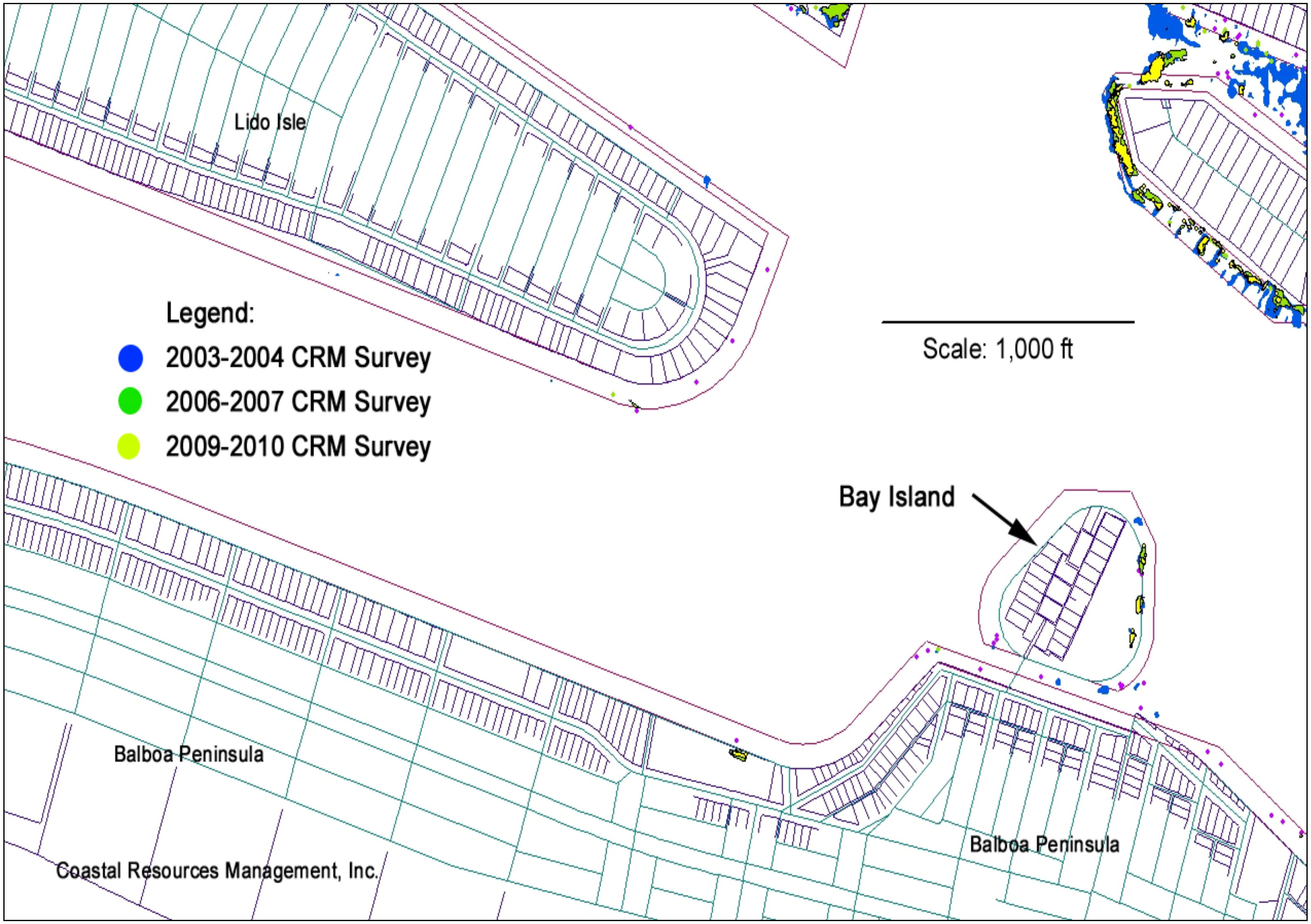


Figure 11. 2003-2004, 2006-2007, and 2009-2010 Eelgrass Habitat Maps. West Balboa Peninsula and South Lido Isle

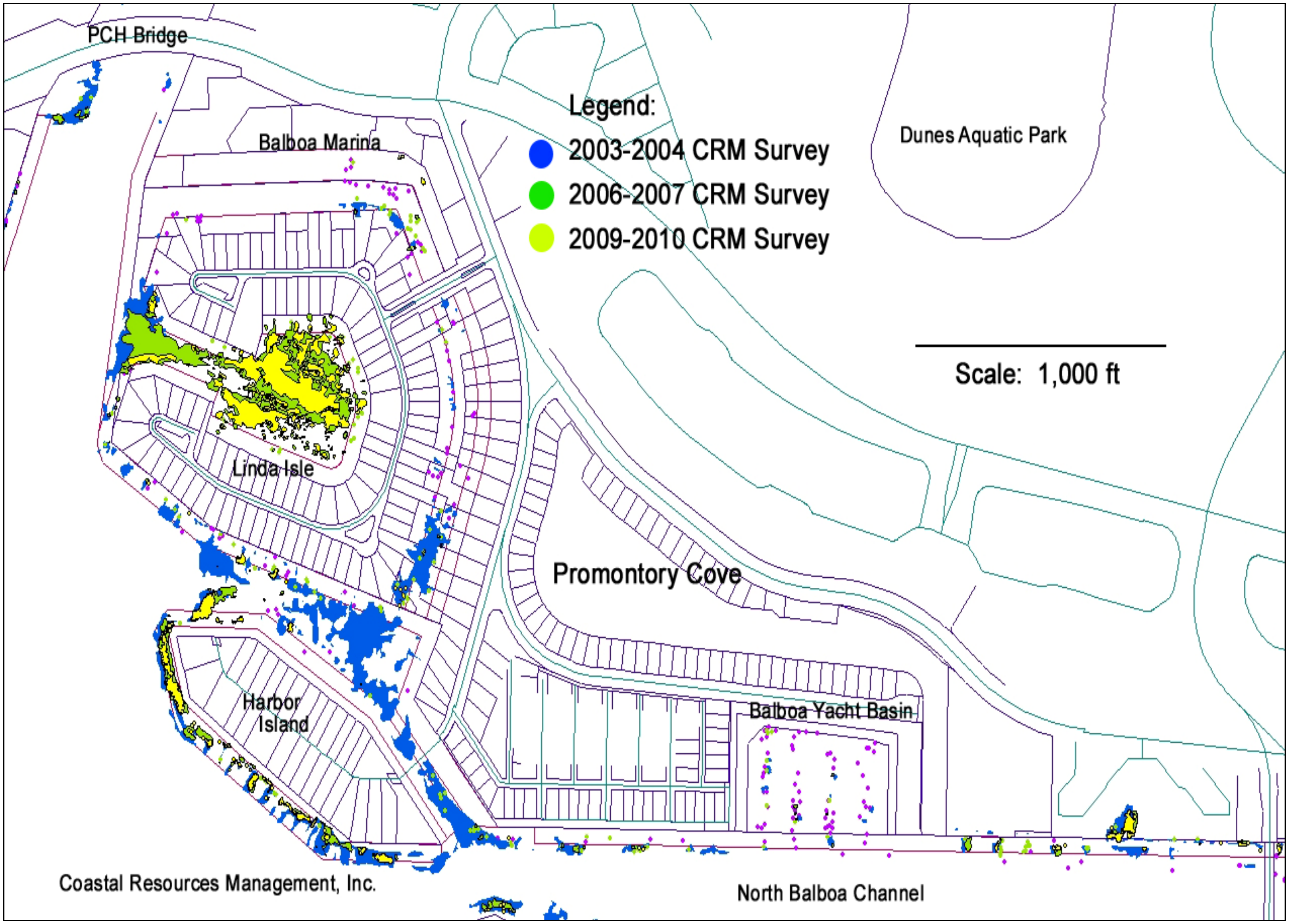


Figure 12. 2003-2004, 2006-2007, and 2009-2010 Eelgrass Habitat Maps. Harbor Island Reach, Linda Isle, Balboa North Channel

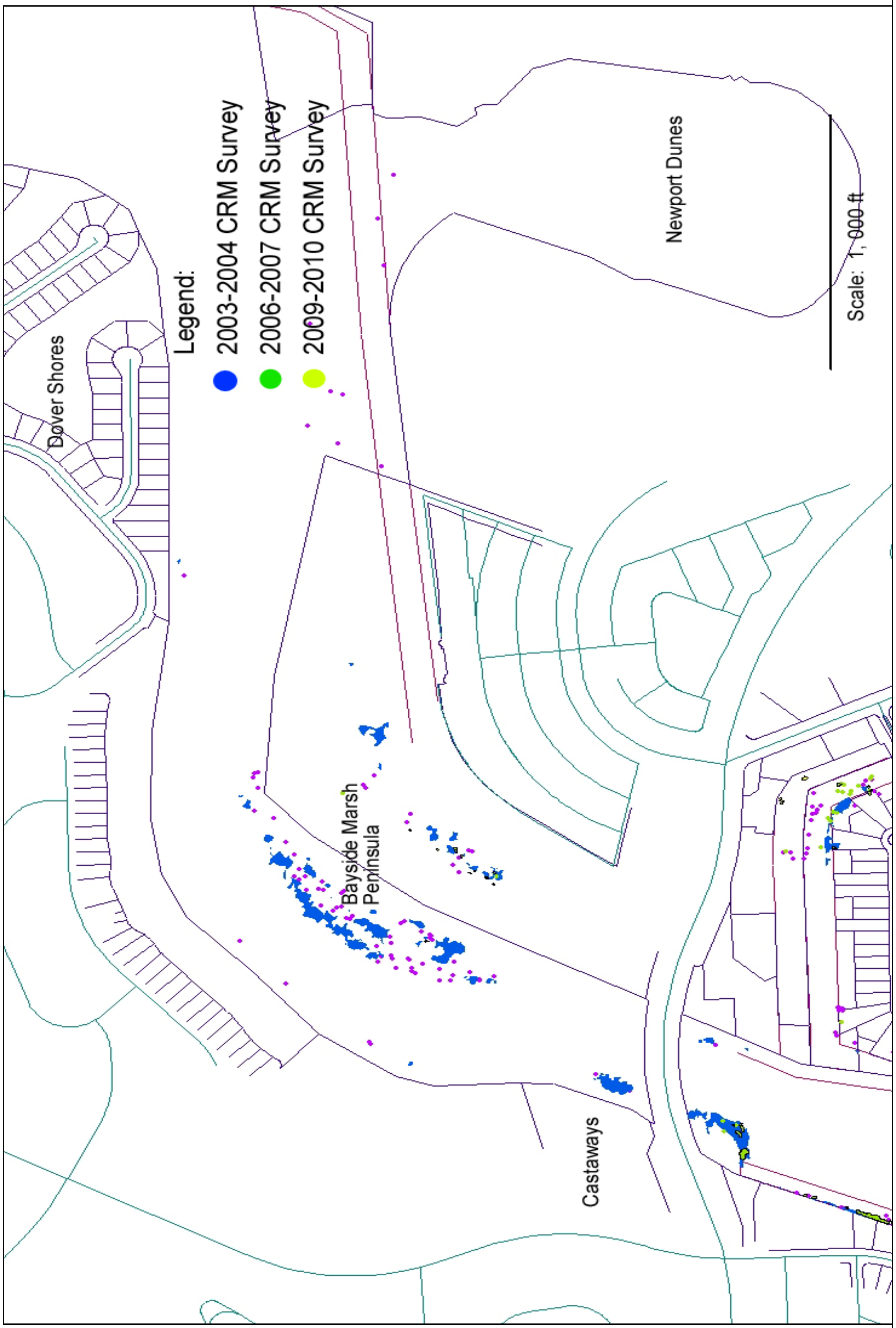


Figure 13. 2003-2004, 2006-2007, and 2009-2010 Eelgrass Habitat Maps. Balboa Marina Channel, PCH Bridge, and Upper Newport Bay

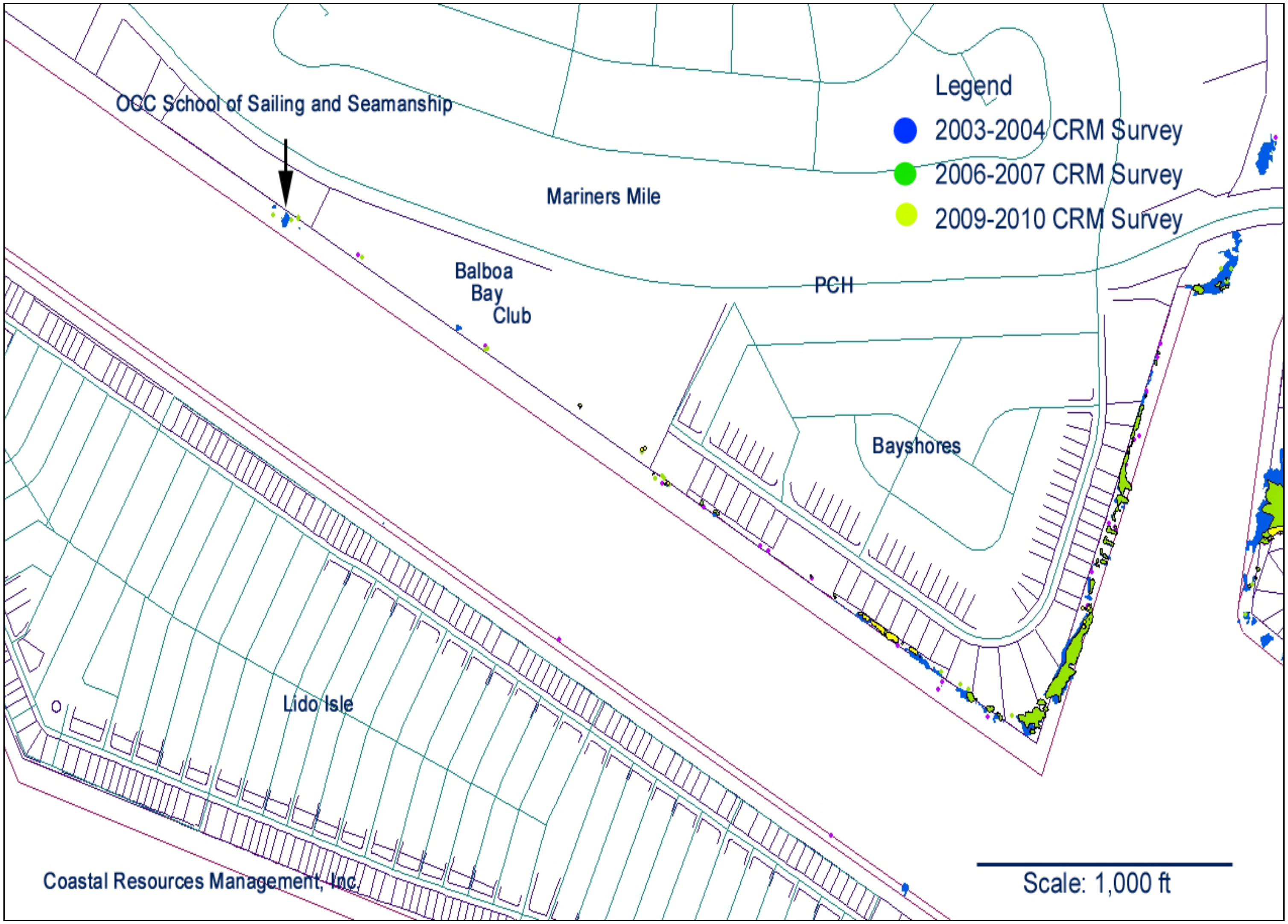


Figure 14. 2003-2004, 2006-2007, and 2009-2010 Surveys. Lido Isle Reach, North Lido Isle, and Bayshores

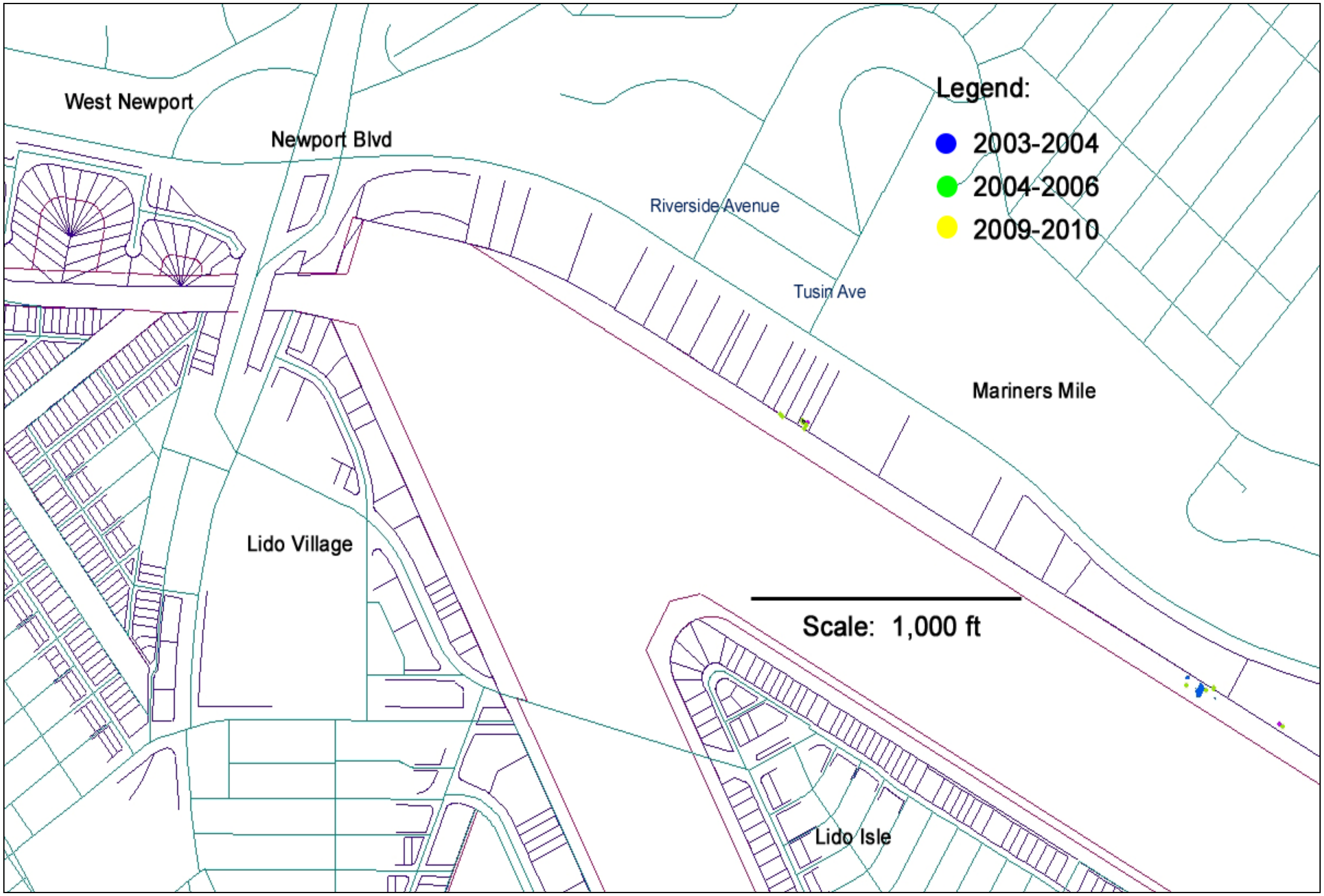


Figure 15. 2003-2004. 2006-2007, and 2009-2010 Eelgrass Habitat Maps. Lido Peninsula and West Lido Isle Reach

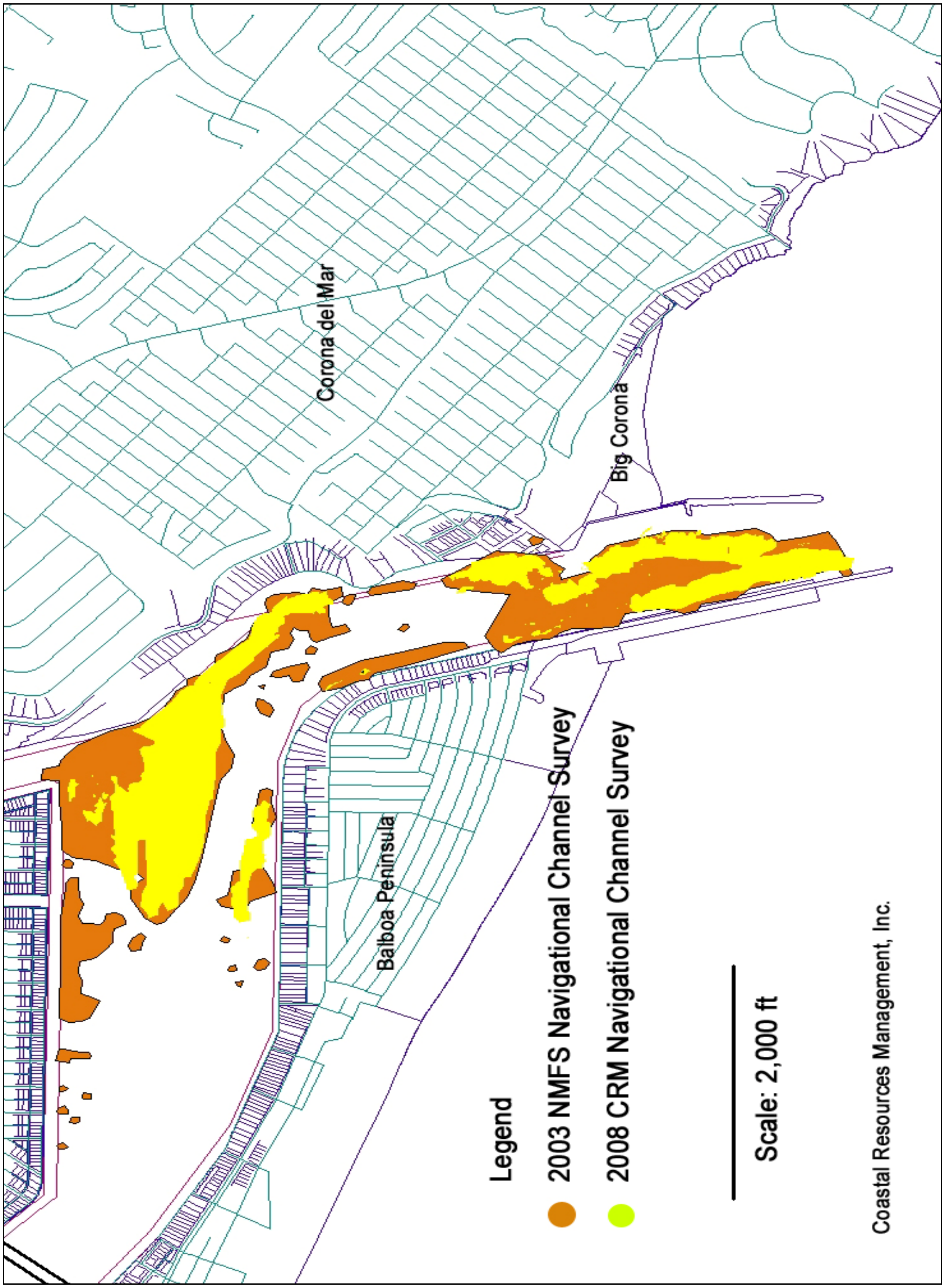


Figure 16. 2003 and 2008 Eelgrass Habitat Maps. Harbor Entrance Channel

3.3 EELGRASS DISTRIBUTION BY REGION

Table 3 summarizes eelgrass distribution and abundance within the 18 shallow water regions and the one deepwater navigational channel eelgrass region for each of the three surveys conducted to date. Refer to Figures 8-16 for the following discussion of individual survey regions.

3.3.1 Region 1-Corona del Mar-Bayside Drive including Coast Guard/O.C. Harbor Patrol Facilities (10.363 acres)

Eelgrass was dense and extensive between Bayside Drive and the County of Orange Sheriff Harbor Patrol Facilities, accounting for 52% of all of the eelgrass in Newport Bay (Table 2, Figure 8). The depth range of eelgrass extended between the intertidal and -15 ft MLLW. Intertidal and subtidal meadows of eelgrass were again present in this region, along with both narrow and wide blade forms of eelgrass. This region was one of two regions in the bay that recorded gains in eelgrass acreages between 2003 and 2010 (0.842 acres, 8.8%, Table 3), relative to higher eelgrass cover in and around the Channel Reef Apartment dock system. However, the cover of intertidal eelgrass continued to decline around the storm drain at Bayside Place. This decline was first evident during the 2006-2007 survey.

3.3.2 Region 2-Yacht Club Basins and Marinas Between the Orange County Harbor Department and the Balboa Bridge along Bayside Drive (1.758 acres)

Eelgrass colonized the yacht club and marina basins at depths from -1 to -10 ft MLLW. The Bahia Corinthian and Balboa Yacht Club basins contained the most eelgrass (Figure 9), while most eelgrass in the Bayside Marina complex occurred as small beds or patches between the bulkhead and the headwalk of the dock system. This region accounted for 8.8 % of all shallow water eelgrass during 2009-2010 (Table 2). Eelgrass acreage declined by 0.711 acres compared to the 2003-2004 survey (Table 3). Eelgrass in the Bahia Corinthian Yacht Club Basin however, exhibited a slight gain in coverage (0.2 acre) compared to 2006-2007 (Figure 10).

3.3.3 Region 3-East and Mid Balboa Peninsula (1.391 acres)

The East/Mid Balboa Peninsula region includes the shallow water zone between the bulkhead and the seaward ends of docks between the Entrance Channel to, but not inclusive of Bay Island (Table 2, Figures 8 and 10). Primarily lined with docks, this shoreline consists of bulkheads and pocket beaches. Many small eelgrass beds and patches were mapped between docks, within boat slips, and shoreward and seaward of docks at depths between -1 and -9 ft MLLW. The amount of eelgrass has sequentially declined since 2003 (Table 3), decreasing from 1.672 acres to 1.391 acres in 2009-2010 (16.8% decline). In 2009-2010, this region accounted for 7% of the vegetated shallow water eelgrass habitat.

3.3.4 Region 4-Grand Canal (0.623 acres)

The Grand Canal separating “Little Balboa” and “Balboa Island” was vegetated with 0.623 acres of eelgrass along its entire length at depths between 0.0 and -6 ft MLLW, and at both the north and south entrance channels. Eelgrass accounted for 3.1% of the vegetated shallow water eelgrass (Table 2, Figure 9) and its overall areal cover declined 30.6% since the 2003-2004 survey. While the bed south of the Park Street Bridge remained stable, the bed north of the bridge exhibited a significant decrease in eelgrass area compared to 2006-2007 (-0.489 acres) and 2003-2004 (-0.395 acres) (Table 3, Figure 10).

3.3.5 Region 5-Balboa and Collins Islands, Excluding Grand Canal (3.052 acres)

Balboa Island is rimmed with City-nourished sand beaches while Collins Island is bulkheaded and dredged. The east, south, and west sides of the island contain most of the eelgrass and during the 2009-2010 survey, 3.052 acres of eelgrass were mapped around the island. Very little eelgrass was again found on the north side of Balboa Island compared to the 2003-2004 survey (Figure 9).

Eelgrass continued to recede along Bay Front South and Bay Front East compared to the 2003-2004 and 2006-2007 surveys. The receding trend is particularly evident at the southeast corner of Little Balboa Island, where its width has decreased approximately 60%.

While Balboa Island and Collins Island eelgrass habitat still accounts for a large proportion of all shallow water eelgrass habitat in the bay (15.3%, Table 2), eelgrass areal cover around Balboa and Collins Islands has decreased by 3.64 acres (54%) since 2003-2004 and by 1.5 acres (33%) since 2006-2007 (Table 3).

3.3.6 Region 6-Bay Island (0.041 acre)

Bay Island accounted for 0.2% of the shallow water eelgrass habitat (0.041 acre, Table 2). All of the eelgrass in 2009-2010 grew along the east-facing sandy beach and between the boat docks similar to conditions observed in 2006-2007 (Table 3, Figure 11). In 2003-2004, the acreage of eelgrass around Bay Isle was 0.132 acres. During that survey, eelgrass was also present in the channel on the south side and southwest corner of the island but these beds were missing during both the 2006-2007 and 2009-2010 surveys. Eelgrass abundance around Bay Island was 0.09 acre and 68.9% less than during the 2003-2004 survey.

3.3.7 Region 7-West Balboa Peninsula (0.014 acre)

Region 7’s eelgrass habitat was found exclusively in the Newport Harbor Yacht Club Basin at depths between 0.0 and -3 ft MLLW, similar to the 2006-2007 survey. It accounted for 0.1% of the shallow water eelgrass habitat (Table 2, Figure 11). No eelgrass was located west of the Newport Harbor Yacht Club. It has declined 58.8% in this region since 2003-2004 when the acreage of eelgrass along the West Balboa Peninsula was 0.034 acres.

3.3.8 Region 8-North Balboa Channel (North Side) from the Balboa Bridge to Beacon Bay (0.119 acres)

Eelgrass on the north side of the North Balboa Channel accounted for 0.6% of the shallow water eelgrass (Table 2, Figure 12). Small eelgrass beds and patches were found behind and among dock structures similar to the location of eelgrass in East Balboa Reach (Region 2). A small and receding eelgrass bed was present in the shallows of Bayside Cove behind the Belcourt Marina; eelgrass in the Balboa Yacht Basin was virtually absent (two patches). West of the Balboa Yacht Basin, a few small patches were present along the Beacon Bay shoreline. Substantial losses of eelgrass occurred between Beacon Bay and the Balboa Yacht Basin beginning in 2006-2007, and these areas have not recovered. Eelgrass abundance was 83.0% less than in 2003-2004 when 0.698 acres of eelgrass were mapped (Table 3).

3.3.9 Region 9-Harbor Island (0.446 acres)

Eelgrass accounted for 2.2% of the shallow water eelgrass (Table 2). A large eelgrass bed is present along the dock-free, west-face of the island, but it has continued to recede since the 2006-2007 survey. Eelgrass along the southwest-and-northeast side of the island grew among and between docks and slips, but was absent from the rest of the channel that separates Harbor Island and Linda Isle (Figure 12) primarily due to shading issues. The depth range of eelgrass varied between 0.0 and -8 ft MLLW. Eelgrass was once abundant in the shallow water channel east of the bridge connecting Harbor Island and Beacon Bay (Figure 12), but it has not been seen since 2003-2004. During the 2009-2010 survey, eelgrass abundance was 83.6% less than during the 2003-2004 survey, when 2.721 acres of eelgrass were mapped (Table 3).

3.3.10 Region 10-Outer Linda Isle Channels (0.068 acres)

Eelgrass habitat accounted for 0.3% of the shallow water eelgrass habitat in 2009-2010 (Table 2, Figure 12). Depth ranges of eelgrass in this region varied between -2 and -7 ft MLLW.

Eelgrass was reduced to small patches and small beds primarily in the eastern section of the Balboa Marina Channel (north of Linda Isle) between 2006 and 2007. These were later eliminated during channel dredging in early 2009 for the renovation of the Balboa Marina (Coastal Resources Management, 2009). An eelgrass transplant program was implemented at the marina in July 2009 to mitigate for these losses (Coastal Resources Management, Inc. 2009), which resulted in an increase of 0.009 acre sq ft by July 2010 (Coastal Resources Management, Inc. 2010), and 880 sq ft by July 2011 (Coastal Resources Management, Inc., 2011a).

Since 2003-2004, eelgrass in this region has decreased 97.7%, when the areal cover of eelgrass was 2.961 acres (Table 3). Eelgrass habitat decreases were observed throughout this region, with losses occurring in the channels between Harbor Island, Linda Isle and between Linda Isle and Promontory Bay, and in the Balboa Marina Channel.

3.3.11 Region 11-Linda Isle Inner Basin (1.974 acres)

This region was mapped in 2009 by CRM and Nearshore and Wetland Surveys using side scan sonar and diver/GPS techniques. Linda Isle Inner Basin eelgrass accounted for 9.9% of all eelgrass during the 2009-2010 survey, but decreased by a total of 1.2 acres (38.7%) compared to 2006-2007 when the first full mapping survey of the basin was completed (Table 3). Losses were greatest within the entrance of the inlet and in the center of the basin. Eelgrass was mapped at depths between -3 and -6 ft MLLW (Figure 12).

3.3.12 Region 12-DeAnza/Bayside Peninsula, Inner Area (0.000 acre)

No eelgrass was located on the east side of the DeAnza/Bayside Peninsula during the 2009-2010 survey and it followed a period of decline in 2006-2007 (Table 2, Figure 13). During the previous survey (2006-2007) eelgrass areal cover was 0.009 acres and in 2003-2004, eelgrass encompassed 0.209 acres (Table 3). Sediments in this region were fine silts except at the swimming beach which contained a greater percentage of sand.

3.3.13 Region 13-DeAnza/Bayside Peninsula, Outer Area, Main Channel of Upper Newport Bay (0.001 acre)

One patch of eelgrass was found during the 2009-2010 survey, conducted in July 2009 totaling 0.001 acre (Table 2, Figure 13). No eelgrass was found during the 2006-2007 survey (Figure 13), although it was abundantly present during the 2003-2004 survey. The 2003-2004 bay-wide survey identified 0.792 acres of eelgrass along the shoreline in this region (Table 3) which consisted of small-to large patches and beds that extended along the southern one-half of the peninsula.

Eelgrass appears to be recolonizing this section of shoreline, based upon surveys conducted by Merkel and Associates in September 2010, when they mapped a total of 1,614 sq ft (0.037 acre) along the southern one-half of the peninsula in September 2010. In the earlier July 2009 survey, CRM mapped 0.001 acre of eelgrass within this same region.

Eelgrass was present in this section of Upper Newport Bay in the late 1960s and early 1970s. In 1999, only low density patches were observed (Chambers Group, Inc. and Coastal Resources Management 1999). Efforts to transplant eelgrass to this area were unsuccessful in 1985 (MBC Applied Environmental Sciences, 1987), and again in 2006 (Mike Curtis MBC Applied Environmental Sciences, Inc. personal communication with R. Ware).

3.3.14 Region 14-Castaways to Dover Shores, Upper Newport Bay (0.000 acres)

Similar to the 2006-2007 survey, no eelgrass was found along the Castaways and Dover Shores shoreline on the west side of Upper Newport Bay (Table 2, Figure 13). During the 2003-2004 survey, 0.132 acres were mapped along the shoreline (Table 3). Most of this was present immediately north of the Coast Highway Bridge in front of the old Castaways Marina bulkhead at depths between -1 and -5 ft MLLW. A large section of this area was a staging area for Upper Newport Bay dredging and a debris containment boom was located in the vicinity of the previously-present eelgrass bed. The bed was present in the early 1990s (R. Ware, pers. observation), but disappeared following the 1998 El Nino (R. Ware, pers. observation). It was found again in 2002, (Coastal Resources Management and Chambers Group, 2002) and then during the 2003-2004 CRM mapping survey.

3.3.15 Region 15-Bayshores (0.000 acres)

This region extends from the Coast Highway Bridge to the junction of the Lido Reach. With the exception of two very small patches, no eelgrass beds was found in this region during the 2009-2010 survey (Table 2, Figure 14). CRM mapped 0.664 acres during the 2006-2007 survey (Table 3). It constituted 2.9% of shallow water eelgrass habitat at that time (Table 3, Figure 12), but was 33% less abundant compared to the amount in 2003-2004, when 0.991 acres of eelgrass was mapped.

Most of the eelgrass previously located on a shoal in front of the Anchorage Marina near the Coast Highway Bridge was missing during the 2006-2007 survey but eelgrass located along the bulkhead south to the Lido Reach persisted. Eelgrass grew between the bulkhead and the docks, between adjacent docks, and in wider, open areas adjacent to the community's swimming beach near the juncture of the Lido Reach. All of this eelgrass was missing during the 2009-2010 survey.

3.3.16 Region 16-Mariners Mile (0.070 acre)

During the 2009-2010 survey, eelgrass along Mariners Mile accounted for 0.4% of the shallow water eelgrass in Newport Bay (Table 2, Figures 13 and 14). Note: this section also includes the south portion of Bayshores. This region's eelgrass vegetation totaled 0.234 acres of eelgrass during the 2003-2004 survey (Table 3). Compared to 2003-2004, there has been a 71.8% loss of vegetation in this region.

Eelgrass was located at depths between -2 and -7 ft MLLW in fine sand to silt sediments. Beds were again concentrated between the bulkhead and the headwalks of the residential marina at Bayshores. No eelgrass was found west of this area during the 2009-2010 survey

However, in September 2010, Coastal Resources Management, Inc. conducted a transplant of 1,937 square feet 1,393 sq ft of eelgrass into the OCC boat basin for losses of 1,133 square feet that occurred during a dock renovation project in 2005. As of

September 2011, 1,393 sq ft (.032 acre) has survived the initial transplant (Coastal Resources Management, Inc. 2011b).

3.3.17 Region 17-Lido Island (0.000 acres)

No eelgrass was located around Lido Island in 2009-2010 (Table 2, Figures 11, 14, and 15). In 2006-2007, eelgrass coverage encompassed 0.004 acres and <0.1% of shallow water eelgrass vegetation (Table 3). Eelgrass abundance was 84% less in 2006-2007 than during the 2003-2004 survey, when 0.025 acres were mapped. All beds within the Lido Isle Yacht Club Basin and around the northeast tip of the island found previously were missing during the 2009-2010 survey.

3.3.18 Region 18-Lido Peninsula (0.000 acres)

Eelgrass was not observed along the bulkhead of the Lido Peninsula extending between the Rhine Channel to the Newport Blvd Bridge (Figure 15). This region was not surveyed during the 2003-2004 survey.

3.3.19 Navigational Channel Eelgrass Beds

Although not surveyed between 2009-2010, the distribution of eelgrass in the Entrance Channel, Corona del Mar Reach, and Balboa Island Reach based on surveys conducted in 2003 (National Marine Fisheries Service, 2003) and 2008 (Coastal Resources Management, Inc., 2010) is shown in Figure 16. These beds covered 90.3 acres of eelgrass in 2003 (NMFS, 2003), and 45.8 acres of bottom habitat at depths between 15 and 28 ft MLLW. The large discrepancy between surveys is likely related to survey techniques rather than actual changes in habitat. Surveys of this area will be again conducted in early 2012 by Coastal Resources Management, Inc. for the City of Newport Beach.

3.4 TWO WAY CLASSIFICATION ANALYSIS OF EELGRASS DISTRIBTUION IN NEWPORT BAY

Figure 17 illustrates an analysis of the relationship between eelgrass acreages and eelgrass regions in Newport Bay between 2004 and 2011. This analysis clusters eelgrass survey regions based upon their respective eelgrass acreage similarity coefficient over the three-year survey periods between 2003-2004, 2006-2007, and 2009-2010. The results indicate the presence of two temporal groups (1 and 2) and four (4) eelgrass region groups (A, B, C, and D). Acreage similarity was highest among the 2006-2007 and the 2009-2010 surveys, with most decreases in acreages occurring between the 2003-2004 and the 2006-2007 surveys. Site Group A consisted of regions with typically moderate-to -high abundances of eelgrass designated in the Stable and Transitional Zones, although both Harbor Island and Linda Isle outer channel regions were characterized by having substantially less eelgrass during the Year 2 and Year 3 surveys than during Year 1. Group B regions included sites with low eelgrass abundance and/or that exhibited a full loss of eelgrass during the Year 2 and Year 3 surveys (i.e., the Upper Newport Bay sites and Bayshores). These sites are Transitional Zone stations located throughout the Mid-

Bay, West Bay, and Upper Newport Bay. Groups C and D were Stable Eelgrass Zone, single entity sites (Balboa Island, Group C; Corona del Mar/Bayside Drive, Group D) that exhibited moderately high-to-high eelgrass abundances throughout the three survey periods.

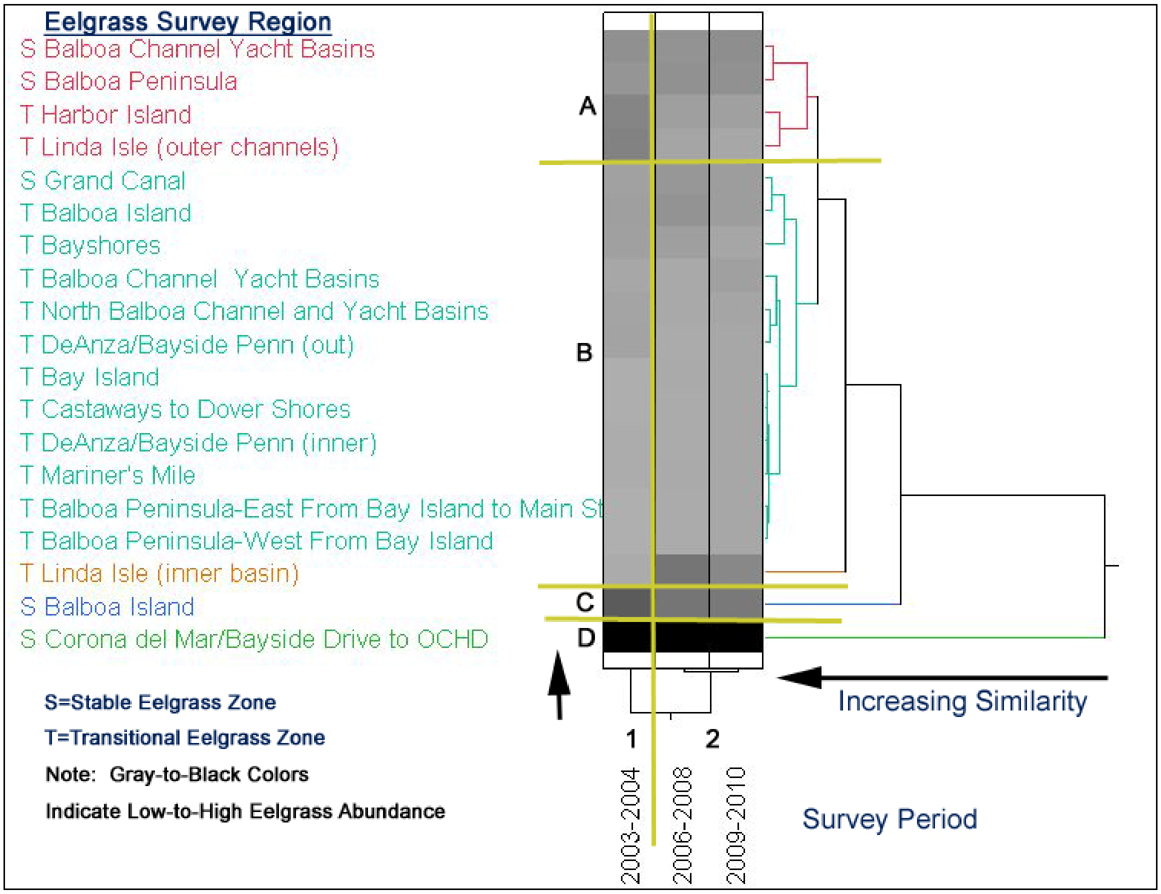


Figure 17. Site Classification Analysis of Eelgrass Distribution and Abundance, 2003-2010

3.5 EELGRASS TURION DENSITY

A turion is an above ground unit of eelgrass growth that consists of an eelgrass shoot and associated eelgrass blades (see Photograph 5). Eelgrass density refers to the number of turion units per area of bayfloor. Turion density can be highly variable as a result of water temperature, water currents and tidal exchange rates, sediment characteristics, light availability, and water depth. A combination of low and high density canopy, and open patches of unvegetated sediment may contribute to a greater diversity of organisms and a more complex ecological system.

During the March 2011 survey, Newport Bay eelgrass turion density was 123.5 turions per sq m) which was 90.8 % of the average density observed in Newport Bay in 2008 (136.1 turions per sq m) and 58.1% of the turion density observed in 2004. The lower survey density is likely reflective of (1) timing of the late-winter 2011 survey period and

(2) a continued bay-wide decrease in density first observed during the 2008 survey. For all three surveys, eelgrass mean density was 170 +/-106.7 turions per sq m (n=1,230), and ranged between 14.3 and 629 turions per sq m.

3.5.1 Eelgrass Density Spatial Trends

Station density varied from 50.5 (OCC Boat Basin) to 225.7 turions per square meter (Grand Canal). No eelgrass was observed at four sites originally surveyed for eelgrass density in 2004- Bayshores Private Beach, PCH Bridge, the Lido Yacht Club, and the east side of the DeAnza Peninsula in Upper Newport Bay.

Figure 18 compares the results of the three turion density surveys conducted between 2004 and 2011. A summary of eelgrass density data for all three surveys conducted between 2004 and 2011 are provided in Appendix 2. The data used for this analysis included all stations originally monitored in 2004. In cases where no eelgrass was subsequently found during the 2008 and 2011 surveys, “0” values were included in the graphical analysis. While decreases in turion density were particularly severe at mid-bay and Upper Newport Bay sites in 2008 compared to 2004, the data for 2011 indicates that there was a perceptible recovery in mid-and-upper Bay densities, with increases observed at Grand Canal, Bay Island, Harbor Island, DeAnza (outer), and in the OCC Boat Basin (as a result of an eelgrass transplant conducted in 2010). Conversely, eelgrass density in the Entrance Channel, along Carnation Cove (Corona del Mar), the eastern end of Balboa Island, and the eastern end of the Balboa Peninsula slightly decreased.

Eelgrass turion density was significantly different between years ($F=16.6 \geq 3.37$ critical value of F, 2 df) as well as significantly different between stations ($F=3.51 \geq 2.11$ critical value of F, 13 df; 2 Way ANOVA without replication, square root +1 transformed means).

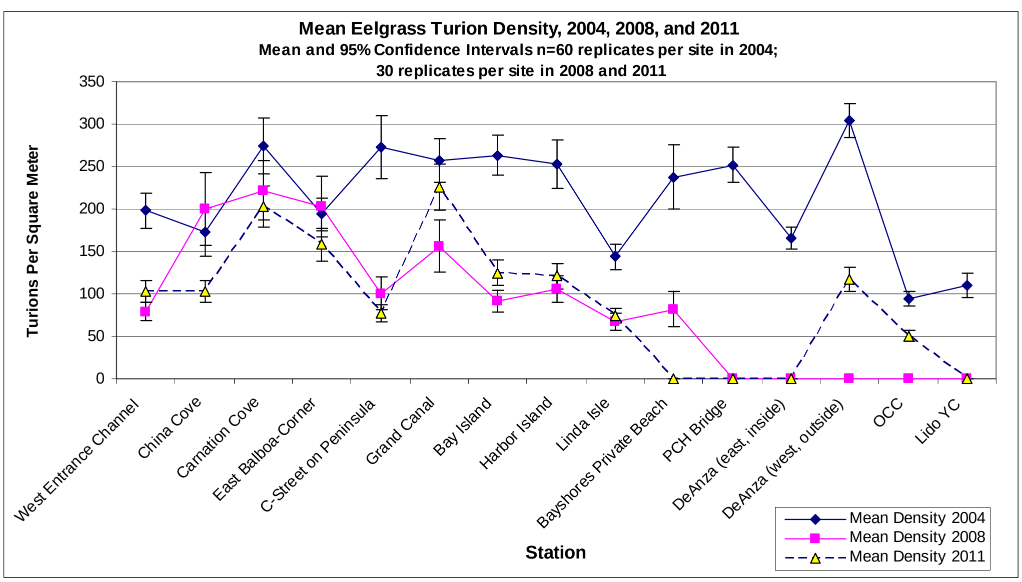


Figure 18.

3.5.2 Eelgrass Density and Depth Relationships

Eelgrass turion density decreased with increasing depth in 2011 (r^2 = 0.44). The relationship was not as strong as during 2008 (r^2 = 0.72) or 2004 (r^2 = 0.72). As in 2008, this likely occurred because of the substantial decrease in eelgrass density at shallower depths at mid-bay stations, but also in shallower depths near Balboa Island and Corona del Mar. This correlation is primarily dependent upon a decrease in submarine light levels with increasing depth (Zimmerman, 1991) but other factors appear to be affecting turion density-for example, possible higher levels of suspended sediments that limit submarine light values even at shallow depths, as shown by lower luminance and light energy levels in the mid-bay section of the Harbor in 2008-2009 (Coastal Resources Management, Inc., 2010).

When all of the data were combined over all years and grouped into 25 depth classes (between +1 to 0 ft MLLW and -22 to -23 ft MLLW), the decreasing turion density-depth relationship was much stronger (r^2 = 0.79), as illustrated in Figure 19.

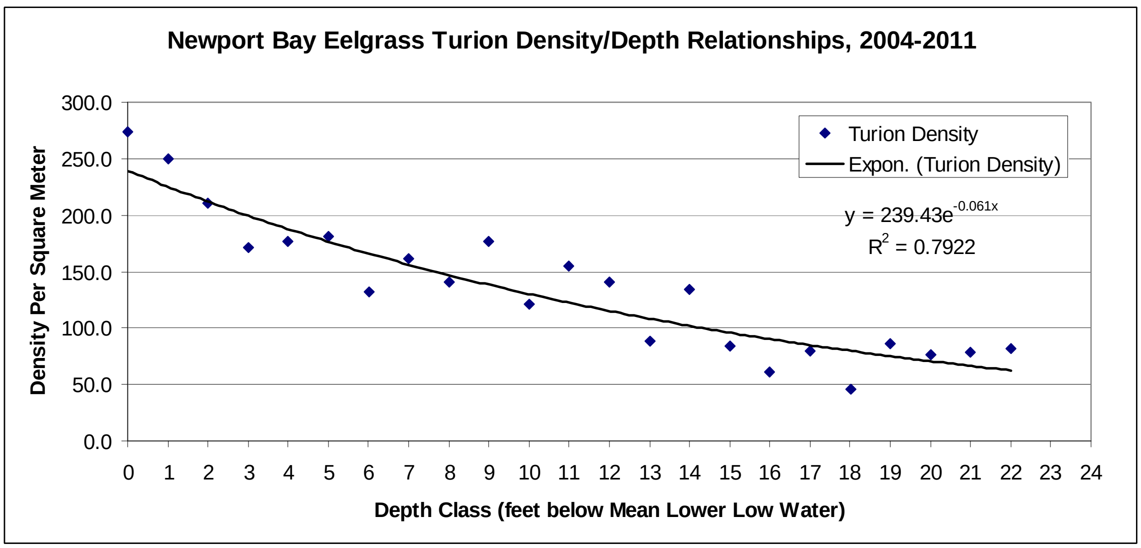


Figure 19. Newport Bay Eelgrass Turion Density/Depth Relationships, 2004-2011

3.6 EELGRASS TURION DENSITY TWO-WAY CLASSIFICATION ANALYSIS

Figure 20 illustrates the relationships between eelgrass regions and eelgrass turion density over the three survey periods between 2003 and 2011. Two temporal groups (1 and 2) and three spatial groups (A-C) were identified. Mean turion density was highest during Survey 1, and significantly greater than in Surveys 2 and 3, which formed the second temporal cluster group.

By region, Site Groups A and B (primarily Transitional Eelgrass Zone Sites) exhibited a higher similarity to each other than to Group C which consisted of Stable Eelgrass Zone sites. Group A consisted of three Transitional Eelgrass Zone Sites and one Stable Eelgrass Zone Site (West Entrance Channel). The grouping of the West Entrance

Channel site with the Transitional sites was a function of lower turion density at a deeper depth in the West Entrance Channel, and these densities were similar to those of the shallower Transitional Zone sites within this group. The Group C sites included all Stable Eelgrass Zone sampling sites between China Cove and the Grand Canal.

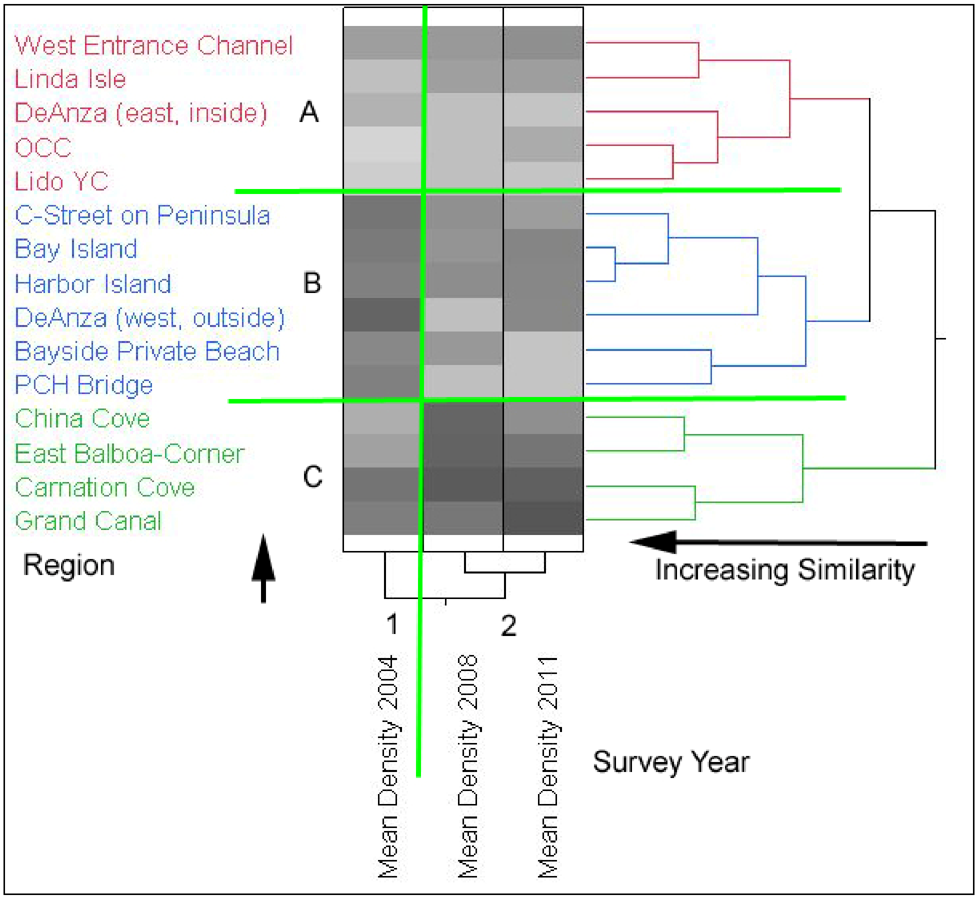


Figure 20. Two-Way Classification Analysis Dendrogram of Newport Bay Eelgrass Turion Density by Sampling Site, 2004-2011

4.0 EELGRASS ZONES IN NEWPORT BAY

Based upon the knowledge obtained during the first and second bay-wide eelgrass surveys conducted between 2003 and 2011 (Coastal Resources Management, Inc. 2010 and this report), the known tidal residence time periods in the bay (Everest International, 2009), and the 2008-2009 oceanographic survey results (Coastal Resources Management, Inc., 2010), eelgrass distribution in Newport Bay can be divided into three zones as shown in Figure 21.

A Stable Eelgrass Zone, where eelgrass distribution appears relatively stable from year-to-year. This zone is primarily located within the Lower Bay and includes the Entrance Channel, the southern and eastern portions of Balboa Island and Grand Canal, Corona del Mar, and the eastern portion of the Balboa Peninsula. This zone is also characterized by

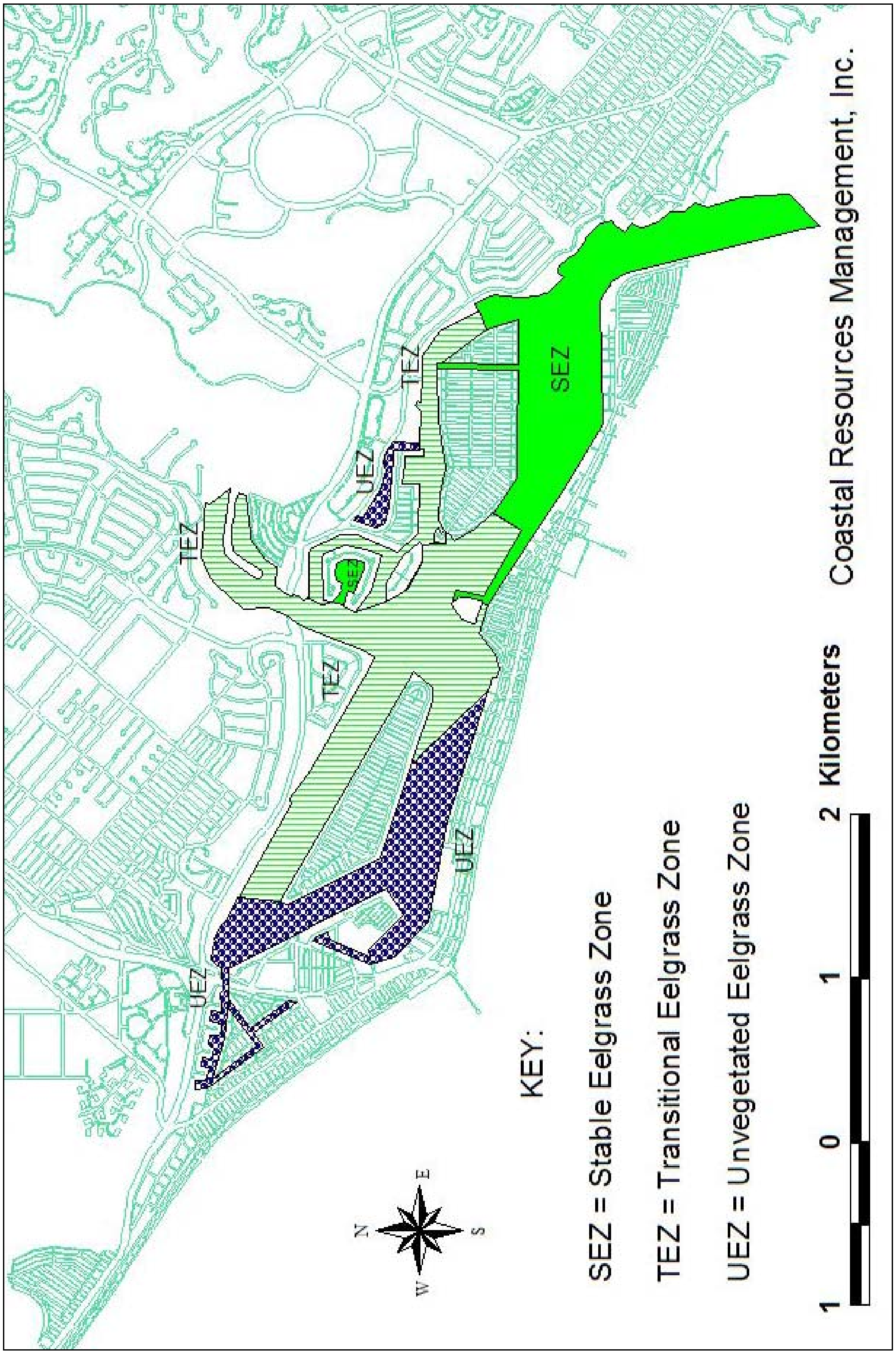


Figure 21. Eelgrass Zones in Newport Bay. Source: CRM (2010)

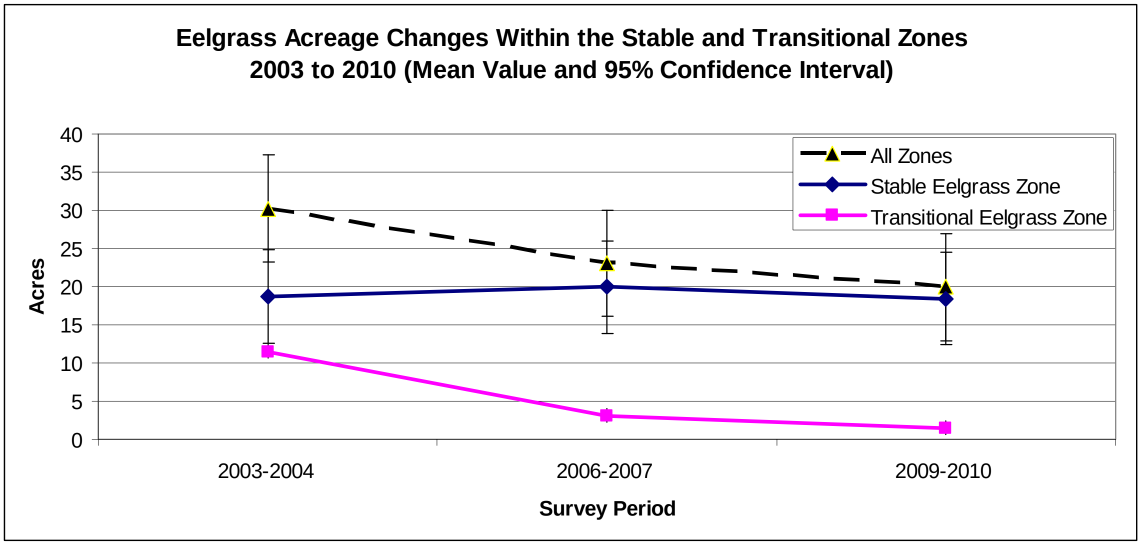
a tidal flushing time of less than 6 days which contributes to the higher water clarity and near-bottom underwater light levels that promote widespread eelgrass growth.

A Transitional Eelgrass Zone where eelgrass is susceptible to year-to-year variation in extent and density. This zone is largely found in the central part of the Lower Bay in areas such as Harbor Island, Linda Isle, the northern and western portions of Balboa Island, and the northern side of the Lido Channel. This zone is characterized by flushing times of 7 to 14 days and is located in a zone influenced by lower water clarity, lower near-bottom light levels heavily influenced by turbidity originating from San Diego Creek discharges during winter months.

An Unvegetated Zone where eelgrass has historically not been found, or is only incidentally found. This zone is located within the western portion of Lower Newport Bay and in Upper Newport Bay above the DeAnza Bayside Peninsula and north of Castaways Park. These areas are characterized by tidal flushing times greater than 14 days.

Eelgrass abundance trends within the Stable and Transitional Eelgrass Zones over time are shown in Figure 22. This graphic illustrates the significant decrease in eelgrass acreage that occurred particularly within the Transitional Eelgrass Zone between surveys conducted between 2003-2004 and the 2006-2007. Data for regions within each of the zones, by survey is provided in Appendix 1.

The distribution of eelgrass within each zone in 2009-2010 was generally consistent with the extent observed during earlier surveys with a single caveat- *the Transitional Eelgrass Zone extended farther east along the shoreline Balboa Islands (including portions of the Grand Canal) into the Stable Eelgrass Zone.* Losses in Region 5-(see Section 3.3.4), totaled 2.0 acres of eelgrass compared to the previous survey conducted between 2006 and 2007. Although overall reduction in eelgrass acreage continued within the Transitional Zone, regrowth was observed in specific regions-the Newport Harbor Yacht Club (Region 7), North Balboa Channel and Yacht Club Basins (Region 8), the DeAnza/Bayside Peninsula (in the UNB Main Channel, Region 13), and Mariners Mile (Region 16, due to an eelgrass transplant was conducted in the OCC Boat Basin).



Eelgrass Acreage Changes Within the Stable and Transitional Zones
2003 to 2010 (Mean Value and 95% Confidence Interval)
40
35
30
25
20
15
10
5
0
Acres
All Zones
Stable Eelgrass Zone
Transitional Eelgrass Zone
2003-2004
2006-2007
2009-2010
Survey Period

Figure 22.

5.0 EELGRASS HABITAT STUDY SUMMARY AND CONCLUSIONS

5.1 EELGRASS DISTRIBUTION AND ABUNDANCE

CRM conducted shallow water eelgrass habitat studies in Newport Bay between 2009 and 2010, and conducted eelgrass turion density surveys in early 2011. No surveys were conducted of deeper (navigational) channels during this period.

A total of 19.92 acres of shallow water eelgrass was mapped in a wide range of sediment types between fine-to-medium sands near the Entrance Channel and to very fine silt in the mid-bay (Harbor and Linda Island), along Mariner's Mile, and in Upper Newport Bay. The amount of shallow water eelgrass mapped in 2009-2010 represented a decline of 10.49 acres (34%) compared to 2003-2004, and a decline of 1.39 acres (13.7%) compared to 2006-2007 (Figure 23). On a longer-term basis, eelgrass acreage in 2009-2010 was comparable to the acreage estimates in 1999. Statistical analysis of the yearly data suggested that the abundance of eelgrass was significantly different between the 18 survey regions and survey years (2003-2004, 2006-2007, and 2009-2010).

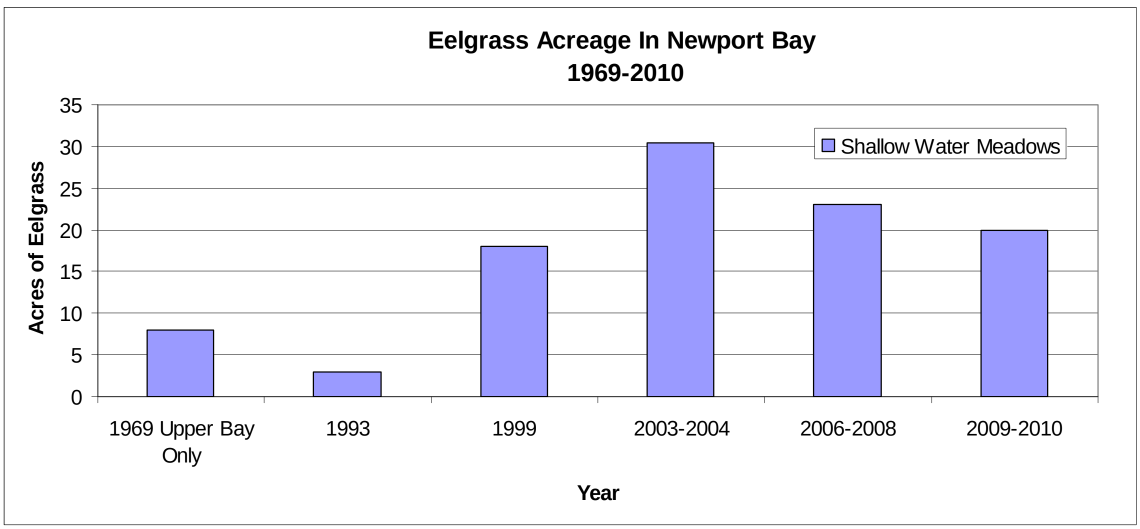


Figure 23.

Sources: Posjepal, 1969; Hoffman, 1993; Chambers Consultants and Coastal Resources Management, 1999; National Marine Fisheries Service, 2003 unpublished data; Coastal Resources Management Inc., 2005, 2010; and Coastal Resources Management, Inc., this report).

The distribution of eelgrass in Newport Bay followed similar patterns as those observed during the previous two surveys-most eelgrass was found in the Stable Eelgrass Zone (the fore bay between Corona del Mar and Balboa Island) with less eelgrass occurring in the Transitional Zone in mid Newport Bay (i.e., the western and northern part of Balboa Island, Bay Island, Harbor, Lido Island and Channels), West Newport Bay, and in Upper

Newport Bay. Some areas of Newport Bay continue to lack eelgrass (most of West Newport Bay and in Upper Newport Bay above the DeAnza Bayside Marsh Peninsula and Castaways Park). Hierarchical clustering techniques (two-way classification techniques) were useful in visualizing the relative abundances of eelgrass within each region over time, and illustrated the similarity of regions to each other within the Stable and Transitional Eelgrass zones.

A substantial decrease of eelgrass occurred within the Inner Linda Isle Basin during the 2009-2010 survey (1.2 acres). This region is still classified as a "Stable" Eelgrass Zone however, since it still contains the 3rd highest amount of eelgrass of all 18 regions surveyed, and is the second highest-ranked area in terms of the amount of eelgrass per linear-mile of shoreline, second only to the Corona del Mar/Bayside Region.

Another significant loss of eelgrass occurred along the Bayshores region between the PCH Bridge and the intersection with Lido Reach, with a loss of nearly 1 acre of vegetation since 2003-2004. Reductions in eelgrass were also observed along the southern shoreline and in the northern portion of Grand Canal.

Despite an overall reduction in eelgrass within both the Stable and Transitional eelgrass zones, increases were recorded in several individual survey regions within the Transitional Zone. These regions included the Newport Harbor Yacht Club (Region 7), North Balboa Channel and Yacht Club Basins (Region 8), the DeAnza/Bayside Peninsula (in the main channel) located in Upper Newport Bay (Region 13), and Mariners Mile (Region 16, due to an eelgrass transplant).

The changes in eelgrass distribution between 2003 and 2011 illustrate the highly dynamic nature of the eelgrass system and that eelgrass distribution and abundance will contract-and-expand particularly in zones that are more susceptible to variation in the physical and chemical environment. The most dynamic area is within the Transitional Eelgrass Zone where oceanographic parameters display greater variation than in the Stable Eelgrass Zone. Patterns in eelgrass abundance in Newport Bay have been correlated particularly to tidal residence time which then influences water temperature, pH, salinity, dissolved oxygen, light luminance, and light energy levels. Particularly important are spatial gradients in underwater light levels and turbidity (Coastal Resources Management, Inc., 2010)

5.2 EELGRASS TURION DENSITY

Eelgrass turion density during March 2011 was the lowest of the three survey periods between 2003 and 2011 (Figure 24) and continued a density decline first observed during the summer 2008 survey. The percent decline however, was much less between 2008 and 2011 than between the 2004 and 2008 surveys.

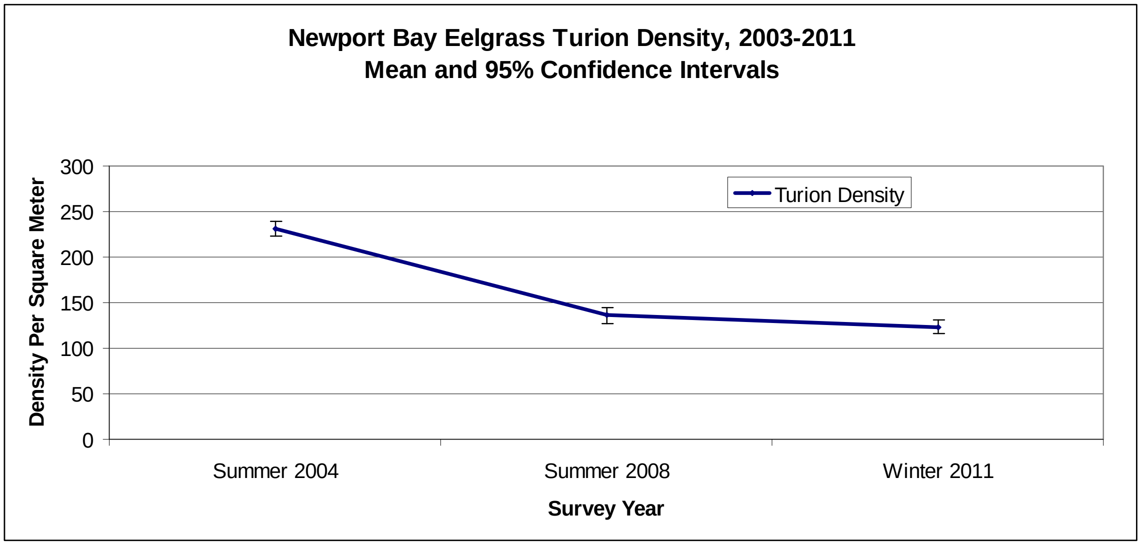


Figure 24.

In March 2011 a decrease in eelgrass turion density was moderately correlated with an increase in depth ($r^2 = 0.44$). Combining all three sets of yearly survey data between 2003 and 2010 however, the correlation between decreasing turion density with an increase in depth was strong ($r^2 = 0.79$). Eelgrass turion density is known to be correlated with light levels, sediments types, and increasing distance away from the Entrance Channel along the tidal residence time gradient (Coastal Resources Management, Inc., 2010).

Hierarchical clustering techniques (two-way classification techniques) were also useful in visualizing the relationships between turion density within and between sites over the three sampling periods. Similar to eelgrass abundance, the two-way classification technique illustrated the similarity (or dissimilarity) of stations within both the Stable and Transitional Eelgrass zones. Statistical analysis of the data indicated that turion density was significantly different between years as well as between stations.

Despite an overall decrease in area-wide eelgrass density, a perceptible increase in eelgrass density was observed in the Transitional Eelgrass Zone at Bay Island, Harbor Island, DeAnza (outer), and in recently transplant zones in the Balboa Marina and in the OCC Boat Basin. Turion density was also higher than in previous surveys in the southern portion of the Grand Canal.

Conversely, eelgrass density slightly decreased in the Entrance Channel, along Carnation Cove (Corona del Mar), along southeastern Balboa Island, and along the eastern section of the Balboa Peninsula. This again illustrates the dynamics and variability of eelgrass within Newport Bay.

6.0 LITERATURE CITED

Anchor EQA, L.P. 2009a. Conceptual development plan. Lower Newport Bay CAD site feasibility study. Prepared for the City of Newport Beach Harbor Resources Division. April 2009. 47 pp.

Anchor EQA. L.P. 2009b. Memorandum: Field investigation results from Lower Newport Bay CAD cell location explorations. June 25th, 2009. 123 pp.

Chambers Group, Inc. and Coastal Resources Management. 1998. Pre-dredging eelgrass survey in Lower Newport Bay. Prepared for the U.S. Army Corps of Engineers. Los Angeles District. 15 pp. plus figures and appendices.

Chambers Group, Inc. and Coastal Resources Management. 1999. Lower Newport Harbor eelgrass restoration project field reconnaissance report. Prepared for the U.S. Army Corps of Engineers. Los Angeles District. 18 pp. plus figures and appendices. August 1999.

City of Newport Beach. 2009. City of Newport Beach Local Coastal Plan. Coastal Land Use Plan. Final Adoption by the California Coastal Commission July 2009.

Coastal Resources Management, Inc. (CRM) 2002. City of Newport Beach Local Coastal Plan. Biological Appendix. Prepared for the City of Newport Beach Planning Department. Various Paging. December 2002.

Coastal Resources Management, Inc. (CRM) 2005. Final report. Distribution and abundance of eelgrass (*Zostera marina*) in Newport Bay. 2003-2004 eelgrass habitat mapping project. Bulkhead to pierhead line surveys. Prepared for the City of Newport Beach Harbor Resources Division. April 2005. 30 pp. Maps on the City website at:

http://www6.city.newport-beach.ca.us/website/InteractiveMap/map.asp

Coastal Resources Management, Inc. (CRM) 2007. Remote video eelgrass and invasive algae survey, Dunes Marina. Prepared for Chambers Group, Inc. 5 November, 2007. 3 pp.

Coastal Resources Management, Inc. 2009 (CRM). Appendix B: Eelgrass capacity and management tools. Prepared for the City of Newport Beach Harbor Resources Division. June 2009. 46 pp.

Coastal Resources Management, Inc. (CRM) 2010. Results of the second Newport Bay eelgrass (*Zostera marina*) bay-wide habitat mapping survey: Status and distribution between 2006-2008 and oceanographic conditions in Newport Bay between 2008 and 2009. Prepared for the City of Newport Beach Harbor

Resources Division. August 18th, 2010. 126 pp. Survey maps on the City website at: **http://www.city.newport-beach.ca.us/gis/gis_main.html**

Coastal Resources Management, Inc. (CRM) 2011a. Balboa Marina eelgrass (*Zostera marina*) transplant survey. Year 2 post-transplant monitoring report. July 2011 survey. Prepared for The Irvine Company. August 4th, 2011. 20 pp.

Coastal Resources Management, Inc. (CRM) 2011b. Orange Coast College School of Sailing and Seamanship Boat Basin. Eelgrass (*Zostera marina*) transplant Year 1 post-transplant monitoring report. Prepared for the Orange Coast College School of Sailing and Seamanship. December 15th, 2011. 21 pp.

Coyer, J. A., K. A. Miller, J. M. Engle, J. Veldsink, A. Cabello-Pasini, W.T. Stam, and J. L. Olsen. Eelgrass meadows in the California Channel Islands and adjacent coast reveal a mosaic of two species, evidence for introgression and variable clonality. Annals of Botany 101: 73–87, 2008

Everest International Consultants. 2009. Appendix F: Hydrodynamic and water quality monitoring requirements technical report for the City of Newport Beach Harbor Area Management Plan (HAMP). Prepared for City of Newport Beach Harbor Resources Division. June 2009. 20 pp.

Foss, Stephen F., P. Ode, M. Sowby, and Marian Ashe. 2007. Non-indigenous aquatic organisms in the coastal waters of California. *California Fish and Game* 93(3):111-129. Summer 2007.

Hartog, C. den. And J. Kuo. 2006. Taxonomy and biogeography of seagrasses. Chapter 1. Pages 1-123 *in:* A.W. Larkum , R. J. Orth, and C. M. Duarte (eds). Seagrasses: Biology, Ecology, and Conservation. Springer, The Netherlands.

MBC Applied Environmental Sciences (MBC). 1987. Mola Development Corporation eelgrass (*Zostera marina*) mitigation project. Transplant monitoring survey results and evaluation of transplant success. Prepared for the Mola Corporation, Huntington Beach, Ca. November, 1987.

MBC Applied Environmental Sciences (MBC). 2004. Army Corps of Engineers Upper Newport Bay eelgrass mitigation project transplant report and monitoring plan", May 2004. Prepared for the U.S. Army Corps of Engineers, Los Angeles District. May 2004.

Mason, H.L. 1957. A Flora of the Southern California Marshes. University of California Press, Berkeley and Los Angeles, Ca. 878 pp,

Merkel and Associates. 2010. Post-construction eelgrass survey in support of the Upper Newport Bay Ecosystem, Restoration Phase 2. Letter report prepared for RDA Contracting, Alameda, Ca. October 5th, 2010. No paging.

National Marine Fisheries Service. 1991. *Southern California Eelgrass Mitigation Policy.* National Marine Fisheries Service, Southwest Region, Long Beach, CA. 11th Revision.

National Marine Fisheries Service. 2003. Newport Bay down-looking sonar survey maps of the harbor entrance channel and Corona del Mar Reach, Newport Harbor. Prepared for the City of Newport Beach Harbor Resources Division. Maps available on City website http://www6.city.newport-beach.ca.us/website/InteractiveMap/map.asp

National Marine Fisheries Service (NMFS). 2008a. Essential Fish Habitat (EFH) evaluation for the Balboa Marina Project, Newport Beach, Ca. February, 2008. Prepared by Robert Hoffman, NMFS, Long Beach, CA. 4 pp.

Phillips, R. C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: A community profile. FWS/OBS-84/24. 85 pp.

Phillips, R.C. and E. G. Menez. 1988. Seagrasses. Smithsonian Contributions to the Marine Sciences: 34.

Phillips, R.C. and S. W. Echeverria. 1990. *Zostera asiatica* Miki on the Pacific Coast of North America. Pacific Science Vol 44 (2):130-134.

Posey, M H. 1988. Community changes associated with the spread of an introduced seagrass, Zostera japonica. Ecology 69(4): 974-983

SAS Institute. 2009. JMP 8 Statistical Discovery Graphics and Statistics Package Software. Ver 8.0.2.

Short, F. T. and S. Wyllie-Echeverria. 1996. Natural and induced disturbances of seagrasses. Environmental Conservation 23:17-27.

Stevenson, R. E., and K. O. Emery. 1958. Marshlands at Newport Bay. Allan Hancock Foundation Publications. Occasional Paper No. 20. University of Southern California Press, Los Angeles, California.

Zimmerman, R. C., L. Reguzzoni, S. Wyllie-Echeverria, M. Josselyn and R. S. Alberte. 1991. Assessment of environmental suitability for growth of *Zostera marina* L. (eelgrass) in San Francisco Bay. Aquatic Botany 39:353-366.

APPENDIX 1. EELGRASS ACREAGES WITHIN EACH REGION AND HABITAT ZONE, 2003-2010

SHALLOW WATER HABITAT*	2003-2004	2006-2007	2009-2010	MEAN (acres)	STANDARD DEVIATION	95% CONFIDENCE LIMITS
STABLE ZONE						
Balboa Island/Collins Isle	0.91	0.51	0.2	0.54	0.36	0.4
Bay Island	0	0	0	0	0	0
Corona del Mar (Bayside)	0.78	0.66	1.77	1.07	0.61	0.69
East Balboa Peninsula	0.16	0.11	0.02	0.1	0.07	0.08
Grand Canal	0	0	0	0	0	0
Linda Isle Inner	0.1	2.62	1.62	1.45	1.27	1.44
Yacht Club/Basins	0.26	0.03	0.11	0.13	0.11	0.13
TOTAL STABLE ZONE	2.21	3.95	3.72	3.29	0.94	1.07
TRANSITIONAL ZONE						
Balboa Island/Collins Isle	0.25	0.06	0	0.1	0.13	0.15
Bay Island	0	0	0	0	0	0
Bayshores	0.26	0.02	0	0.09	0.14	0.16
Castaways	0.13	0	0	0.04	0.08	0.09
Harbor Island	0.5	0.09	0.04	0.21	0.25	0.28
Lido Isle	0	0	0	0	0	0
Inner DeAnza Peninsula	0.21	0.01	0	0.07	0.12	0.13
Linda Isle Inner	0.09	0.09	0	0.06	0.05	0.06
Linda Isle Outer	1.63	0.16	0	0.6	0.89	1.01
Mariners Isle	0	0	0	0	0	0
North Balboa Channel and Yacht Basin	0.04	0	0	0.02	0.03	0.03
West Balboa Peninsula	0	0	0	0	0	0
Outer DeAnza Peninsula	0.77	0	0	0.26	0.44	0.5
Yacht Club/Basins	0.01	0	0	0	0.01	0.01
TOTAL TRANSITIONAL ZONE	3.89	0.43	0.05	1.46	2.11	2.39
	6.1	4.38	3.77	4.75		
SHALLOW WATER EELGRASS TOTALS						
TOTAL STABLE ZONE	18.69	19.95	18.42	19.02	0.82	0.92
TOTAL TRANSITIONAL ZONE	11.5	3.12	1.5	5.37	5.37	6.07
ALL AREAS	30.19	23.07	19.92	24.39	6.19	6.99

*Shallow Water Habitat-all areas surveyed by Coastal Resources Management, Inc. at depths between +1 and approximately +10 to -12 ft MLLW. Includes some areas that are outside of the boundaries of dredging as specified in the ACOE Regional General Permit (RGP) 54. Does not include deeper water navigational channels.

APPENDIX 2. EELGRASS TURION DENSITY DATA, 2004, 2008, AND 2011

2004	**Mean**	**Std dev**	**N**	**95% CI**
West Entrance Channel	198.3	81.6	60.0	20.6
China Cove	173.1	113.8	60.0	28.8
Carnation Cove	273.8	91.6	30.0	32.8
East Balboa-Corner	193.8	54.3	30.0	19.4
C-Street on Peninsula	273.1	104.1	60.0	37.3
Grand Canal	256.7	72.1	30.0	25.8
Bay Island	263.1	94.0	60.0	23.8
Harbor Island	252.9	112.4	60.0	28.4
Linda Isle	144.0	58.3	60.0	14.8
Bayside Private Beach	237.4	148.8	60.0	37.7
PCH Bridge	252.1	82.5	60.0	20.9
DeAnza (east, inside)	165.5	52.2	60.0	13.2
DeAnza (west, outside)	304.3	79.9	60.0	20.2
OCC	94.3	31.8	60.0	8.0
Lido YC	109.8	56.7	60.0	14.4

2008	**Mean**	**Std dev**	**N**	**95% CI**
West Entrance Channel	79.0	30.2	30.0	10.8
China Cove	199.5	119.1	30.0	42.6
Carnation Cove	221.9	97.1	30.0	34.7
East Balboa-Corner	203.3	100.0	30.0	35.8
C-Street on Peninsula	100.5	52.7	30.0	18.9
Grand Canal	156.2	86.0	30.0	30.8
Bay Island	91.4	36.9	30.0	13.2
Harbor Island	105.7	42.0	30.0	15.0
Linda Isle	67.1	29.1	30.0	10.4
East Balboa Mooring 30	68.7	34.8	26.0	12.4
Bayside Private Beach	81.9	58.4	30.0	20.9
PCH Bridge	0.0 (no eelgrass)			
DeAnza (east, inside)	0.0 (no eelgrass)			
DeAnza (west, outside)	0.0 (no eelgrass)			
Lido YC	0.0 (no eelgrass)			
OCC	0.0 (no eelgrass)			

2011	Mean	Std dev	N	95% CI
West Entrance Channel	103.3	46.2	30.0	12.7
China Cove	103.3	69.2	30.0	12.7
Carnation Cove	202.9	71.0	30.0	25.0
East Balboa-Corner	158.1	105.8	30.0	19.5
C-Street on Peninsula	77.1	66.9	30.0	9.5
Grand Canal	225.7	108.4	30.0	27.8
Bay Island	124.8	47.6	30.0	15.4
Harbor Island	121.0	51.8	30.0	14.9
Linda Isle	74.3	27.9	30.0	9.1
East Balboa Mooring 30	71.9	36.9	30.0	8.9
DeAnza (west, outside)	117.6	67.3	30.0	14.5
OCC	50.5	28.8	30.0	6.2
Bayside Private Beach	0.0 (no eelgrass)			
PCH Bridge	0.0 (no eelgrass)			
DeAnza (east, inside)	0.0 (no eelgrass)			
Lido YC	0.0 (no eelgrass)			