RESULTS OF THE FOURTH NEWPORT BAY EELGRASS MAPPING SURVEY: STATUS AND DISTRIBUTION BETWEEN 2012 AND 2014 NEWPORT BEACH, CALIFORNIA



Prepared for:

City of Newport Beach Public Works, Harbor Resources Division
829 Harbor Island Drive, Newport Beach, Ca 92660
Contact: Chris Miller, Harbor Resources Manager
CMiller@newportbeachca.gov (949) 644-3043

Prepared by:

Coastal Resources Management, Inc.
144 N. Loreta Walk, Long Beach, CA 90803
Contact: Rick Ware, Senior Marine Biologist
rware.crm@gmail.com (949) 412-9446

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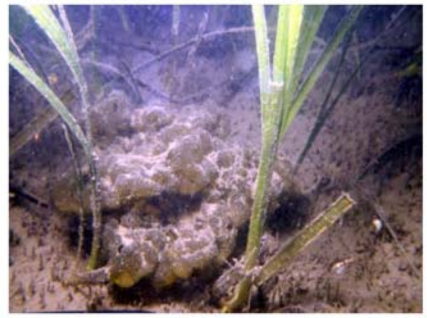

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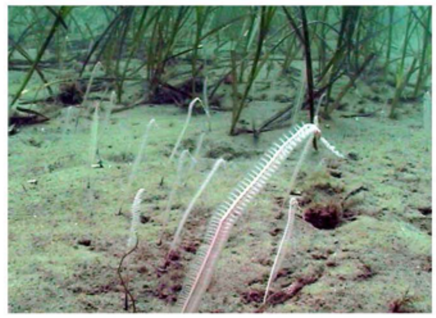

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EXECUTIVE SUMMARY

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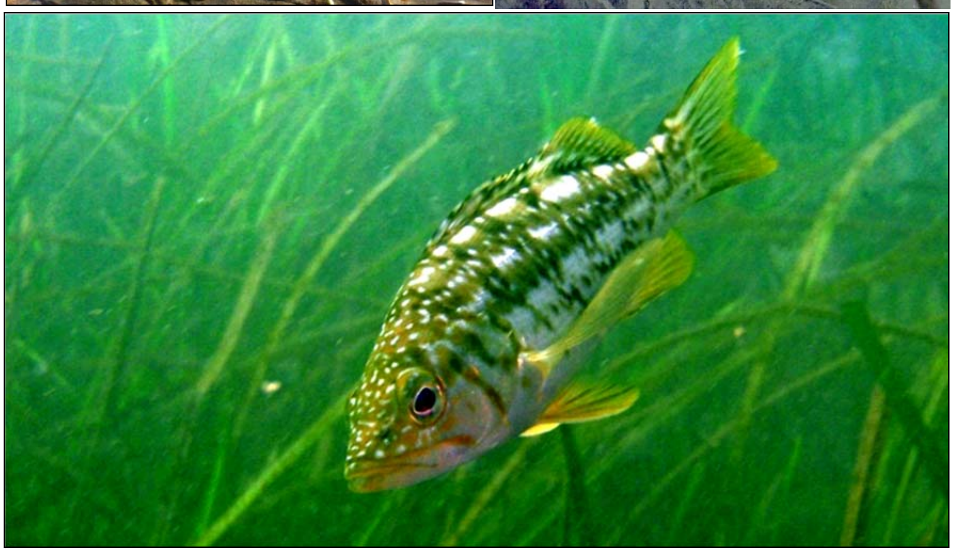

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Eelgrass species (*Zostera marina* and Z. *pacifica*) play an important role in bays and nearshore coastal environments. Among its most important features, eelgrass:

1. Attracts many marine invertebrates and fish to the vegetation's vertical relief and enhances the abundance and the diversity of the marine life compared to areas where the sediments are barren;
2. serves as protective cover for invertebrates and fish;
3. is a fish spawning area and refuge for juvenile fishes including species of commercial and/or sports fish value such as California halibut and barred sand bass;
4. is an important foraging center for seabirds and sea turtles;
5. contributes to the detrital (decaying organic) food web of bays;
6. filters pollutants from the water, absorbs large quantities of the greenhouse gas carbon dioxide from the atmosphere and stores it in the sediments helping to offset carbon emissions; and
7. protects shorelines from erosion by absorbing wave energy.

Shallow Water and Deep Water eelgrass *(Z. marina* and *Z. pacifica*) surveys were conducted in Newport Bay in support of the City of Newport Beach Harbor Area Management Plan (HAMP) between 2012 and 2014. The bay was divided into twenty-one Shallow Water and one Deepwater mapping regions (Figure 1). The results of these surveys indicate eelgrass is common in many parts of Newport Bay and covers 88.27 acres of bottom habitat between the low tide zone to depths of -28.5 feet below Mean Lower Low Water in silt to sandy sediments. The following were key findings of the intensive diver and bioacoustical eelgrass surveys conducted in Lower Newport Bay (Newport Harbor) and Upper Newport Bay between March 2012 and April 2014.

1. A total of 42.35 acres of vegetated Shallow Water Eelgrass Habitat was mapped at depths between 0.0 and -15 feet relative to Mean Lower Low Water (Figure 2).
2. Three regions accounted for 77.6% of all eelgrass in the Bay: Corona del Mar/Bayside Drive (22.372 acres); Balboa and Collins Islands (5.978 acres); and Linda Isle Inner Basin (4.495 acres)
3. Other regions with significant amounts of eelgrass included: Balboa Peninsula east of Bay Island (2.267 acres);Balboa Channel Yacht Basins (2.056 acres);Outer DeAnza/Bayside Peninsula (1.596 acres);Grand Canal (1.062 acres); and Harbor Island (0.991 acre)

4. Lowest eelgrass abundances were found in the western section of Newport Bay in the Lido Reach and Rhine Channel Reach.

5. Eelgrass was absent from the Lido Peninsula and West Newport (west of the Newport Blvd Bridge).

6. Following a period of declining eelgrass abundance in Newport Bay between 2006 and 2010, the amount of Shallow Water eelgrass increased in all regions in Newport Bay to levels not observed since the initial 2003-2004 survey (Figure 3). Significant recolonization occurred around Balboa/Collins Island, Linda Isle Inlet, the DeAnza Bayside Peninsula in Upper Newport Bay, Balboa Peninsula east of Bay Island. Higher acreages along the Corona del Mar shoreline were in part, due to surveying an expanded area in 2014 to include bayfloor to depths of -15 feet that had been mapped as Deep Water Eelgrass Habitat in 2008 and 2012.

7. Based upon eelgrass distributional patterns observed since 2003, eelgrass grows within a Stable and Transitional Eelgrass Zone (Figure 4). The distribution of eelgrass in Newport Bay followed similar patterns as those observed during the previous 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-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. The fluctuating (and expanding boundary) of eelgrass within the Transitional Zone during the 2013-2014 survey was illustrated by eelgrass being mapped farther west along the Balboa Peninsula (west of Bay Island) in the Rhine Channel Reach, and along Mariners' Mile in the Lido Reach than during any earlier survey.

8. A two-way classification analysis (cluster analysis) was used to identify the relationship between eelgrass abundance within each region and among the four surveys. The results indicated a strong relationship between stations within the Stable Eelgrass Zone and a second strong relationship among Transitional Zone eelgrass regions. Analysis by time interval identified discreet differences between the first survey conducted in 2003-2004; the second and third surveys conducted in 2006-2007 and 2009-2010; and the fourth survey conducted in 2013-2014. This analysis provided additional evidence as to the presence of discreet eelgrass zones within Newport Bay.

9. The changes in eelgrass distribution between 2003 and 2014 illustrate the highly dynamic nature of the eelgrass system and that eelgrass distribution and abundance will contract-and-expand particularly in areas of Newport Bay that are more susceptible to variation in the physical and chemical environment.

10. 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.

11. Eelgrass turion (i.e., shoot) density information was collected at 15 sites between March 2013 and January 2014. Bay-wide turion density in 2013-2014 (117 turions per sq meter) was 95% of the value observed during the 2009-2010 survey and 51% of the value recorded during 2003-2004. Overall, turion density was highest in the Entrance Channel and along the Corona del Mar shoreline. Where density counts were taken at the site during August 2013 and January 2014, higher density counts in January 2014 compared to August 2013 may indicate a regrowth following a period of eelgrass turion density reduction in the Bay.

12. Turion density was moderately correlated to depth. However, the correlation was weaker than in prior surveys particularly at shallower bay depths.

13. Bioacoustical mapping methods using sidescan sonar to map eelgrass on the bayfloor of the Entrance Channel, Corona del Mar Bend, and Balboa Reach in March 2012 quantified 45.92 acres of eelgrass at depths between -15 and -28.5 ft MLLW. This acreage corresponds with the CRM 2008 survey when a total of 45.86 acres of eelgrass was mapped in the same area. Both the wide-bladed form (*Z. pacifica*) and the narrow-bladed form (*Z. marina*) were found in these areas, with *Z. pacifica* primarily occupying the deeper portions of the Entrance Channel and Corona del Mar Bend.

Executive Summary

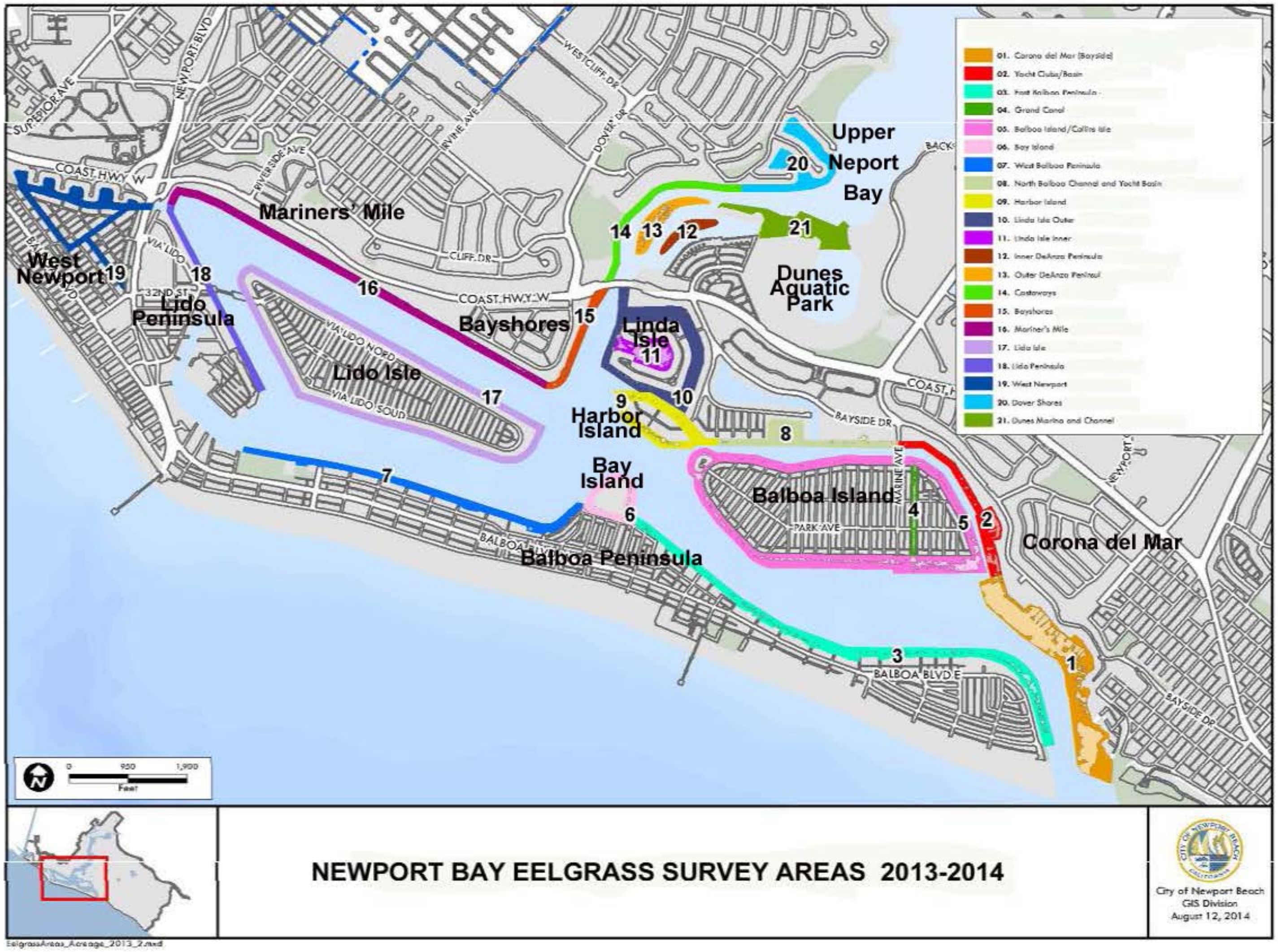


Figure 1

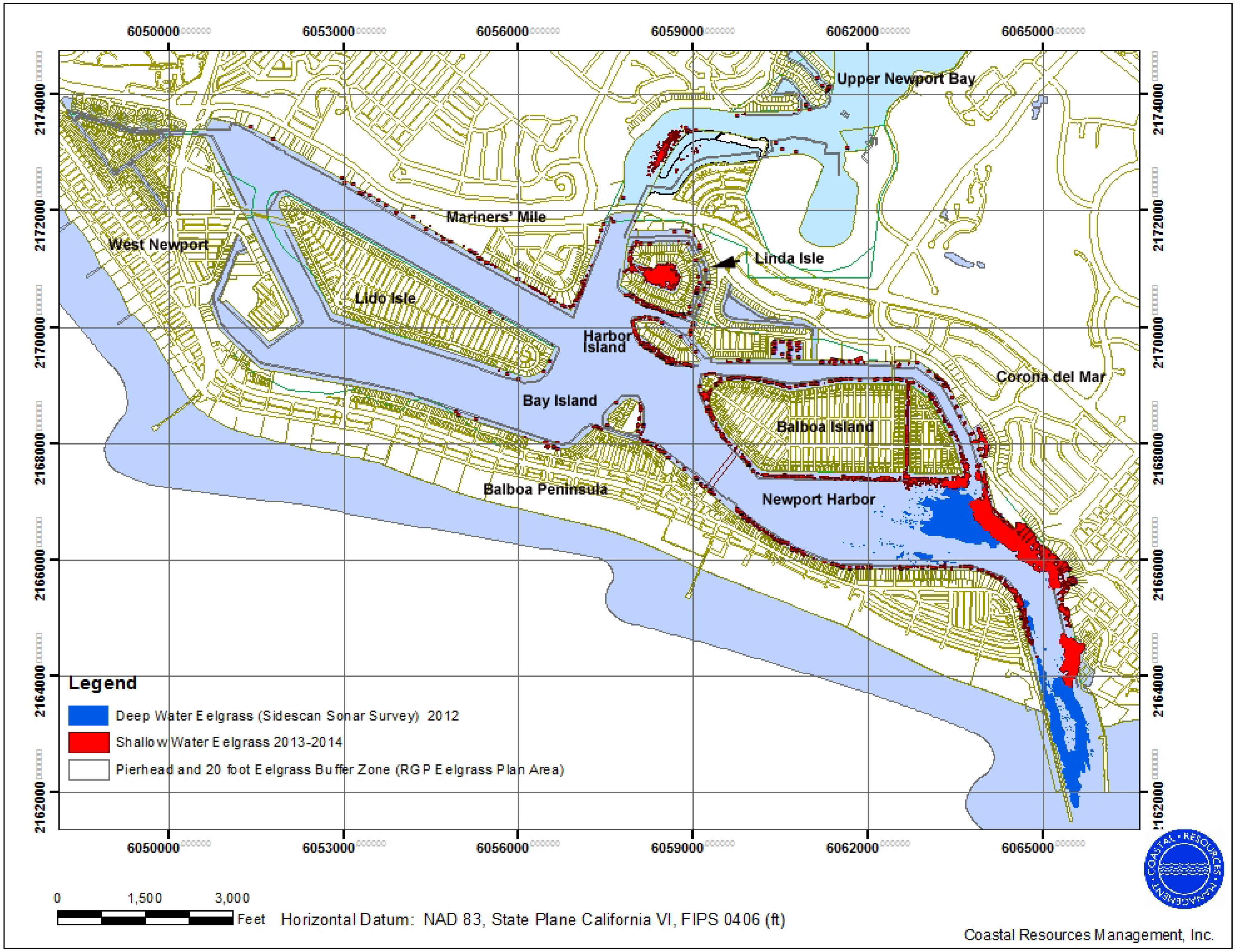
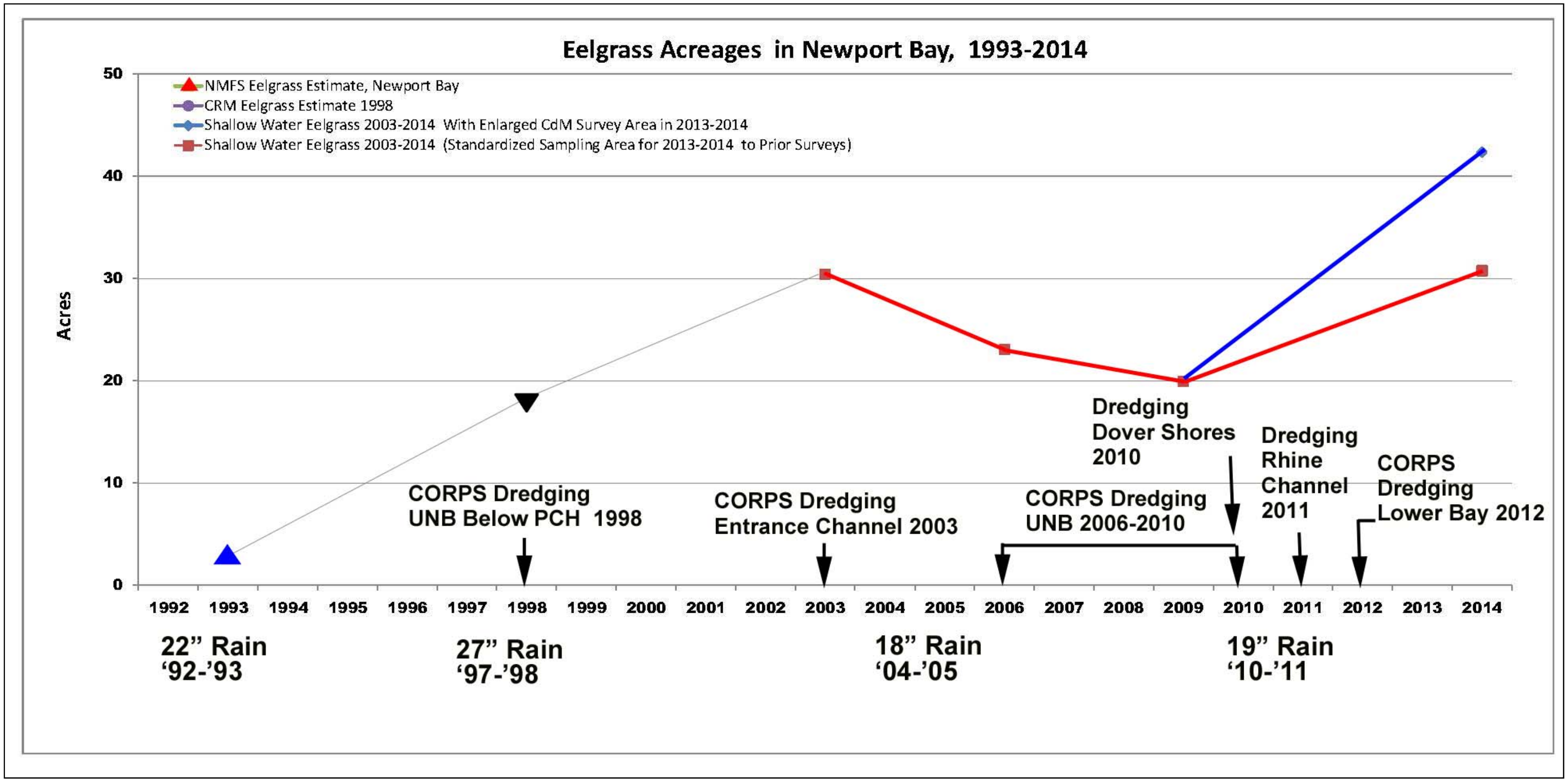


Figure 2. Shallow Water and Deep Water Eelgrass Habitat Map. 2012-2014 Surveys



Eelgrass Acreages in Newport Bay, 1993-2014
NMFS Eelgrass Estimate, Newport Bay
CRM Eelgrass Estimate 1998
Shallow Water Eelgrass 2003-2014 With Enlarged CdM Survey Area in 2013-2014
Shallow Water Eelgrass 2003-2014 (Standardized Sampling Area for 2013-2014 to Prior Surveys)
Acres
50
40
30
20
10
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
CORPS Dredging UNB Below PCH 1998
CORPS Dredging Entrance Channel 2003
CORPS Dredging UNB 2006-2010
Dredging Dover Shores 2010
Dredging Rhine Channel 2011
CORPS Dredging Lower Bay 2012
22” Rain ‘92-’93
27” Rain ‘97-’98
18” Rain ‘04-’05
19” Rain ‘10-’11

Figure 3

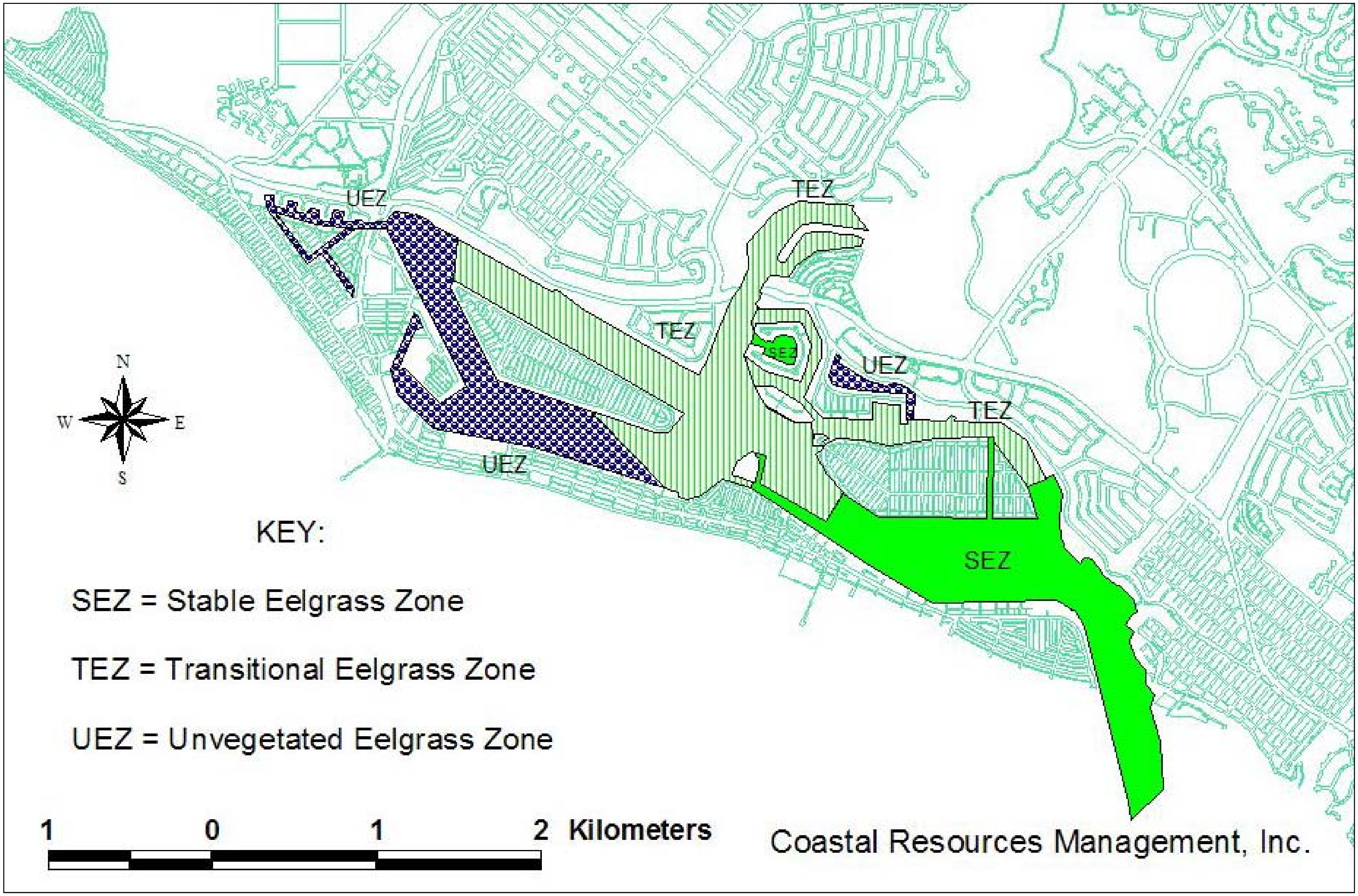


Figure 4. Eelgrass Zones In Newport Bay

1. INTRODUCTION

As part of the ongoing investigations to identify the distribution and abundance of eelgrass in Newport Bay, Coastal Resources Management Inc., under contract to the City of Newport Beach, California conducted Bay-Wide eelgrass mapping surveys in Newport Bay, between March 2012 and April 2014. The March 2012 survey consisted of mapping Deep Water Eelgrass Habitat (DWEH) in the Newport Harbor Entrance Channel and Balboa Island Reach. Shallow Water Eelgrass Habitat (SWEH) was mapped between March 2013 and February 2014, with two mapping regions added by the City of Newport Beach in April 2014. This is the fourth in a series of SWEH investigations in support of the City of Newport Beach Harbor Area Management Plan (HAMP), and the second City DWEH mapping survey. Previous eelgrass habitat assessments were conducted in 2003-2004 (Coastal Resources Management, Inc. 2005), 2006-2008 (Coastal Resources Management, Inc. 2010), and 2009-2010 (Coastal Resources Management, Inc. (2012).

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. This data base of information is assisting the City in managing the bay's eelgrass resources as mandated in the City's Harbor Area Management Plan (City of Newport Beach, 2009). 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 by utilizing the City's online GIS eelgrass habitat database.

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 (2006-2007), 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).

Year 3 Survey Summary. A total of 19.92 acres of shallow water eelgrass was mapped between 2009 and 2010. The amount of eelgrass present in 2009-2010 represented 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. Turion density averaged 123.5

and ranged between 14.3 and 629 turions per sq m. CRM and Nearshore and Wetland Surveys (NWS) also conducted mapping surveys in the Harbor Entrance Channel and navigational channels leading into Newport Harbor using sidescan sonar and mapped 45.4 acres of deep water eelgrass to depths of -28 ft MLLW.

Based upon the patterns of eelgrass distribution and turion density, 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 2003-2010 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, Costa Mesa to the north, 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 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.

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 periodically dredged (Anchor QEA, 2009). Some areas 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. Subsequently, Newport Harbor federal navigational waterways were dredged in 2012 and early 2013 over a 9-month period when over 600,000 cubic yards of sediment were barged out of the harbor, including 120,000 cubic yards of contaminated sediment that were used as fill for the Port of Long Beach Middle Harbor Fill Project (City of Newport Beach Harbor Resources Division; Orange County Register, Feb 13, 2013). As an add-on to this project by the County of Orange and the City of Newport Beach, channels around Linda Isle and Harbor Island were dredged and 0.5 acre of eelgrass was impacted. An eelgrass transplant program was then implemented to mitigate the loss in the Main Channel of Newport Harbor near Corona del Mar.

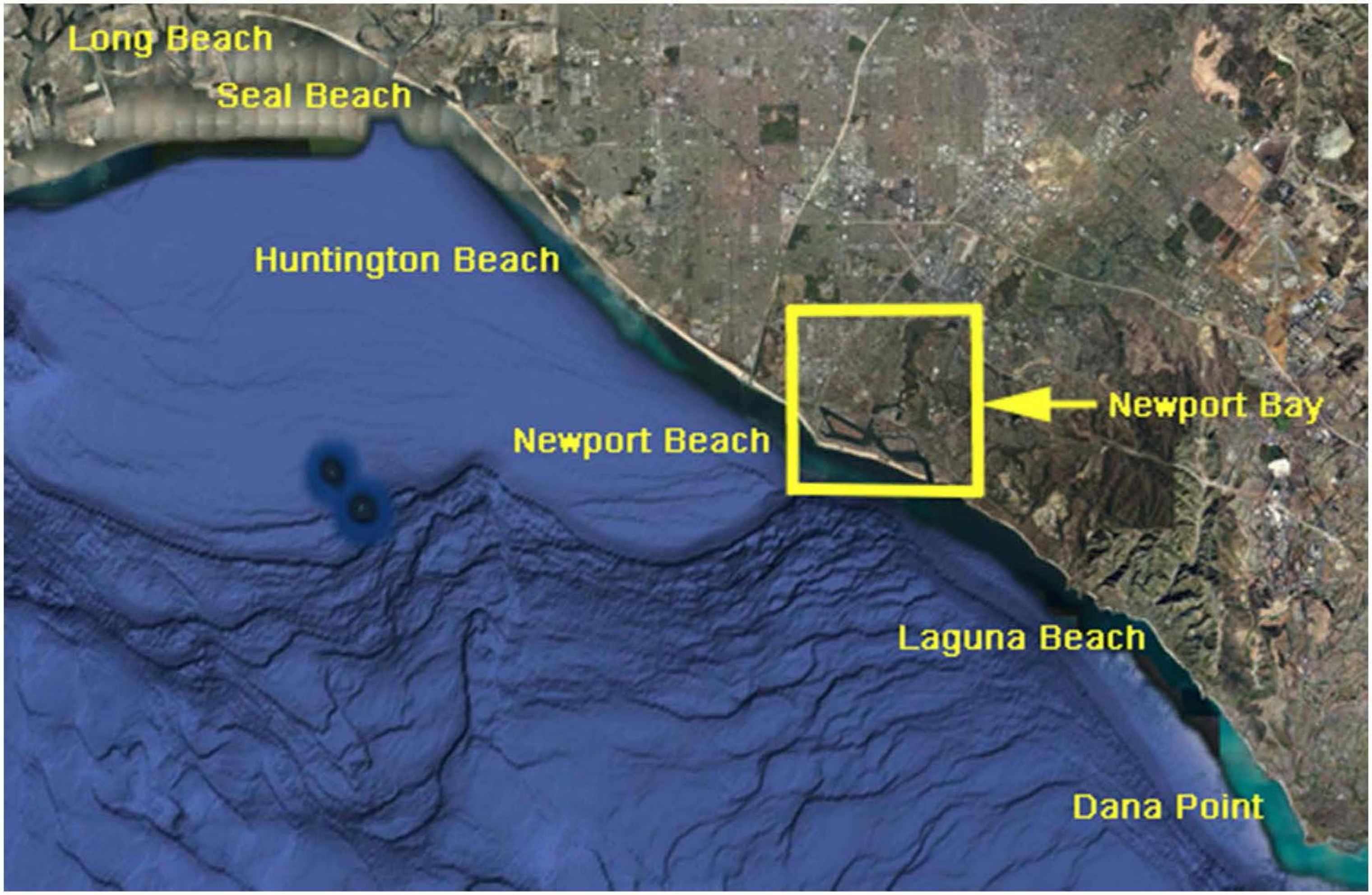


Figure 1. Regional Setting

Upper Newport Bay. 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. This watershed is the major contributor of suspended sediments, nutrients, and other pollutants to the Newport Bay ecosystem (http://ocwatersheds.com/programs/ourws/wmaareas/wmacentraloc)

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 State Marine Conservation Area. 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 has been dredged and filled since the early 1900's for housing development, recreational swimming, marinas, and a boat launch ramp.

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 AND ITS IMPORTANCE

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* (Photograph 1) is more commonly found between the low intertidal zone and depths of two to three 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). *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., 2005, 2010, 2012).

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

Seagrasses are one of the most productive and valuable resources on Earth but one of the most threatened habitats worldwide due to dredging, filling, and pollution (Waycott et al, 2009). Economically, eelgrass is more than twice as important as salt marsh or mangrove, and three to eight times as important as coral reef and tropical rain forest, based upon commercial and recreational fisheries, jobs, tourism, and other economic indicators (Duarte et al, 2008 and Costanza, 1997). From a local recreational standpoint, eelgrass meadows in Newport Bay provide sport fishing opportunities. This translates into a consistent economic base for businesses within Orange County including the recreational fishing industry, boat and automobile fuel, boat and kayak rental/retail stores, and food concessions.

Like all plants, eelgrass produces oxygen as a by-product of photosynthesis. Eelgrass meadows increase the level of dissolved oxygen in the water contributing to the abundance of fish and other marine life. Eelgrass provides an added vertical component to a mostly featureless, soft bottom habitat. It attracts microbes, algae, invertebrates (including lobsters, crabs, worms, snails and clams) and fishes. Some fish (such as pipefish and kelpfish) are long-term residents in the eelgrass meadows. Others (such as barred sand bass, spotted sand bass, and California halibut) utilize eelgrass during their juvenile life stages. Still others (such as topsmelt, anchovy, perch, round sting rays and kelp bass) seek food in the meadow on a daily or opportunistic basis. The abundance of fish provides an important feeding opportunity for foraging seabirds including the endangered California least tern. Green sea turtles although rare in southern California

In addition to providing shelter for marine life, eelgrass enhances seafloor stability and baffles water flow. Its dense intertwined rhizome system forms a strong mat that penetrates the bottom and secures the plant and sediment against movement. Its upright blades form a three-dimensional baffle in the water that softens the impact of waves and currents preventing coastal erosion and providing a calm space where organic matter and sediments are deposited.

The importance of this fishery habitat potentially 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.

1.5 EELGRASS REGULATORY SETTING

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. Eelgrass is considered a protected resource by California Department of Fish and Game, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service although it does not have a formal listing as a state-or-federal rare, sensitive, endangered, or candidate species. Additional protection is afforded under both State and local City of Newport Beach codes and plans.

1.5.1 Federal Legislation. 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).

1.5.2 National Marine Fisheries Service Mitigation Policies. 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 defined measures to mitigate eelgrass habitat losses in the Southern California Eelgrass Mitigation Policy (National Marine Fisheries Service 1991 as amended).

This policy was revised between 2012 and 2014 and is now known as the California Eelgrass Mitigation Policy (NOAA Fisheries, West Coast Region 2014). The intent of the "CEMP" is to help ensure consistent and effective mitigation of unavoidable impacts to eelgrass habitat throughout NOAA's South Western Region. The CEMP is a unified policy document based on the highly successful implementation of the Southern California Eelgrass Mitigation Policy, which has improved mitigation effectiveness since its initial adoption in 1991.

5.1.3 California Department of Fish and Game Regulations

2014 Department of Fish and Game Ocean Fishing Regulations. Section 4 Ocean Fishing. Non Commercial Use of Plants. Section **30.00**. Kelp General. (a) Except as provided in this section and in Section 30.10 there is no closed season, closed hours or minimum size limit for any species of marine aquatic plant. The daily bag limit on all marine aquatic plants for which the take is authorized, except as provided in Section 28.60, is 10 pounds wet weight in the aggregate. (b) Marine aquatic plants may not be cut or harvested in state marine reserves. Regulations within state marine conservation areas and state marine parks may prohibit cutting or harvesting of marine aquatic plants per sub-section 632(b). 30.10. Prohibited Species. No eelgrass (*Zostera*), surf grass (*Phyllospadix*), or sea palm (*Postelsia*) may be cut or disturbed.

California Code of Regulations, Title 14, 650. Natural Resources. Division 1. Fish and Game Commission-Department of Fish and Game. Subdivision 3, General Regulations. Chapter 1. Collecting Permits

(a) General. Except as otherwise provided, it is unlawful to take or possess marine plants, live or dead birds, mammals, fishes, amphibians, or reptiles for scientific, educational, or propagation purposes except as authorized by a permit issued by the department.

1.5.4 City of Newport Beach Policies. 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).

In 2013, the City of Newport Beach prepared a Newport Bay-specific eelgrass mitigation plan entitled *"Draft **Eelgrass Protection and Mitigation Plan for Shallow Waters in Lower Newport Bay**"* (City of Newport Beach, 2013). The Plan is an outcome of the City of Newport Beach Harbor Area Management Plan (HAMP), as issued in April 2010 and approved by City Council in November 2010. The HAMP established goals and best management practices (BMPs) to ensure a healthy eelgrass population within Newport Harbor, including the development of the Plan (City of Newport Beach, 2013). The Plan will serve the principal goals of protecting and promoting a long-term sustainable eelgrass population while serving Lower Newport Bay's navigational and recreational beneficial uses. The touchstone of the Plan is an ecosystem-based approach that works by protecting a sustainable eelgrass population in the Lower Newport Bay and enforcing BMPs that will promote eelgrass growth. The purpose of this document is to describe an approach (the Plan) to eelgrass *(Zostera marina*) protection and mitigation within Newport Harbor for maintenance dredging activities associated with residential and small commercial docks. The Plan focuses on the shallow water eelgrass protection and mitigation measures associated minor maintenance dredging under and adjacent to currently authorized private, public, and commercial docks, floats, and piers. Dredging depth is not to exceed -10 feet mean lower low water (MLLW; plus 2 feet of allowable over depth). This document is currently in the review stages by State and Federal agencies and as of November 2014, has not yet been implemented by the City.

2.0 METHODS AND MATERIALS

2.1 PROJECT STAFF

The eelgrass survey team included CRM Senior Marine Biologist Rick Ware (Principal Investigator/Senior Marine Biologist, M.A. Biology); Tom Gerlinger (Marine Biologist, M.A. Biology); Amanda Bird (Marine Biologist, B.S. Biology/M.A candidate); Mike Anghera (Marine Biologist, B.A. Aquatic Biology); Nick DaSilva (Marine Biologist, B.A, Aquatic Biology); and Rick Hollar (Senior Hydrographic Engineer, Nearshore and Wetland Surveys, M.S. Engineering). Mr. Hollar was the principal investigator for sidescan sonar surveys. Mr. Ryan Stadlman and Mr. Jordan Baltiera (City of Newport Beach GIS Department) assisted CRM and made the GIS data available to the public by uploading the maps to the City's website. Michael Josselyn (PhD) and Chris Zumwalt of WRA Associates provided additional GIS assistance. Chris Miller (City of Newport Beach Harbor Resources Manager) and Tom Rossmiller (Harbor Resources Manager, 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). The project area included the intertidal and subtidal soft bottom habitats of Lower Newport Bay (Newport Harbor) and the southern reach of Upper Newport. Eelgrass surveys were conducted within two eelgrass depth regimes: (1) ***Shallow Water Eelgrass Habitat (SWEH)*** defined as between the intertidal zone to a depth of -15 feet (ft) Mean Lower Low Water (MLLW) and (2) ***Deep Water Eelgrass Habitat*** **(DWEH)** defined as the eelgrass zone from -15 to -28 ft MLLW that included the Newport Harbor Entrance Channel and the Balboa Reach located in the Federal Navigational Channel. For acreage accounting purposes, the Bay was divided into 21 SWEH mapping regions (Figure 2). In 2013-2014, CRM enlarged the survey area for eelgrass in Regions 1 and 5 (Corona del Mar/Bayside and Balboa Island) to document the extent of eelgrass in SWEH surveyed previously as part of the DWEH study within the 15 ft depth contour.

2.3 SURVEY DATES

Deepwater Eelgrass Habitat surveys were conducted in March 2012. Shallow Water Eelgrass Habitat mapping surveys were conducted between March 31st 2013 and April 10th, 2014. Eelgrass turion density studies were conducted between March 2013 and January 2014.

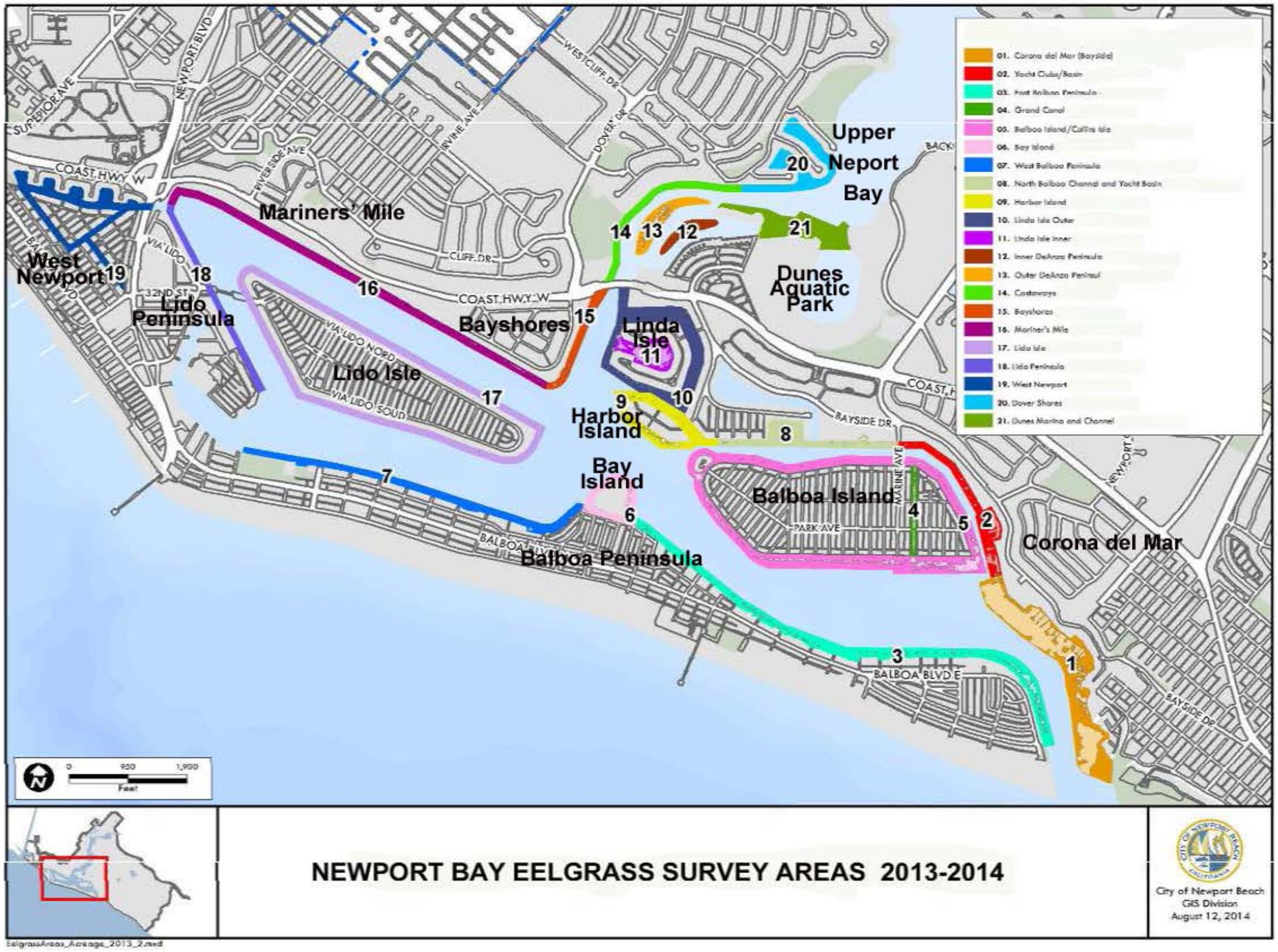

NEWPORT BAY EELGRASS SURVEY AREAS 2013-2014
01. Corona del Mar (Bayside)
02. Yacht Clubs/Basin
03. East Balboa Peninsula
04. Grand Canal
05. Balboa Island/Collins Isle
06. Bay Island
07. West Balboa Peninsula
08. North Balboa Channel and Yacht Basin
09. Harbor Island
10. Linda Isle Outer
11. Linda Isle Inner
12. Inner DeAnza Peninsula
13. Outer DeAnza Peninsul
14. Castaways
15. Bayshores
16. Mariner's Mile
17. Lido Isle
18. Lido Peninsula
19. West Newport
20. Dover Shores
21. Dunes Marina and Channel
Upper Neport Bay
Mariners' Mile
West Newport
Lido Peninsula
Lido Isle
Bayshores
Linda Isle
Dunes Aquatic Park
Harbor Island
Bay Island
Balboa Island
Balboa Peninsula
Corona del Mar
COAST HWY W
CLIFF DR
VIA LIDO NORD
VIA LIDO SOUD
BAYSIDE DR
MARINE AVE
PARK AVE
BALBOA BLVD E
NEWPORT BLVD
WESTCLIFF DR
DOVER DR
IRVINE AVE
RIVERSIDE AVE
SUPERIOR AVE
32ND ST
VIA LIDO
City of Newport Beach
GIS Division
August 12, 2014
Feet

Figure 2

2.4 EELGRASS SURVEY METHODS

Three methods were used to map eelgrass during the mapping surveys. For SWEH, the primary method utilized biologist-divers using SCUBA and a surface support vessel equipped with GPS to outline eelgrass bed areas. In most regions, diver surveys included the bayfloor from the low intertidal zone to about 30 feet past the end of docks and piers except where the pierhead line was irregular such as along Carnation and China Cove where the shallow water eelgrass bed formed a continuum with the deeper Navigational Channel eelgrass bed.

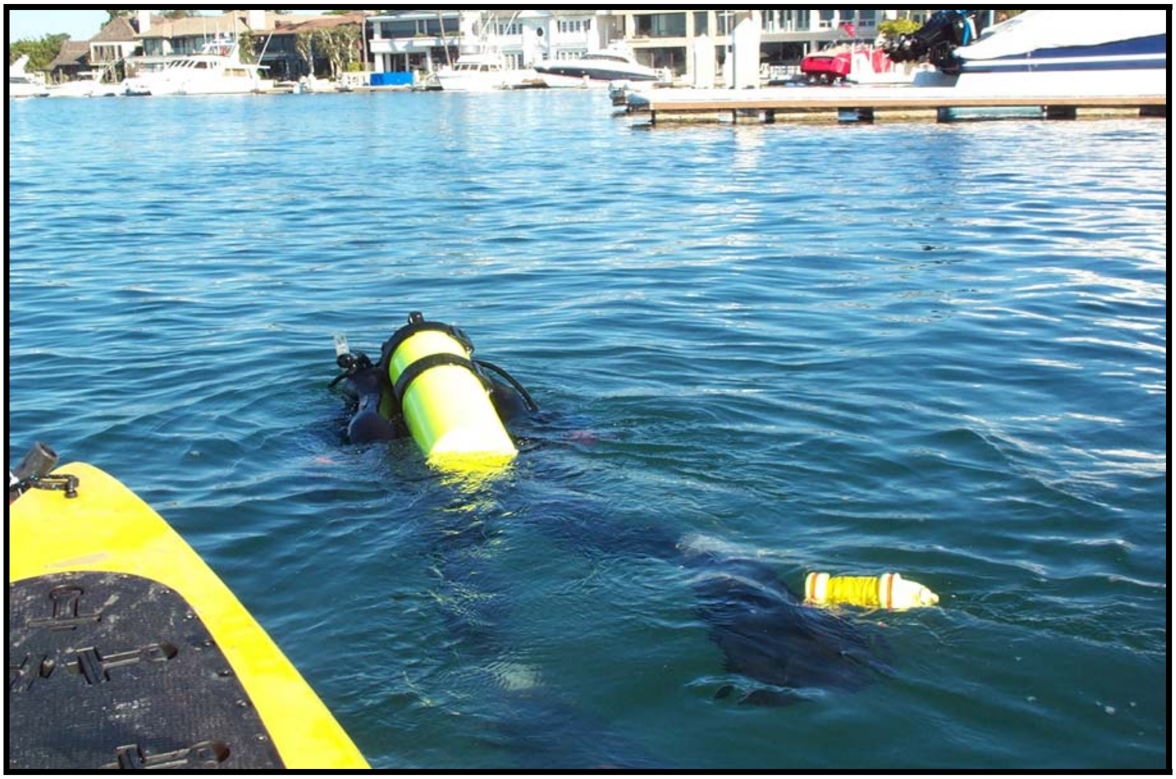
Remote sensing techniques (downlooking and sidescan sonar) were used also used to survey for eelgrass. Downlooking sonar was used to augment the shallow eelgrass surveys generally within the -6 to -15 ft contours in the Main Channel along shoreline of Balboa Island and Corona del Mar where diver survey areas were either extremely large and/or where dive conditions were considered hazardous due to currents or vessel traffic. Sidescan sonar surveys were conducted in Deep Water Habitat in the Newport Harbor Entrance Channel and the Balboa Reach.

2.4.1 Shallow Water Eelgrass Habitat (SWEH) 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. An Ocean Technology Systems (OTS) surface-to-diver communications system was used to assist in the mapping process and for diver safety. 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 one 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 one-to-three meters. Biologist divers first conducted transect surveys within an area. Where eelgrass was located, 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 (defined as between one-to-three square meters in size) 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,



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

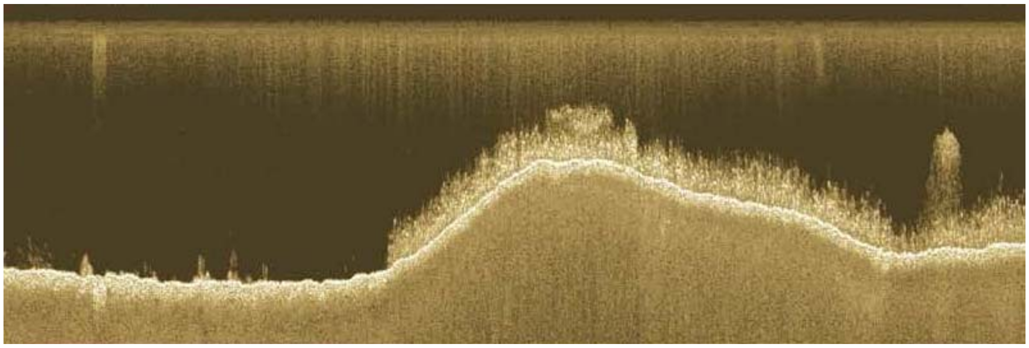
between 18 and 30 eelgrass turion counts were made at each of 15 stations throughout the study area by SCUBA-diving biologists who counted the number of live, green shoots at the sediment/shoot interface within replicated 0.07 square meter (sq m) quadrats. These counts were conducted along an underwater 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 SWEH and Deepwater Eelgrass Habitat (DWEH) Downlooking Sonar Surveys

CRM's Lowrance HDS-12 Gen2 Touch Chartplotter was used to remotely and acoustically collect data on bottom depth, subsurface features, and subsurface vegetation from the unit's 200 kHz transducer acoustic signal associated with a WAAS-corrected GPS position. Downlooking and sidescan sonar techniques were used to augment the diver mapping surveys in the larger SWEH areas and/or and in SWEH navigational areas considered a risk to divers (Regions 1, 5, 11, 12, 13, 19, 20, and 2). Lastly, downlooking and sidescan sonar techniques were also used to update the CRM and Nearshore and Wetland Surveys Deep Water Habitat March 2012 sidescan sonar survey. A 455/800 kHz transducer and power module with duel channels (structure scan and down-looking) provided a 180 degree view of the seafloor. A representative downlooking sonar view is shown in Photograph 6. Data were logged on the 800 kHz channel. Data analyses were performed using cloud-based software models and statistical algorithms incorporated into ciBioBase developed by Contour Innovations, LLC, St. Paul, Minnesota (Contour Innovations LLC 2013; http://www.cibiobase.com).



Photograph 6. Downlooking Sonar Image. Low density and high density eelgrass is shown as well as a school of fish above the eelgrass.

Therefore, the attribute value (e.g., depth and plant height) of each data point along a traveled path comprised a summary of 5-30 pings. Each ping went through a quality test to determine whether features can be extracted and if so, sent on to feature detection algorithms. Those failing quality assurance tests were removed from the set considered for summarization. Acoustic (traditional, downlooking, and sidescan) and GPS signals were logged to data storage cards (.sl2 format).

Following the completion of the bioacoustical survey, CRM conducted Remote Underwater Video (RUV) surveys to identify targets obtained by the bioacoustical equipment. The camera system was an Ocean Systems, Inc. Deep Blue Professional Grade Underwater Video Camera ("Splash Cam") attached to a military-grade umbilical cable (). The camera dimensions were 3" diameter wide and 3.5" long. The unit's resolution was 540 TV lines, the CCD was a 1/3" Sony Super HAD, and the focus was fixed 1 inch to focal infinity. The lens was a 3.6 mm wide angle lens. It is designed to operate in super low light conditions. Real-time observations of the were collected along the pre-determined tracks that were used for the bioacoustical surveys.

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

In addition to the RUV survey, diver-biologists were also used to (1) ground-truth areas mapped by bioacoustical methods (2) to verify or eliminate selected underwater targets.

2.4.5 Sidescan Sonar Surveys

Coastal Resources Management, Inc. and Nearshore and Wetlands Surveys (NWS) conducted sidescan sonar/remote video surveys in March 2012. The bottom survey was based on the use of an Imagenex 881 Sportscan sidescan sonar "fish" (Photograph 8). 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 sidescan 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 sidescan 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 sidescan 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 sidescan 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 sidescan 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. After the equipment had been installed, integrated, and tested, the data collection began. Position, sidescan, 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 sidescan 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 sidescan sonar 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 sidescan sonar system. Therefore, an additional field day was used to locate and identify the sidescan 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.

Photograph 8. Imagenex 881 Sportscan Sidescan Sonar Towfish

2.5 DATA PROCESSING

2.5.1 Eelgrass Habitat Maps

Diver-collected data were downloaded into a laptop computer and using Geographic Information Systems Software (Thales Mobile Mapping Software, GPS PRO Tracker, and ArcView 10.1). 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, 21 eelgrass "regions" (Figure 2) were developed. 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. Eelgrass areal cover is reported in English (acre) units.

Acreage conversion to square feet:
Multiply "x" acres by 43,560

Acreage conversion to square meters
Multiply "x" acres by 4038.327

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 the survey regions within and between each of the four survey periods. Graphics and statistics were prepared with Excel 2003, and SAS JMP 8 Statistical Discovery Graphics and Statistics Package software.

2.5.3 Vegetation Detection Using Bioacoustical Mapping Methods

Data from the downlooking sonar survey were uploaded to Contour Innovations' LLC centralized cloud servers for analysis. Acoustic signals from HDS 200 kHz transducers traveled through eelgrass (SUV, submerged aquatic vegetation) on their way to bottom. The distance between the seafloor acoustic signature and top of the plant canopy was recorded as the plant height for each ping.

CRM implemented the following data limit and filter:

Plant height point data included for analysis was limited to a range between 0.5 feet and 3 feet which is a good approximation of subtidal occurring developed eelgrass beds in southern California bays (R. Ware personal observations). This range eliminates bioacoustic returns of bottom-occurring red and green algae that may also be present in the survey area. Combined with the results of diver and video target verification, the filtered data were then outputted into ArcGIS 10.1 for map production. Final maps were refined based upon a review of the bioacoustic target verification information, diver observations, and preliminary bioacoustic map outputs. All generated eelgrass polygons were projected in NAD 83 (feet), California Zone VI FIPS 0406).

2.5.4 Sidescan Sonar Data

Sidescan sonar data were processed 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 ArcGIS 10.1. Eelgrass polygons were developed based upon the identifiable eelgrass locations observed within the photomosaics. All generated eelgrass polygons were projected in NAD 83 (feet), California Zone VI FIPS 0406 (survey ft).

3.0 EELGRASS HABITAT MAPPING SURVEY RESULTS AND DISCUSSION

Eelgrass habitat mapping surveys were conducted during 45 field days between March 31st 2013 and April 10th, 2014. Surveys were conducted using a combination of diver/GPS mapping techniques and bioacoustical mapping surveys. Twenty one 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 2013 and January 2014. Habitat survey maps for prior CRM eelgrass habitat mapping surveys conducted between 2003 and 2010 are provided in Coastal Resources Management, Inc. (2005, 2010, and 2012) and are also available online along with the current survey maps at the City of Newport Beach's website at:

http://www.newportbeachca.gov/index.aspx?page=903

3.1 UNDERWATER VISIBILITY MEASUREMENTS

Under water visibility (horizontal measurements) was regularly recorded by CRM diver-biologists between 2003 and 2013. Average bottom water visibility during the 2013-2014 survey was 3.7 +/ 2.7 ft (n=46 observations). Over the four surveys, underwater visibility varied between a low of 3.3 ft in 2006-2008 and a high of 5.5 ft in 2003-2004 (Figure 3a). By survey zone (Figure 3b), visibility averages were highest in the Newport Harbor Entrance Channel, along the Corona del Mar shoreline, Mariners' Mile/Bayshores, the East Balboa Channel, and Lido Isle. Mean underwater visibility was greater than four feet over the four surveys within these areas. Areas with means between 3 and 4 ft included the Balboa Peninsula, Balboa Island (Main Channel), and Linda Isle/Balboa Marina). The remaining site means varied from 2 to 3 ft and Harbor Island, North Balboa Channel, and DeAnza Peninsula and Castaways. DeAnza and Castaways are located in Upper Newport Bay.

During the 2013-2014 survey, visibility was higher in Linda Isle Inlet, around the Balboa Peninsula, Lido Isle, Mariners' Mile/Bayshores. Visibility was considerably less in Upper Newport Bay, around Harbor Island, in the East Balboa Channel, and along the CDM/Bayside shoreline compared to the 2009-2010 survey (Figure 3b).

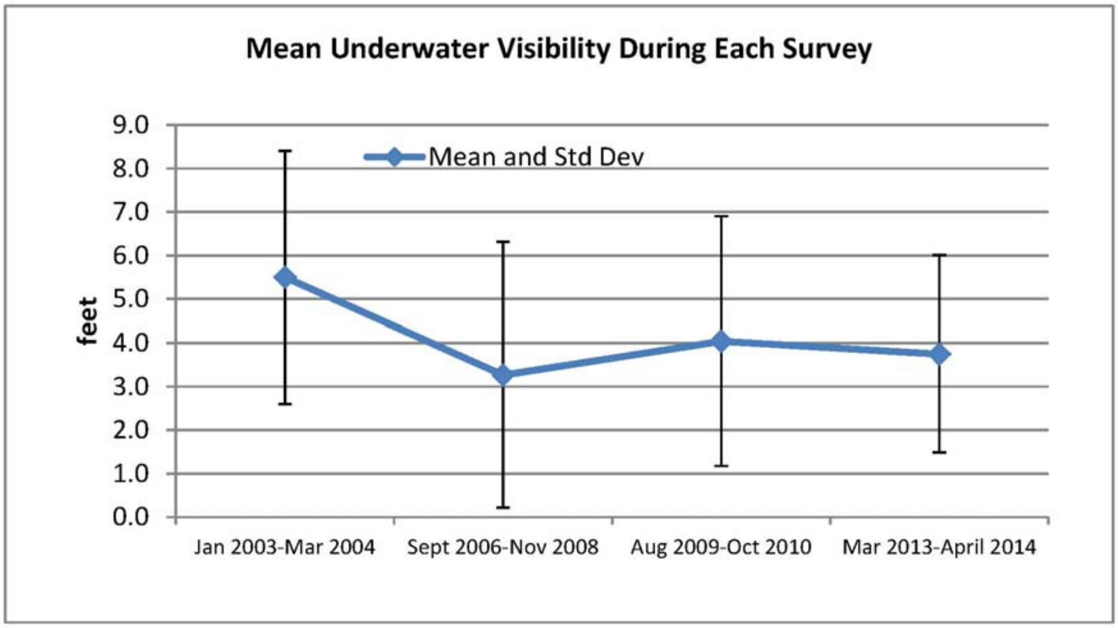


Figure 3a

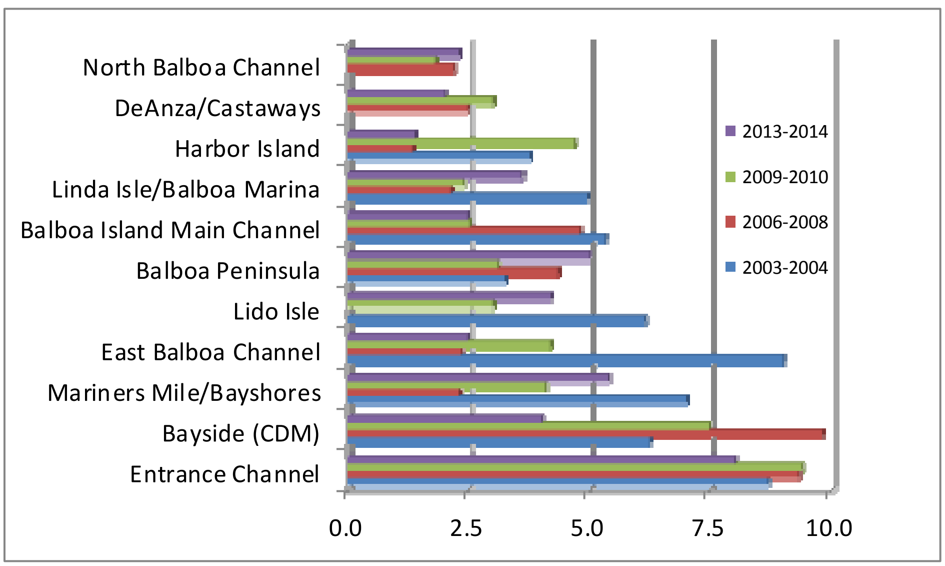


Figure 3b.
Underwater Visibility for Various Survey Regions of Newport Bay.
2003-2004, 2006-2007, 2009-2010, and 2013-2014

3.2 EELGRASS DISTRIBUTION AND ABUNDANCE SUMMARY

A summary overview survey map of both Shallow Water Eelgrass Habitat (SWEH) and Deep Water Eelgrass Habitat (DWEH) is provided in Figure 4.

3.2.1 Shallow Water Eelgrass Habitat

Eelgrass was mapped at depths between +0.5 and -15 feet Mean Lower Low Water (MLLW). The survey team mapped 42.35 acres of eelgrass in SWEG using a combination of diver/GPS tracking methods and downlooking sonar survey methods in 2013 and 2014. Eelgrass covered 4.5% of the soft bottom habitat within the Lower and Upper Newport Bay survey area (Figure 5). By standardizing the survey methods and using only diver-transect survey-collected data as was done during prior Bay-Wide surveys, the dive team mapped 30.76 acres of eelgrass covering 3.3% of the soft bottom habitat (Figure 4). Thus, the standardized data (sans the downlooking sonar survey data collected from the south side of Balboa Island and along Bayside Drive from the Orange County Harbor Patrol to Carnation Cove in Corona del Mar) is comparable to previous survey data.

Eelgrass habitat accounted for 3.4 % of the soft amount of bottom habitat in the survey area during the 2003-2004 survey, (30.4 acres); 2.6% of the soft bottom habitat in 2006-2007 (23.1 acres) and 2.3 % in the 2009-2010 survey (19.9 acres).

Historical Perspective. It is difficult to assess the abundance of eelgrass in Newport Bay prior to development. However, eelgrass was 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 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.

Distribution records indicate eelgrass has been present to some degree in Newport Bay for the last 65 to 70 years. 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.

The temporal changes in shallow water eelgrass abundance in Newport Bay along with significant periods of rainfall and dredging events that occurred between 1993 and 2014 are illustrated in Figure 6. Eelgrass abundance was roughly estimated to be three acres in 1993 (Robert Hoffman, NMFS , pers. comm. in Ware, 1993). In 1999, eelgrass was estimated to cover about 18 acres of shallow underwater habitat (Coastal Resources Management, unpublished data), while actual intensive Bay-Wide surveys that began in 2003 mapped between a low of 19.9 acres in 2006-2007 to a high of 42.34 acres in 2013-

2014 (30.76 acres standardized to the same diver survey area as in prior surveys) The system went through a period of eelgrass decline between 2006 and 2010, perhaps related to extensive dredging, barge movement, and heavy rainfall (Coastal Resources Management, Inc. 2012) and that episode was followed by extensive regrowth between 2010 and 2013-2014.

Table 1 summarizes eelgrass distribution and abundance within the 21 shallow water regions and the one deep water navigational channel eelgrass region between 2012 and 2014. Eelgrass acreage by survey region compared to prior surveys is presented in Figure 2. Shallow water eelgrass was abundant in the "Fore-Bay" between Corona del Mar and Balboa Island (Corona del Mar Bend and the Balboa Reach) extending to Bay Island at depths between 0.0 and -15 ft MLLW (Table 1, Figure 3). Other areas of significant amounts of eelgrass include Linda Isle in the "Mid-Bay", and DeAnza/Bayside Peninsula north of the Coast Highway Bridge in Upper Newport Bay. The maximum depth range of eelgrass decreased in the Mid-Bay to -8 ft MLLW while in Upper Bay, the maximum eelgrass depth was between -5 and -6 ft MLLW.

Three regions accounted for 77.6% of all eelgrass in the Bay:

- Corona del Mar/Bayside Drive (22.372 acres);
- Balboa and Collins Islands (5.978 acres); and
- Linda Isle Inner Basin (4.495 acres)

Other regions with significant amounts of eelgrass included:

- Balboa Peninsula east of Bay Island (2.267 acres);
- Balboa Channel Yacht Basins (2.056 acres);
- Outer DeAnza/Bayside Peninsula (1.596 acres);
- Grand Canal (1.062 acres); and
- Harbor Island (0.991 acre)

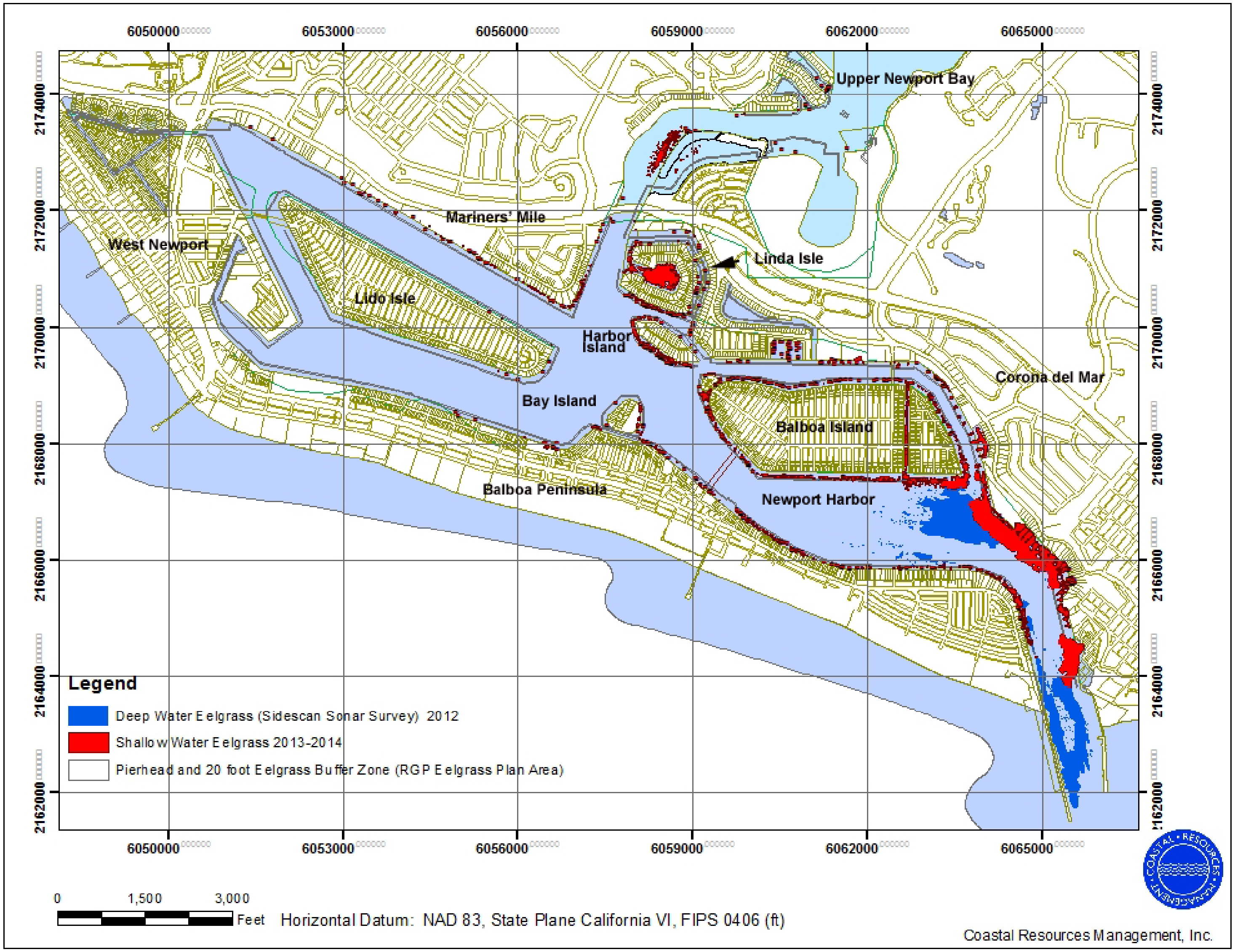


Figure 4. Shallow Water and Deep Water Eelgrass Habitat Map. 2012-2014 Surveys

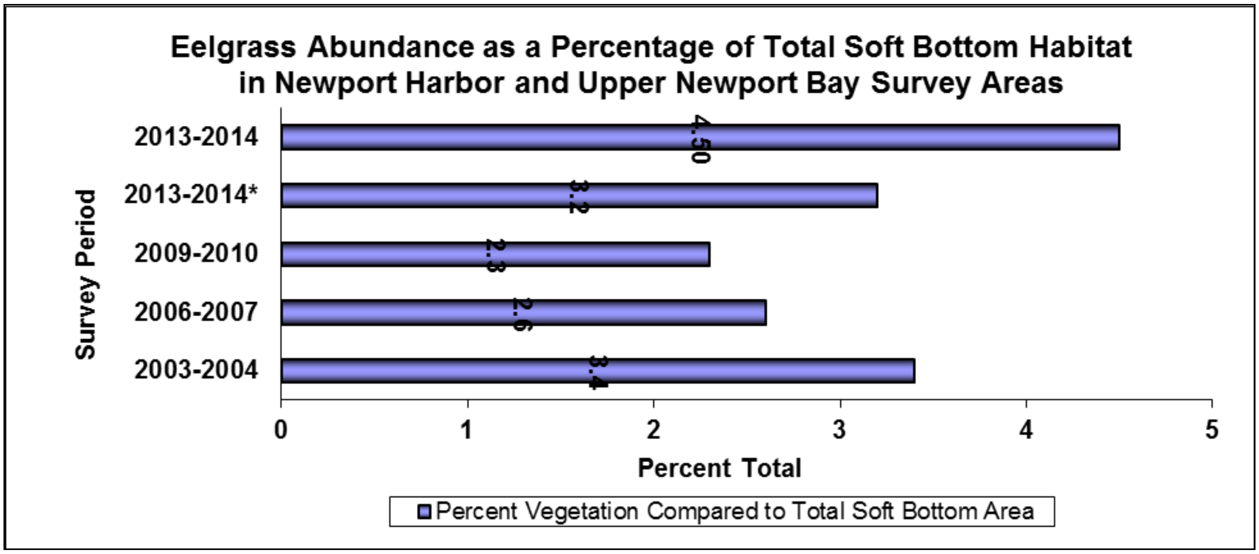


Figure 5.

2013-2014* Note: Standardized to the same survey area size as the previous 3 surveys.

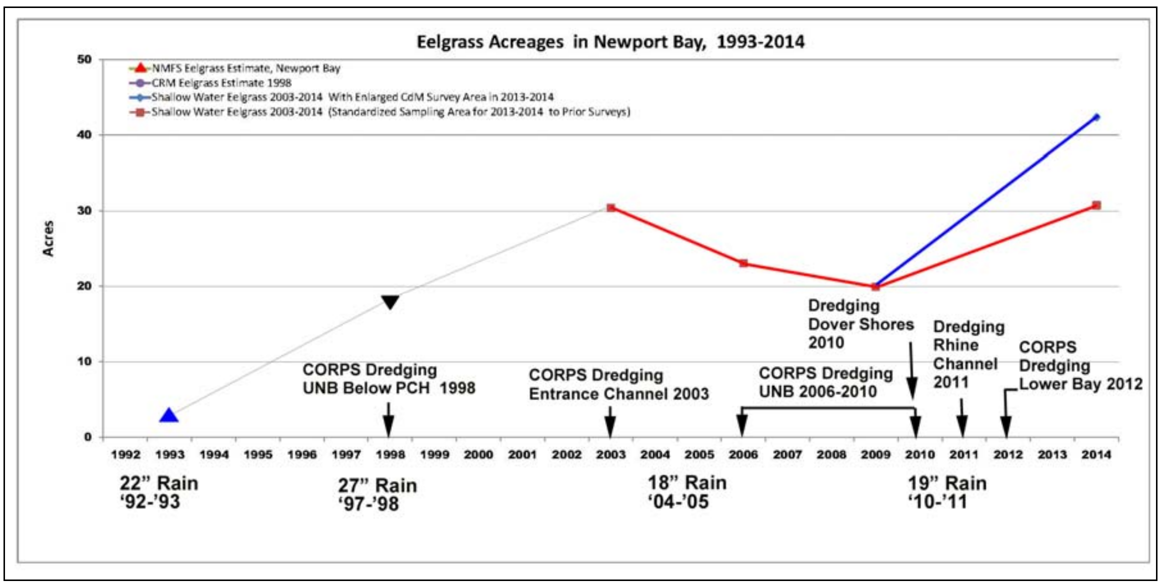


Figure 6.

Sources: Hoffman, 1993; Coastal Resources Management (unpublished data), Chambers Consultants and Coastal Resources Management, 1999; Coastal Resources Management Inc., 2005, 2010, 2012 and Coastal Resources Management, Inc., this report.

Table 1. Results of 2013-2014 Shallow Water Eelgrass Habitat Mapping Survey
(Expanded Survey Area-Diver Surveys and Downlooking Sonar Surveys)

Region	Survey Method*	Description	Acres	% Total	Sediment Type Source: (CRM 2010)
1	DS DLS	Corona del Mar/Bayside Drive to OCHD	22.372	52.8	Coarse Silt to Medium Sand
5	DS DLS	Balboa and Collins Islands	5.978	14.1	Fine Sand
11	DLS	Linda Isle (inner basin)	4.495	10.6	Very Fine Silt
3	DS	Balboa Peninsula East of Bay Island	2.267	5.4	Fine Sand to Medium Sand
2	DS	Balboa Channel Yacht Basins	2.056	4.8	Silt to Fine Sand
13	DLS DS	DeAnza/Bayside Peninsula (outer)	1.596	3.8	Medium Silt, fine sand
4	DS	Grand Canal	1.062	2.5	Fine sands
9	DS	Harbor Island	0.911	2.2	Fine to Coarse Silt
10	DS	Linda Isle (outer channels)	0.393	0.9	Coarse Silt to Fine Sand
16	DS	Mariners' Mile	0.305	0.7	Coarse Silt to Fine Sand
6	DS	Bay Island	0.298	0.7	Coarse Silt to Fine Sand
8	DS	North Balboa Channel and Yacht Basin	0.242	0.6	Coarse Silt to Fine Sand
15	DS	Bayshores	0.156	0.4	Very Fine Sand
7	DS	Balboa Peninsula West of Bay Island	0.102	0.2	Fine Silt to Medium Sand
12	DS DLS	DeAnza/Bayside Peninsula (inner)	0.077	0.2	Medium Silt
17	DS	Lido Isle	0.023	0.05	Coarse Silt to Medium Sand
14	DS	Castaways to Dover Shores	0.010	0.02	Coarse Silt to Medium Sand
20	DS DLS	Dover Shores	0.009	0.02	Medium Silt
21	DLS DS	Dunes Marina and Channel	0.002	0.01	Fine silt to coarse silt
18	DS	Lido Peninsula	0.000	0.00	Medium silt
19	DLS	West Newport	0.000	0.00	Silts to fine sands
		All Regions	42.353	100.00	

***DS=Diver Survey**
DLS=Downlooking Sonar

Table 2. Comparison of Shallow Water Habitat Acreages By Survey
(**Expanded Survey Area-Diver Surveys and Downlooking Sonar Surveys)**

Region	Description	2003-2004 (acres)	2006-2007 (acres)	2009-2010 (acres)	2013-2014 (acres)	Mean (acres)	Difference (acres) between 2003-2014
1	Corona del Mar/Bayside Drive to OCHD	9.521	9.075	10.363	22.372	12.833	12.851
5	Balboa and Collins Islands	6.686	4.554	3.052	5.978	5.068	-0.708
11	Linda Isle (Inner basin)	0.281*	3.218	1.974	4.495	2.492	4.214
2	Balboa Channel Yacht Basins	2.469	1.539	1.758	2.056	1.956	-0.413
3	Balboa Peninsula-East of Bay Island	1.672	1.557	1.391	2.267	1.722	0.595
9	Harbor Island	2.721	0.712	0.446	0.911	1.197	-1.810
4	Grand Canal	0.898	1.143	0.623	1.062	0.931	0.164
10	Linda Isle (outer channels)	2.916	0.328	0.068	0.393	0.926	-2.523
13	DeAnza/Bayside Peninsula (Outer)	0.792	0	0.001	1.596	0.597	0.804
15	Bayshores	0.991	0.664	0.000	0.156	0.453	-0.835
8	North Balboa Channel and Yacht Basins	0.698	0.115	0.119	0.242	0.294	-0.456
16	Mariners' Mile	0.234	0.066	0.070	0.305	0.169	0.071
6	Bay Island	0.132	0.051	0.041	0.298	0.130	0.166
12	DeAnza/Bayside Peninsula (inner side)	0.209	0.009	0.000	0.077	0.074	-0.132
7	Balboa Peninsula-West of Bay Island	0.034	0.03	0.014	0.102	0.045	0.068
14	Castaways to Dover Shores	0.132	0	0.000	0.010	0.036	-0.122
17	Lido Isle	0.025	0.004	0.000	0.023	0.013	-0.002
20	Dover Shores	nd	nd	nd	0.009	0.009	
21	Dunes Marina and Channel	nd	nd	nd	0.002	0.002	
19	West Newport	nd	nd	nd	0.000	0.000	
18	Lido Peninsula	**nd**	0	0.000	0.000	0.000	
	All Regions	**30.411**	**23.065**	**19.920**	**42.353**	**28.937**	**11.942**

Deep Water Eelgrass Habitat (DWEH)

Deep Water Eelgrass acreage by is summarized in Table 3. The amount of eelgrass mapped by bioacoustical methods in March of 2012 at depths between -15 and -28.5 ft MLLW was 57.48 acres. Of this total, 11.56 acres overlapped with the SWEH survey in Regions 1 and 5, and was removed from the DWEH survey total (45.92 acres). In 2008, CRM mapped a total of 45.86 acres. Similar regions of the Bay were mapped by the National Marine Fisheries Service in 2003 (conducted using different methods) totaled 90.3 acres, although this acreage was determined by NMFS to likely overestimate eelgrass acreage (Bryant Chesney, pers. com with R. Ware, 2010).

Table 3. Summary of Distribution and Acreage, Deep Water Eelgrass. 2003-2014

Region	Description	2003-2004 (acres)	2006-2008 (acres)	2009-2010 (acres)	2012 (acres)`	Increase or decrease (acres) between 2012 and 2008
A*	Newport Harbor Deep Water Navigational Channels*	90.3[a]	45.86[b]	no survey	45.92[c]	+0.6

[a] National Marine Fisheries Service, 2003
[b] Coastal Resources Management, Inc., 2010
[c] Coastal Resources Management, Inc., 2012, this study. Note: DWEH map as shown in Figure 3 overlaps 11.56 acres with SWEH surveys.

3.3 EELGRASS DISTRIBUTION BY REGION

The amount of eelgrass within each of the survey regions during the 2013-2014 survey is presented in this section along with a summary of the data recorded during the three prior surveys between 2003 and 2010. The 10-year summary, by region, is provided in Figure 7a (expanded Region 1 and Region 5 survey zones) and 7b (Region 1 and Region 5 survey zones standardized to prior survey limits). Data for standardized survey regions is provided in Appendix 1.

3.3.1 Region 1-Corona del Mar-Bayside Drive including Coast Guard/O.C. Harbor Patrol Facilities (22.372 acres).

Refer to Figure 8. Similar to all previous surveys, the most widespread and abundant eelgrass meadows were located in Region 1, between China Cove and the County of Orange Sheriff Harbor Patrol Facilities along Bayside Drive. The depth range of eelgrass extended between the low intertidal and -15 ft MLLW. Intertidal meadows of eelgrass in this region constitute the most widespread intertidal meadows in Newport Bay, and are abundant because the local sand/mud flats are not dredged. Occasionally, beach sands are replenished. As in prior surveys, the cover of intertidal eelgrass was low around the storm drain at Bayside Place. Eelgrass accounted for 52.8% of all of the eelgrass in Newport Bay (Table 1, Figure 8). This amount was partially greater than in previous surveys because the survey area was extended to cover all SWEH to depths of -15 ft MLLW previously mapped to -12 ft MLLW.

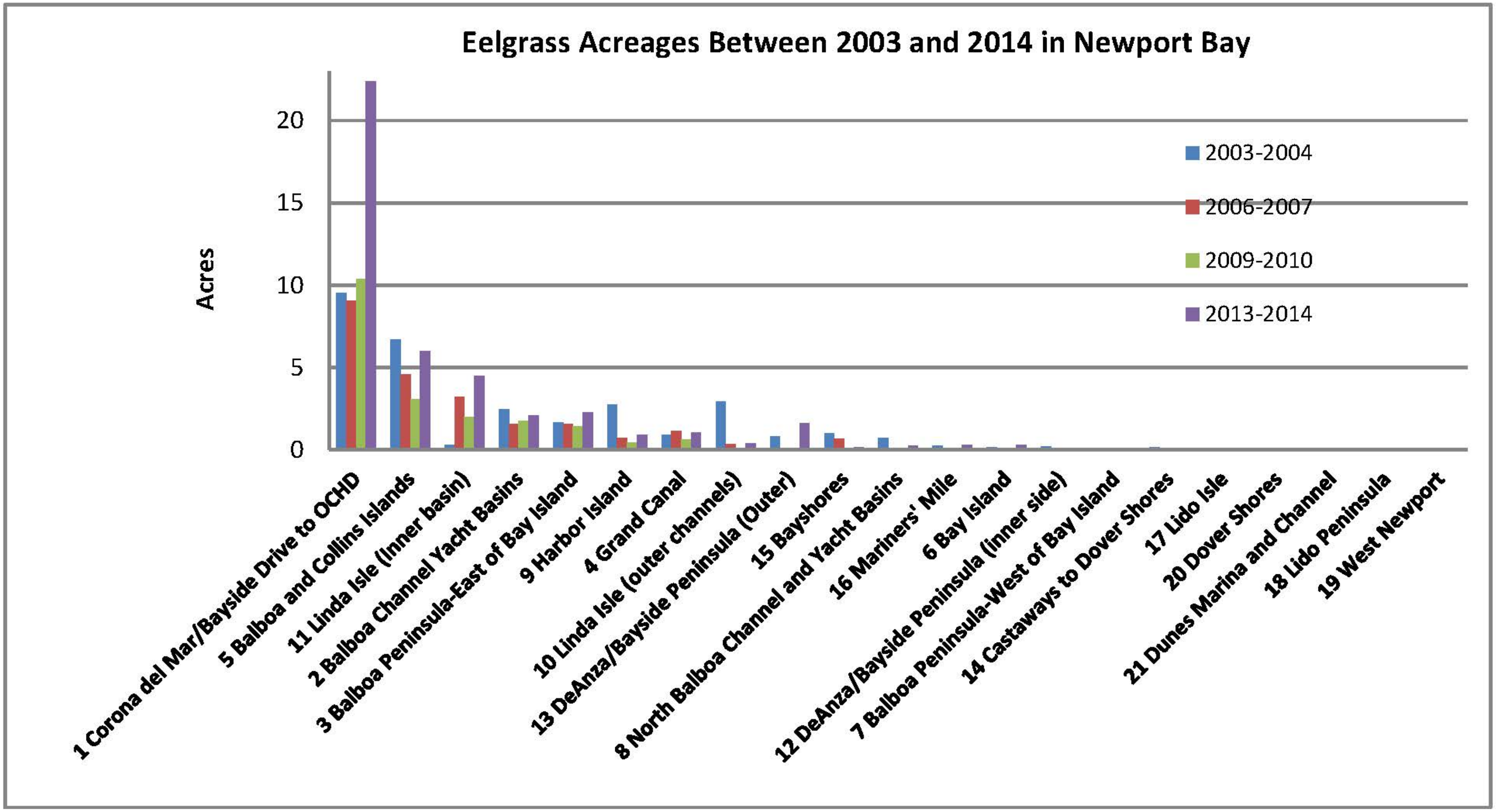

Eelgrass Acreages Between 2003 and 2014 in Newport Bay
Acres
20
15
10
5
0
2003-2004
2006-2007
2009-2010
2013-2014
1 Corona del Mar/Bayside Drive to OCHD
5 Balboa and Collins Islands
11 Linda Isle (inner basin)
2 Balboa Channel Yacht Basins
3 Balboa Peninsula-East of Bay Island
9 Harbor Island
4 Grand Canal
10 Linda Isle (outer channels)
13 DeAnza/Bayside Peninsula (Outer)
15 Bayshores
8 North Balboa Channel and Yacht Basins
16 Mariners' Mile
6 Bay Island
12 DeAnza/Bayside Peninsula (inner side)
7 Balboa Peninsula-West of Bay Island
14 Castaways to Dover Shores
17 Lido Isle
20 Dover Shores
21 Dunes Marina and Channel
18 Lido Peninsula
19 West Newport

Figure 7a.

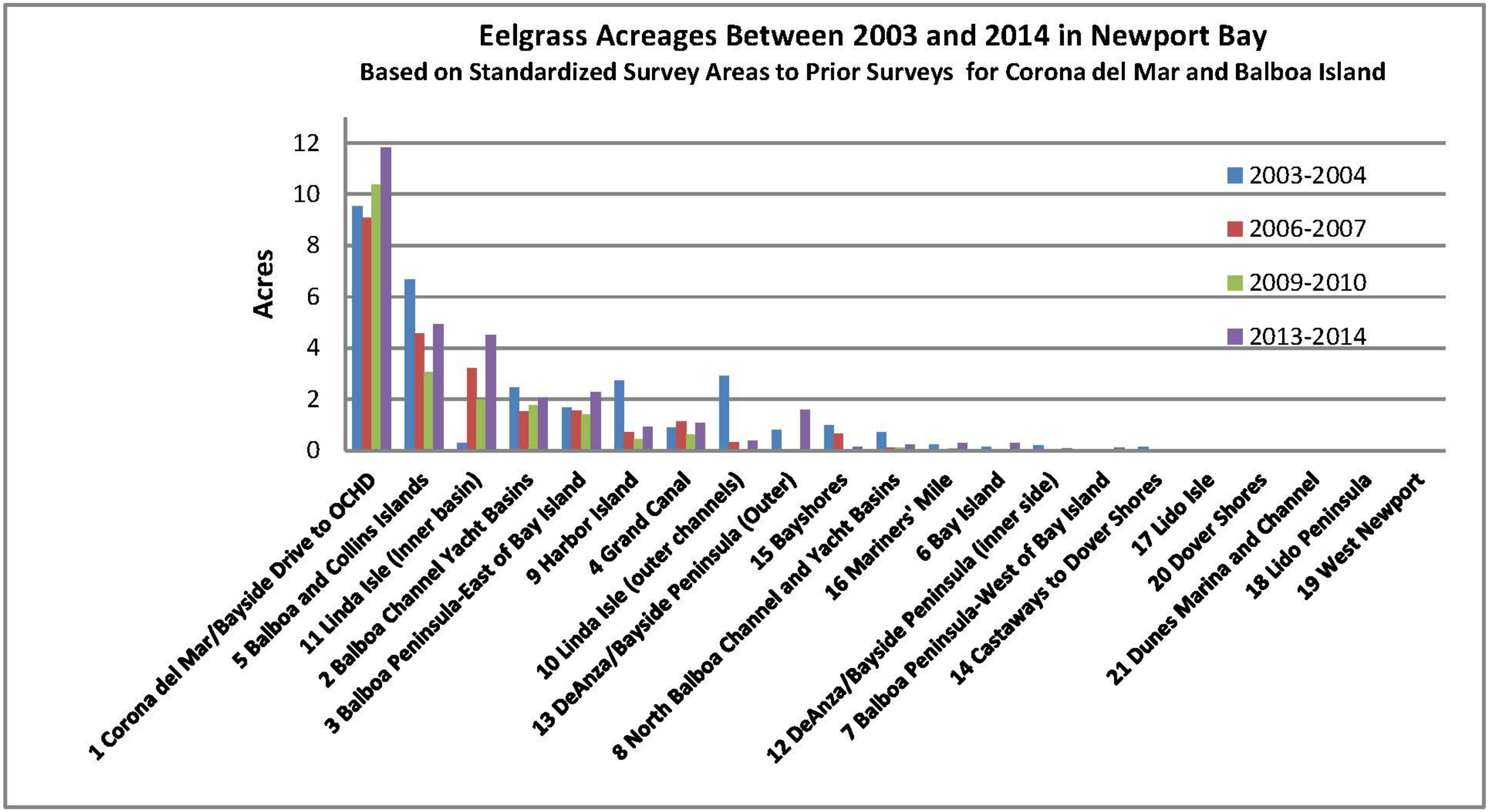

Eelgrass Acreages Between 2003 and 2014 in Newport Bay
Based on Standardized Survey Areas to Prior Surveys for Corona del Mar and Balboa Island
Acres
0
2
4
6
8
10
12
2003-2004
2006-2007
2009-2010
2013-2014
1 Corona del Mar/Bayside Drive to OCHD
5 Balboa and Collins Islands
11 Linda Isle (inner basin)
2 Balboa Channel Yacht Basins
3 Balboa Peninsula-East of Bay Island
9 Harbor Island
4 Grand Canal
10 Linda Isle (outer channels)
13 DeAnza/Bayside Peninsula (Outer)
8 North Balboa Channel and Yacht Basins
15 Bayshores
16 Mariners' Mile
12 DeAnza/Bayside Peninsula (inner side)
6 Bay Island
7 Balboa Peninsula-West of Bay Island
14 Castaways to Dover Shores
17 Lido Isle
20 Dover Shores
21 Dunes Marina and Channel
18 Lido Peninsula
19 West Newport

Figure 7b

Figure 8. 2013-2014 Eelgrass Habitat Map. Corona del Mar/Bayside

When standardized to the prior survey mapping area, eelgrass covered 11.2 acres (34% of the harbor's eelgrass), up from 10.4 acres in 2009-2010. Harbor activities that were occurring in this region during the survey period included dredging and dock reconstruction at the Orange County Harbor Department, an eelgrass transplant in front of the sandy beach on the south side of the facilities for that project, and beach nourishment in China Cove. Eelgrass in this region consisted of both the deeper-occurring wide bladed species (*Zostera nr. pacifica*) and the narrower bladed bay form common throughout Newport Bay (*Zostera marina*).

3.3.2 Region 2-Yacht Club Basins and Marinas Between the Orange County Harbor Department and the Balboa Bridge along Bayside Drive (2.056 acres)

Refer to Figure 9. Eelgrass was common throughout this region's boat basins at depths from -0.5 ft along the bulkheads to -10 ft MLLW seaward of the docks. The Bahia Corinthian and Balboa Yacht Club basins contained the most eelgrass. This region accounted for 4.8% of all of the eelgrass mapped (Table 2) and has exhibited a slow regrowth of eelgrass following losses in 2006-2007 (Table 3). Eelgrass acreage was still 0.413 acres less than originally mapped in 2003-2004.

3.3.3 Region 3-East and Mid Balboa Peninsula (2.267 acres)

Refer to Figure 8 and 10. Region 3 includes the shallow water zone between the bulkhead and the seaward ends of docks between the Entrance Channel to, but not inclusive of the west side of Bay Island. Primarily lined with docks, this shoreline consists of bulkheads and pocket beaches. Eelgrass occurred between boat docks, within boat slips, shoreward and seaward of docks at depths between -0.5 and -10 ft MLLW. The amount of eelgrass increased by 0.876 acres compared to the 2009-2010 survey, following significant reductions recorded in the 2006-2007 survey (Table 3). In 2013-2014, this region accounted for 5.4% of the vegetated shallow water eelgrass habitat in Newport Harbor. Eelgrass acreage in 2013-2014 was the highest of the four surveys conducted to date, and 0.595 acres greater than the amount recorded in the 2003-2004 survey.

3.3.4 Region 4-Grand Canal (1.062 acres)

Refer to Figure 9. The Grand Canal separating “Little Balboa” and “Balboa Island” was vegetated along its entire length at depths between 0.0 and -4 ft MLLW and at both the north and south entrance channels extending to -7 ft MLLW. The depth range of eelgrass in the Grand Canal has decreased due to shoaling in the center of the channel and along the bulkhead. Eelgrass accounted for 2.5% of the shallow water eelgrass in Newport Harbor (Table 2) and it increased 0.439 acres since 2009-2010 when the lowest amount of eelgrass was recorded for all of the surveys. Increases in areal cover were especially evident north of the Park Avenue Bridge.

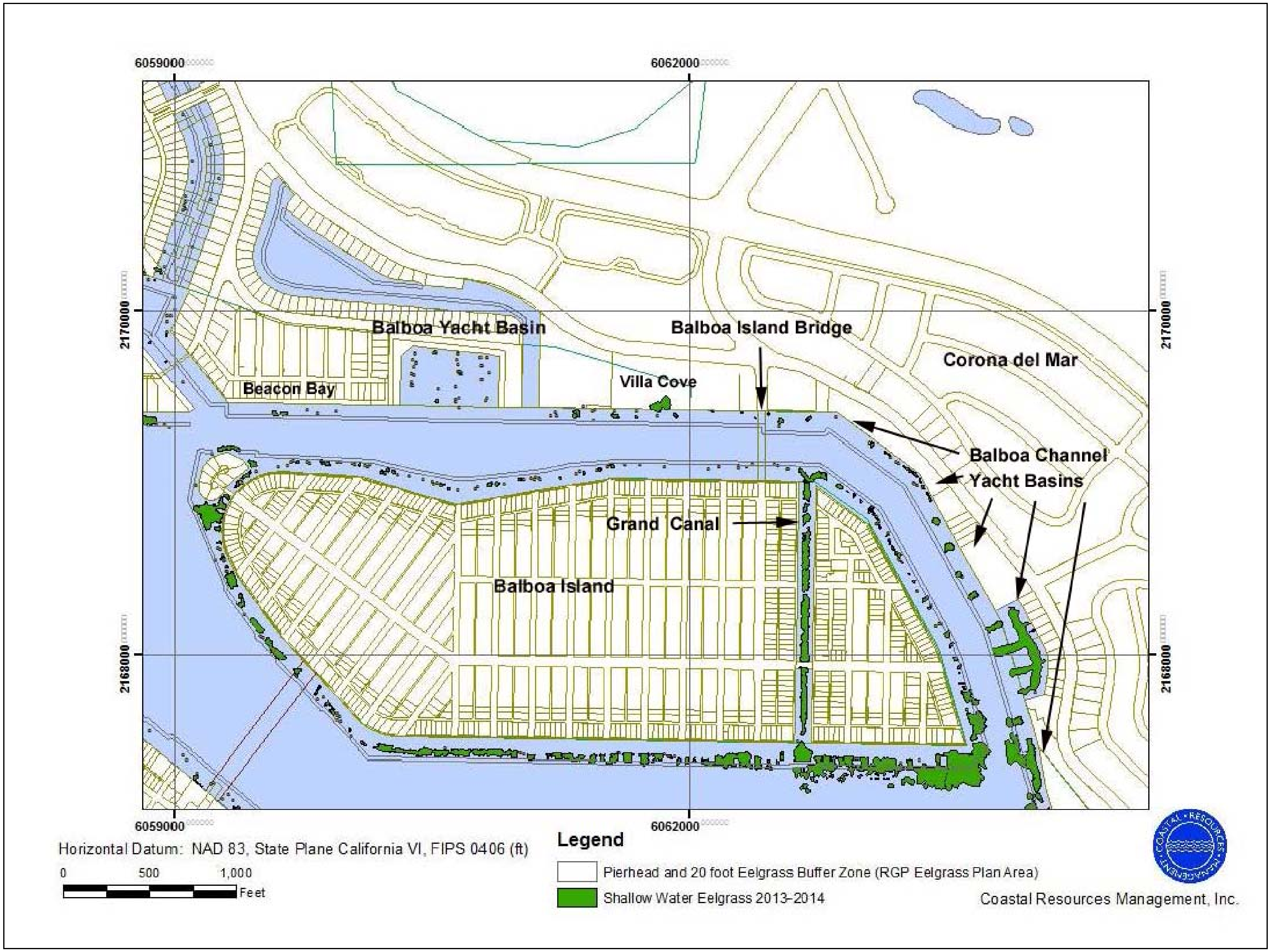


Figure 9. 2013-2014 Eelgrass Habitat Map. Balboa Reach and Harbor Island Reach

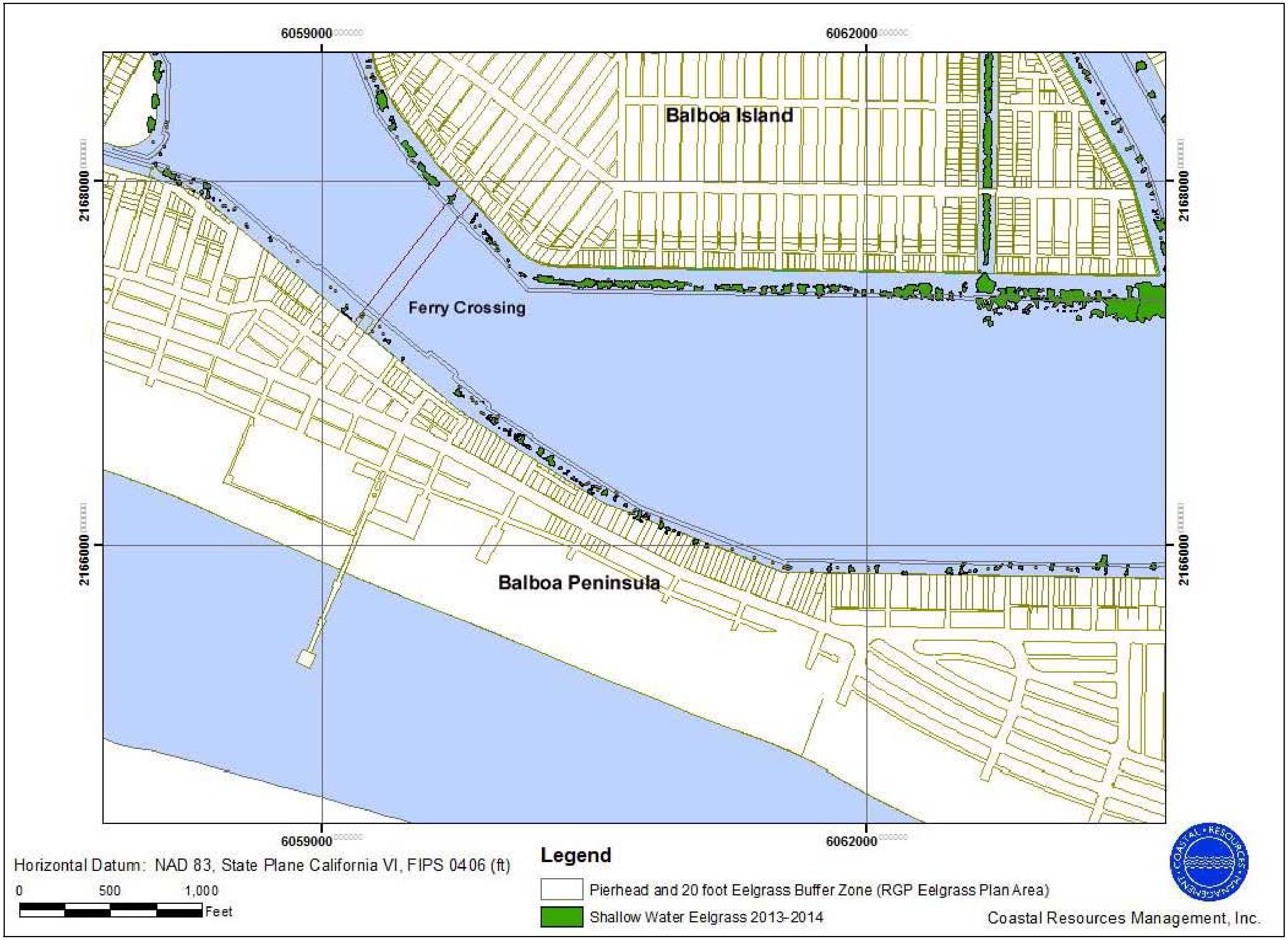


Figure 10. 2013-2014 Eelgrass Habitat Map. Mid Balboa Peninsula

3.3.5 Region 5-Balboa and Collins Islands, Excluding Grand Canal (5.978 acres)

Refer to Figure 9. Balboa Island is rimmed with City-nourished sand beaches while Collins Island is bulkheaded and dredged. Eelgrass around the perimeter of Balboa Island accounted for 14.1% of the Harbor's eelgrass habitat during the 2013-2014 survey and its cover increased substantially since the 2009-2010 (2.926 acres, Table 3). Recovery was particularly strong along the north, east, and southeast sections of the island, while eelgrass along the south side of Balboa Island has been relatively stable over the four survey periods. The amount of eelgrass in this region was 0.7 acres less than the amount first recorded in 2003-2004.

3.3.6 Region 6-Bay Island (0.298 acre)

Refer to Figure 11. Bay Island accounted for 0.7% of the shallow water eelgrass habitat (Table 2). Most vegetation was present along the east-facing sandy beach and between the boat docks. Two small patches were present on the west-facing side of the island. The amount of eelgrass in 2013-2014 was the highest of the four survey periods and was 2 ¼ times greater the amount mapped during the 2003-2004 survey when the acreage of eelgrass around Bay Island was 0.132 acres.

3.3.7 Region 7-West Balboa Peninsula (0.102 acre)

Refer to Figure 11. Region 7's eelgrass habitat extended from Lindo Avenue west of the Bay Island Bridge to 11th Street, which marked a western extension of eelgrass along the Balboa Peninsula. As in previous surveys however, most eelgrass was mapped in the Newport Harbor Yacht Club Basin at depths between 0.0 and -6 ft MLLW and this particular eelgrass bed more than tripled in size compared to 2009-2010. Region 7 eelgrass accounted for 0.2% of the shallow water eelgrass habitat (Table 2). Since the first survey (2003-2004), eelgrass cover has increased by 0.068 acre. Navigational channel dredging in this section of Newport Harbor occurred in 2012 as part of the ACOE Lower Bay Dredging Project.

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

Refer to Figure 12. Eelgrass on the north side of the North Balboa Channel between the Balboa Island Bridge and Beacon Bay accounted for 0.6% of the shallow water eelgrass (Table 2). Small eelgrass beds and patches were between the bulkhead and dock headwalk, and fairways of the marinas. The eelgrass bed in the shallows of Bayside Cove behind the Belcourt Marina reestablished a larger area compared to the 2009-2010 survey as had eelgrass in the Balboa Yacht Basin. 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 2006-2006 but recovery has been slow but steady. Eelgrass abundance was 0.413 acre less during the initial 2003-2004 survey when 0.698 acres of eelgrass were mapped (Table 3). Navigational channel in this section of Newport Harbor occurred in 2012 as part of the ACOE Lower Bay Dredging Project.

3.3.9 Region 9-Harbor Island (0.446 acre)

Refer to Figure 12. Eelgrass around Harbor Island accounted for 0.9 % of the shallow water eelgrass (Table 2) the majority of which was present along the south and west sides of the island.

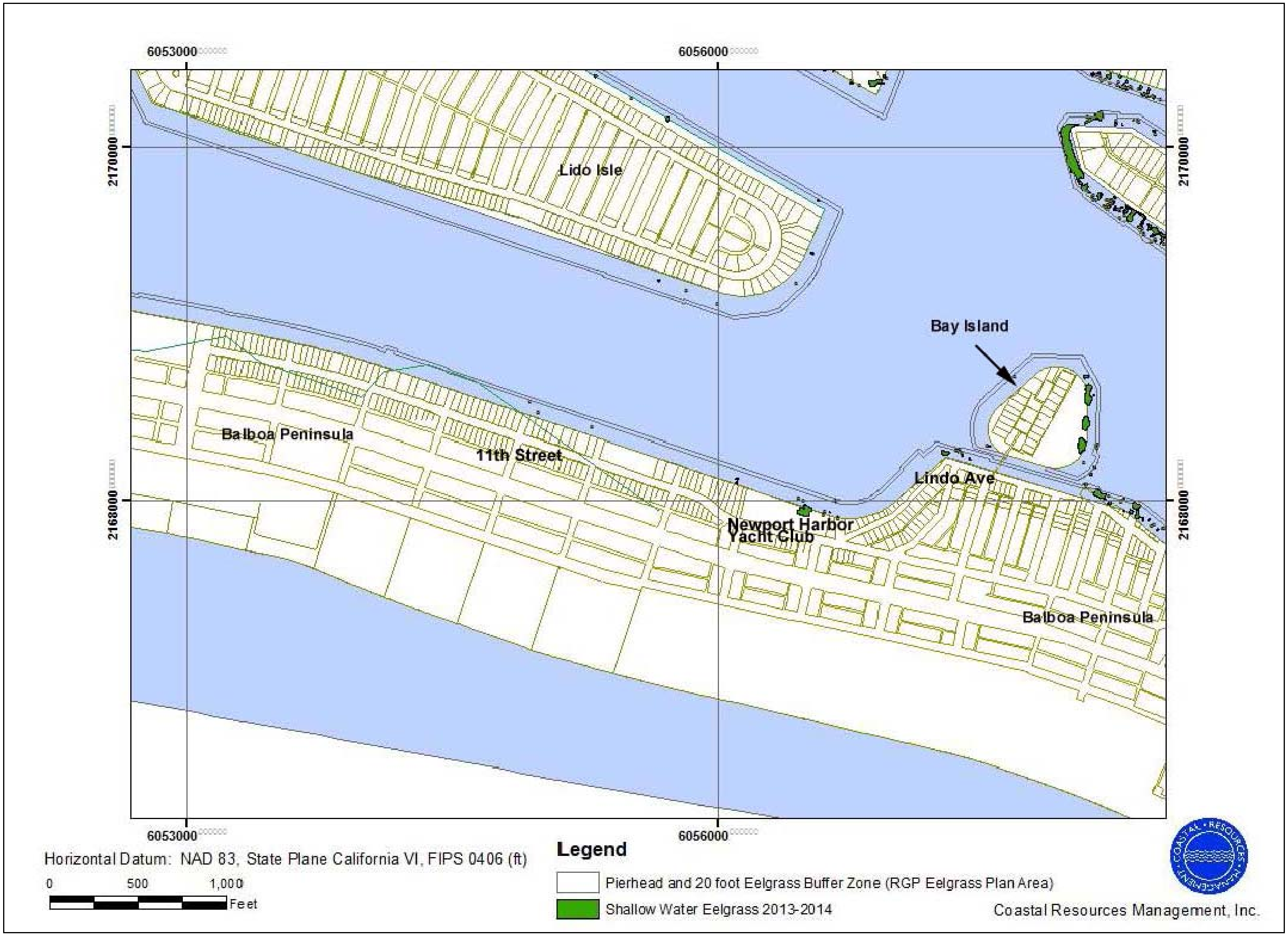


Figure 11. 2013-2014. Eelgrass Habitat Map. West Balboa Peninsula

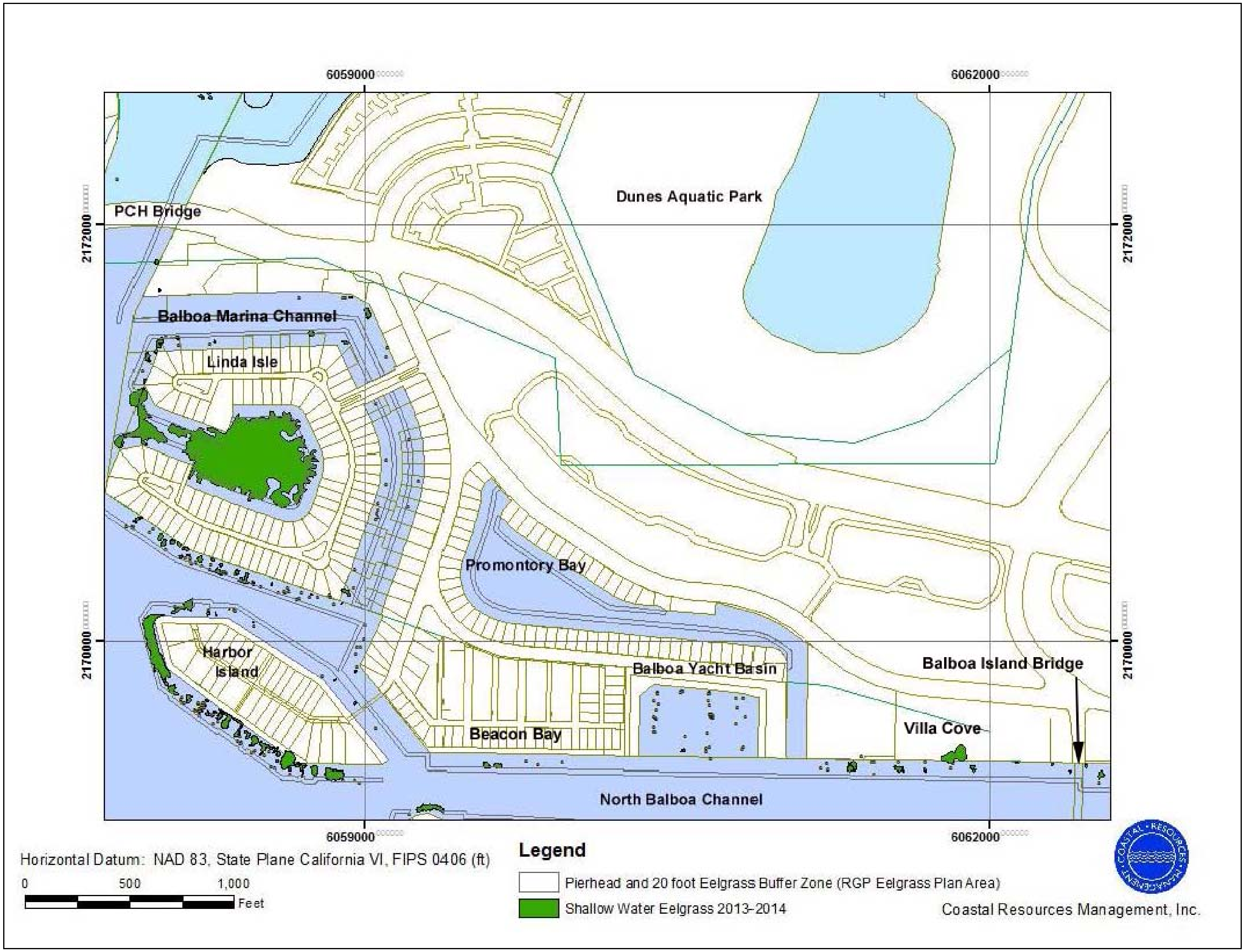


Figure 12. 2013-2014 Eelgrass Habitat Map. North Balboa Channel, Harbor Island Reach and Linda Isle

The depth range of eelgrass varied from -0.5 to -8.5 ft MLLW. Regrowth patterns have been different around the island. Along the south and west sides, eelgrass receded following the 2003-2004 survey continued through 2009-2010, and subsequently recovered in 2013-2014. Along the north side of Harbor Island, eelgrass also receded following the 2003-2004 survey but the degree of recovery and regrowth was much less than along the south and west side of Harbor Island in 2013-2014. This was a dredging-related impact associated with the City of Newport Beach and County of Orange dredge project in 2012, as eelgrass was observed by the CRM dive team right at the edge of the dredge cut on the west and north sides of the island. The acreage of eelgrass in 2013-2014 was 66% less than during the initial 2003-2004 survey, a reduction of 1.8 acres.

3.3.10 Region 10-Outer Linda Isle Channels (0.393 acre)

Refer to Figure 12. Eelgrass habitat accounted for 0.9 % of all eelgrass during the 2013-2014 survey (Table 2) . Most eelgrass was mapped on the south and west sides of Linda Isle and secondarily in the north channel (Balboa Marina Channel). There was a high number of small patches around the island where eelgrass was absent in 2009 and 2010, indicative of the beginning of eelgrass recovery. However, no eelgrass was observed in the center of the channel between Linda Isle and Harbor Island, and Linda Isle and Beacon Bay there were dredged as part of the City of Newport Beach and County of Orange dredge project in 2012. The depth range of eelgrass in this region varied between -1 and -6 ft MLLW. Eelgrass was also located in the Balboa Marina at the northeast corner. This bed was transplanted in July 2009 to mitigate for marina dredging losses (Coastal Resources Management, Inc. 2009). Overall, the amount of eelgrass present in the Outer Linda Isle Channels increased by 0.325 acres since 2009-2010, but the amount present in 2013-2014 was 87% less than mapped during the initial survey in 2003-2004 (2.916 acres).

3.3.11 Region 11-Linda Isle Inner Basin (4.494 acres)

Refer to Figure 12. This region was mapped in 2013 by CRM using both downlooking sonar and diver/GPS techniques. Linda Isle Inner Basin (Linda Isle Inlet) ranked third in eelgrass abundance behind Corona del Mar and Balboa Island (Table 2) and accounted for 10.6% of all of the eelgrass mapped during the 2013-2014 survey. Nearly all of the open-water area of the Inner Basin was vegetated with eelgrass due to the consistent, shallow depth regime (between -4 and -5 ft MLLW), the protective nature of the inlet from storm flows from Upper Newport Bay, and a lack of maintenance dredging. The amount of eelgrass mapped in 2013 was the highest of the four surveys to date and the acreage increased a total of 2.521 acres compared to the 2009-2010 survey (1.974 acres). In 2002, the amount was 0.281 acre, based upon diver transect surveys.

3.3.12 Region 12-DeAnza/Bayside Peninsula, Inner (East) Area (0.077 acre)

Refer to Figure 13. Eelgrass accounted for 0.2% of the eelgrass in the Bay in 2013-2014 (Table 2) after disappearing in 2009-2010 from a die-off that was first observed during the 2006-2007 survey. In 2003-2004, eelgrass encompassed 0.209 acres (Table 3). Currently, eelgrass in this channel represents 63% of the total first mapped in 2003-2004. It occurred at depths between -2 and -3 ft MLLW in silty sediments.

3.3.13 Region 13-DeAnza/Bayside Peninsula, Outer (West) Area, Main Channel of Upper Newport Bay (1.596 acres)

Refer to Figure 13. Since 2009-2010, eelgrass has made a successful recovery along this section of Upper Newport Bay. It encompassed 3.8% of the eelgrass mapped during the recent survey (Table 2) at depths between 0.0 and -6 ft MLLW. It extended a distance of 1,300 ft from the southern tip of the Peninsula to the bend in the Main Channel. One patch of eelgrass was found during July 2009 totaling 0.001 acre (Table 3). No eelgrass was found during the 2006-2007 survey 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. Eelgrass began to recolonize this section of Upper Newport Bay in after the 2009-2010 CRM survey, based upon surveys conducted by Merkel and Associates in September 2010 when a total of 1,614 sq ft (0.037 acre) was mapped along the southern one-half of the peninsula.

Eelgrass was recorded in Upper Newport Bay during 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). In 2012, Orange County Coastkeeper began a restoration project within the same area with the objective to restore eelgrass in Upper Newport Bay Results of first year post-monitoring survey by Coastkeeper and CRM in 2013 and the CRM Bayside Mapping of Region 13 in 2013 indicate the transplants took hold at the northern edge of the natural eelgrass bed encompassing an area about 1,176 sq ft (Orange County Coastkeeper, 2013). Additional restoration transplants are being conducted on the north side of the DeAnza Peninsula channel cut and near Shellmaker Island during the Year 2 and Year 3 restoration project efforts.

3.3.14 Region 14-Castaways to Dover Shores, Upper Newport Bay (0.010 acre)

Refer to Figure 12. Region 14 areas were colonized by 0.010 acre of eelgrass and accounted for 0.02% of all eelgrass in Newport Bay (Table 2). All but one small patch was located in front of the sandy beach immediately south of Dover Shores at depths between -1 and -3 ft MLLW. Another small patch was located in front of the site of the old Castaways Marina. A large section of this area was subsequently used as a tug/barge staging area for the Upper Newport Bay Restoration Dredging Project, and a debris containment boom was also located at the site. The Castaways eelgrass bed was first observed in the early 1990s (R. Ware, pers. observation), but disappeared following the 1998 El Nino (R. Ware, pers. observation). It was located again in 2002 (Coastal Resources Management and Chambers Group, 2002), present during the 2003-2004 Bay-Wide survey, but did not reappear until the 2013-2014 survey. Currently, the amount of eelgrass in Region 13 is 0.127 acre less than that mapped during the 2003-2004 survey.

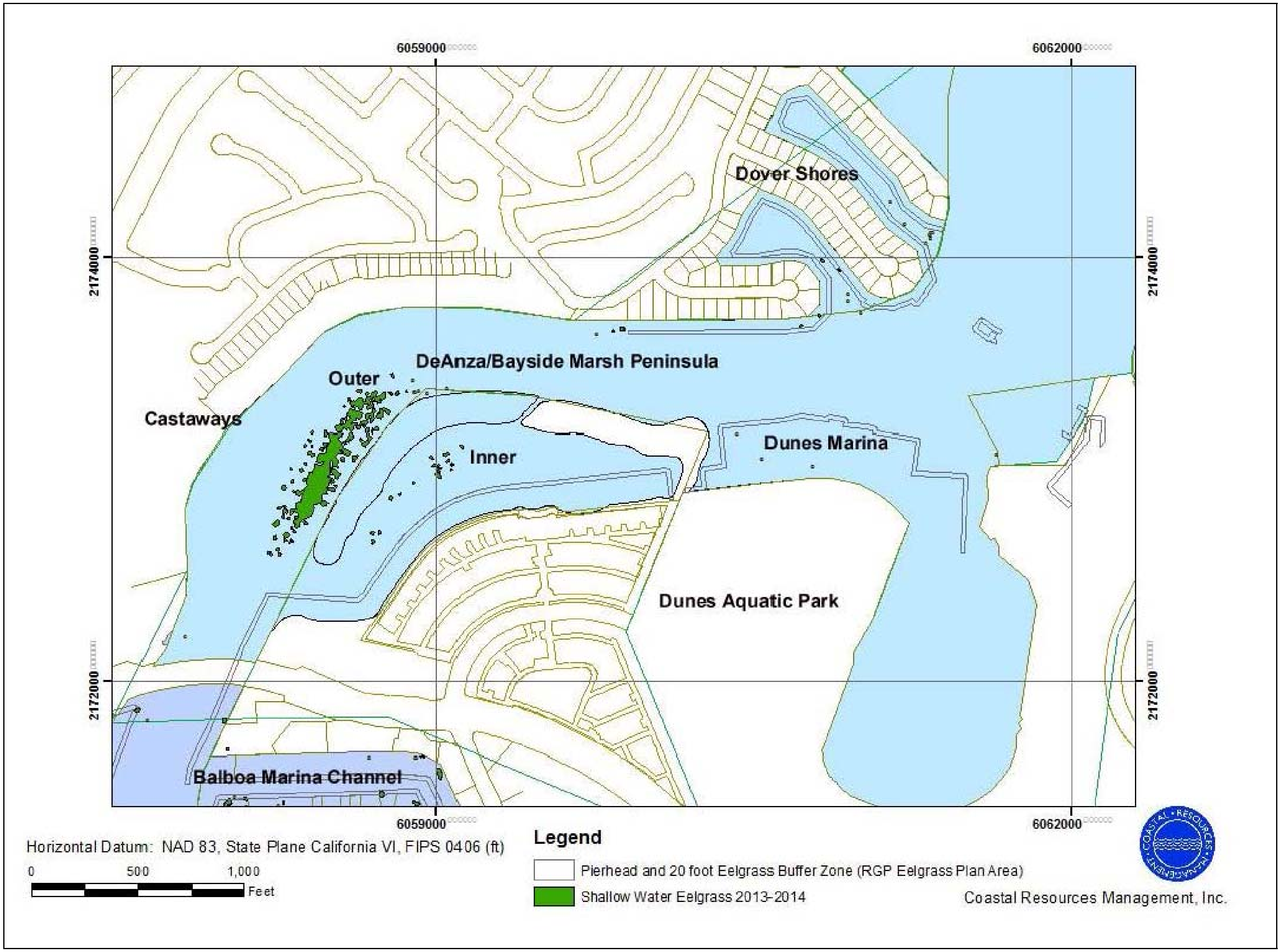


Figure 13. 2013-2014 Eelgrass Habitat Map. DeAnza/Bayside Marsh Peninsula, Castaways, Dover Shores, and Dunes Marina

3.3.15 Region 15-Bayshores (0.156 acre)

Refer to Figure 14. This region extends from the Coast Highway Bridge to the junction of the Lido Reach. Region 15 eelgrass accounted for 0.4% of the eelgrass in Newport Bay (Table 2) at depths from -1 to -6 ft MLLW. This region's eelgrass system made a strong comeback following the complete loss of eelgrass documented during the 2009-2010 survey (Table 3). Eelgrass has partially recolonized the shoal in front of the Anchorage Marina near the Coast Highway Bridge. Eelgrass was present between the bulkhead and the docks, between adjacent docks, and in wider, open areas adjacent to the community's swimming beach. Its decline was first reported during the 2006-2007 survey. Currently, eelgrass in this region is once again expanding but nearly 84% less than mapped during the 2003-2004 survey (0.991 acre).

3.3.16 Region 16-Mariners' Mile (0.305 acre)

Refer to Figures 14 and 15. Eelgrass along the southern portion of Bayshores and along Mariners' Mile accounted for 0.7% of the shallow water eelgrass in Newport Bay (Table 2) between depths of 0.0 and -7.5 ft MLLW. Concentrated areas of eelgrass were located between the bulkhead and docks of the Bayshores Marina and in the Orange Coast College School of Sailing and Seamanship Boat Basin. Small patches and small beds of eelgrass were also located at the Balboa Bay Club as well as within small marinas and boat basins along Mariners' Mile from the OCC Boat Basin to nearly the Newport Blvd Bridge (within the marina at 3301 W. Coast Highway). Eelgrass at this location marked the most westerly range extension of eelgrass along Mariners' Mile since surveys began in 2003. Eelgrass located in the OCC School of Sailing and Seamanship Boat Basin was transplanted to the site in 2010 for losses incurred during dock renovation in 2005. Navigational channel dredging in Lido Reach from the Balboa Bay Club east to the Turning Basin occurred in 2012 as part of the ACOE Lower Bay Dredging Project.

The amount of eelgrass present during the 2013-2014 survey in Region 16 was the most recorded in all of the surveys conducted to date and was 0.071 acre more than recorded during the first survey in 2003-2004 (0.234 acre). Eelgrass recovered from significant losses that were documented first in the 2006-2007 survey with losses of 76% at that time compared to 2003-2004.

3.3.17 Region 17-Lido Island (0.05 acre)

Refer to Figure 14. Scattered, small patches of eelgrass were located around the southeast section of Lido Isle constituting 0.05% of Newport Bay's eelgrass (Table 2). It occurred on the southeast side of Lido Isle from approximately Via Vella to the southeast tip, and up around the northeast side to approximately Via Trieste. Eelgrass abundance has increased since 2006-2007 when most of the eelgrass disappeared around Lido Isle. Currently, it accounts for 94% of the eelgrass abundance observed in 2003-2004 (Table 3) although the distribution of patches and small beds has changed. Eelgrass was not located within the Lido Isle Yacht Club Basin where it was abundant in 2003-2004. However, the geographical range of eelgrass patches expanded farther along the north side of Lido Isle in 2013-2014 than during previous surveys. Eelgrass was transplanted on both the north and south sides of Lido Isle in late summer 2004 as a pilot eelgrass transplant project for the Army Corps of Engineers but the transplant did not survive heavy rainfall in 2004-2005. Navigational channel dredging around the eastern 1/3 of Lido Isle occurred in 2012 as part of the ACOE Lower Bay Dredging Project.

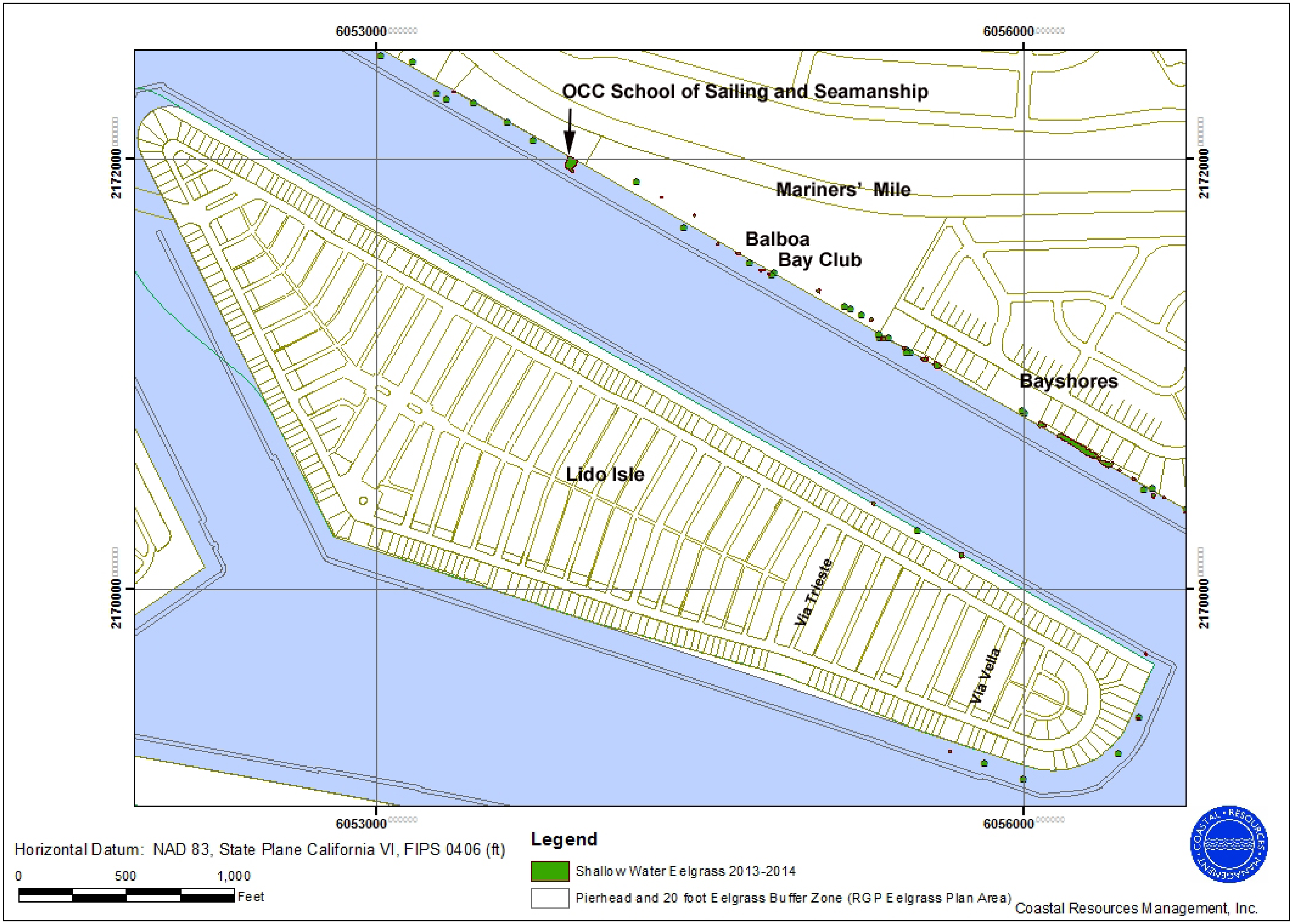


Figure 14. 2013-2014 Eelgrass Habitat Map. Lido Isle, Bayshores and Mariners' Mile.

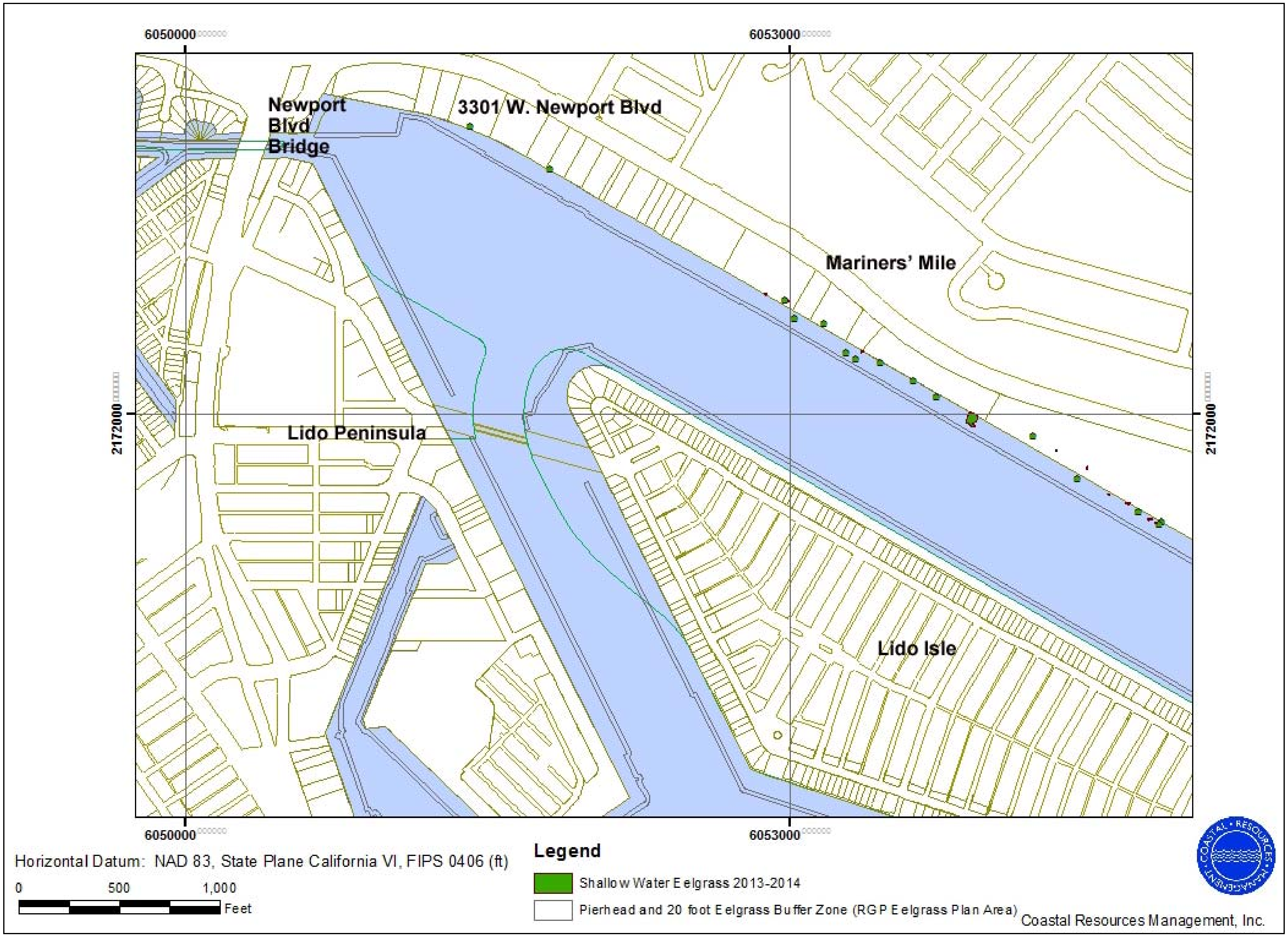


Figure 15. 2013-2014 Eelgrass Habitat Map. Mariners' Mile (continued) and Lido Peninsula

3.3.18 Region 18-Lido Peninsula (No eelgrass)

Refer to Figure 15. Eelgrass was not observed along the bulkhead of the Lido Peninsula extending between the Rhine Channel to the Newport Blvd Bridge. Eelgrass was transplanted at the sand beach at the base of the bridge leading to Lido Isle in late summer 2004 as a pilot eelgrass restoration project for the Army Corps of Engineers but did not survive the heavy rains of 2004-2005.

3.3.19 Region 19-Added Region in 2013-2014. West Newport (No eelgrass)

Refer to Figure 16. Eelgrass surveys were conducted throughout the channels and along the shoreline of West Newport for the first time in April 2014. No eelgrass was located in this region of Newport Harbor.

3.3.20 Region 20-Added Region in 2013-2014. Dover Shores (0.009 acre)

Refer to Figure 17. Eelgrass surveys were conducted for the City's Bay-wide mapping program in the two Dover Shores inlets for the first time in April 2014. Several small patches and small eelgrass beds were located in the outer one-half of the inlets at depths of -6 to -7 ft MLLW that accounted for 0.02% of Newport Bay's eelgrass. These two inlets were dredged to design depths in February 2010 (Chris Miller, City of Newport Beach pers. com with R. Ware) but no eelgrass was observed during 2008 pre-dredge surveys (Coastal Resources Management, Inc., 2008).

3.3.21 Region 21-Added Region in 2013-2014. Dunes Marina (0.002 acre)

Refer to Figure 17. Eelgrass surveys were conducted in the Dunes Marina for the first time in April 2014. Several small patches were found in the Dunes Marina at depths of -5 to -7 ft MLLW that accounted for 0.01% of the eelgrass in Newport Bay. Prior to dredging conducted in 2010, eelgrass surveys were conducted in the Dunes Marina by Chambers Group, Inc. who noted the presence of several small patches.

3.3.22 Deep Water Eelgrass Habitat (DWEH)

Refer to Figure 18. Deep Water Eelgrass was surveyed in March 2012. These beds extended between the Newport Harbor Entrance Channel to Balboa Reach. A total of 57.48 acres of eelgrass was mapped at depths from -10 to -28 ft MLLW. In 2013-2014, the City's Shallow Water Eelgrass Habitat mapping surveys extended to -15 ft MLLW. The overlap between the two mapping efforts (deep water and shallow water) was subtracted from the DWEH acreages so that the corresponding DWEH was updated to 45.92 acres. In 2003, a total of 90.3 acres of eelgrass was mapped in 2003 (NMFS, 2003) and 45.8 acres of bottom habitat was mapped in 2008 by CRM at depths between -15 and -28 ft MLLW. The discrepancy between the 2003 and 2008/2012 surveys is partially related to survey techniques rather than actual changes in habitat.

Army Corps of Engineers eelgrass transplants were conducted in DWEH near Corona del Mar and Balboa Island in May/June and October 2012 for losses associated with the Corps' Lower Newport Harbor Dredging Project. An additional transplant was conducted for losses associated with the County of Orange/City of Newport Beach Linda Isle/Harbor Island Dredging Project (Merkel and Associates, 2014).

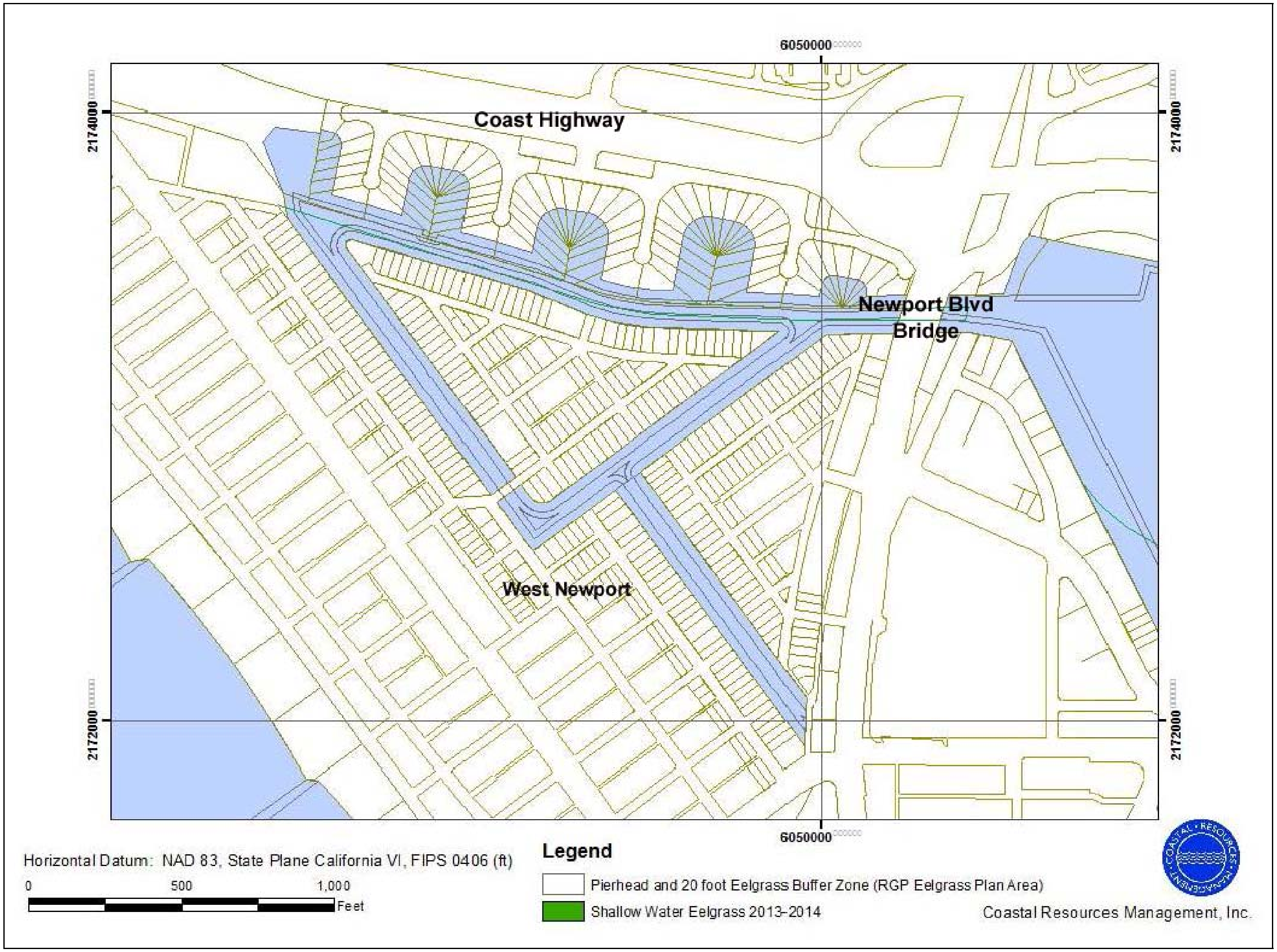


Figure 16. 2013-2014 Eelgrass Habitat Map. West Newport (no eelgrass)

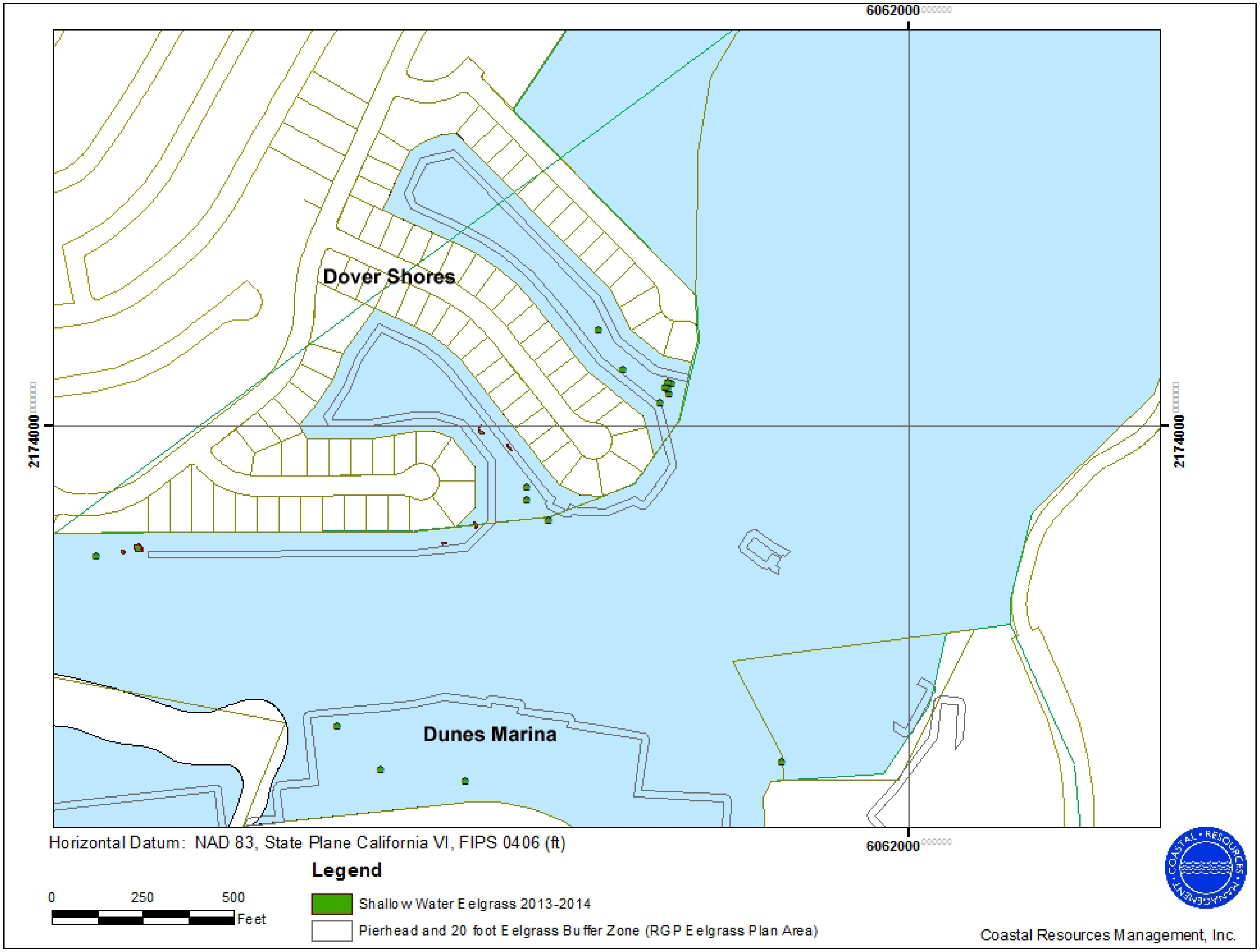


Figure 17. 2013-2014 Eelgrass Habitat Map. Dover Shores and Dunes Marina

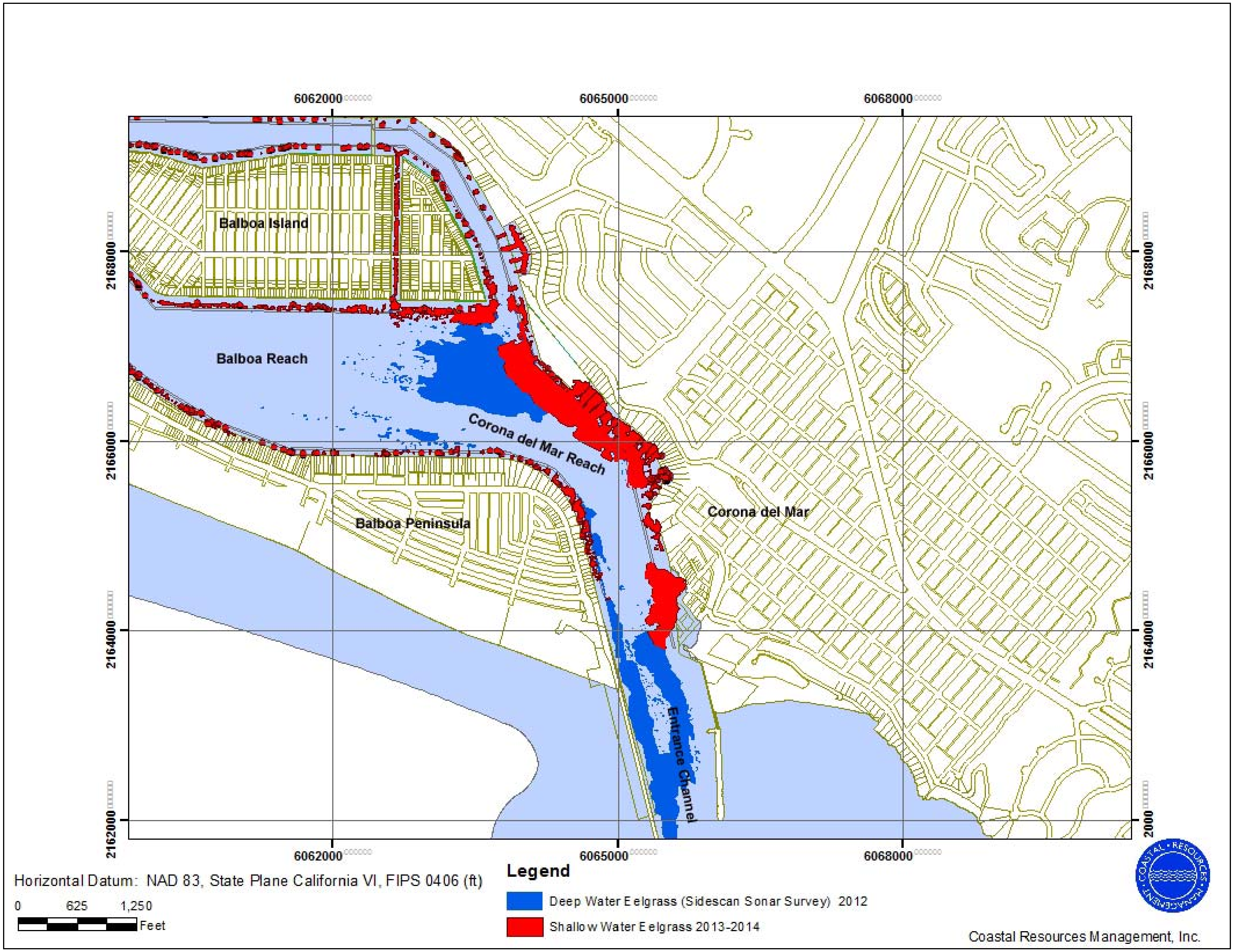


Figure 18. 2013-2014 Eelgrass Habitat Map. Deep Water (and) Shallow Water Eelgrass

3.4 TWO-WAY CLASSIFICATION ANALYSIS OF EELGRASS DISTRIBTUION IN NEWPORT BAY

Figure 19 illustrates the relationship between eelgrass abundance among the 21 Shallow Water eelgrass regions between 2003 and 2014. This analysis groups together (clusters) eelgrass survey regions together based upon their respective eelgrass acreage similarity coefficient (attributes). The more closely related regions exhibit higher similarity coefficients. The results indicate the presence of four eelgrass site groups (A-D) and three temporal groups (1-3).

Site group A included a singular member (Corona del Mar/Bayside), located in the Fore-Bay Stable Eelgrass Zone (CRM 2010), which is the dominant eelgrass region within Newport Harbor. Site Group B members are also located in the Stable Eelgrass Zone but primarily in the Mid-Bay region centered on Balboa Island. Linda Isle was an anomaly. It was also included in this Site Group and considered a “Stable Zone” member, but was geographically removed since it is located at the juncture of Newport Harbor and Upper Newport Bay. Its inclusion was related to high abundance (>1 acre) between 2006 and 2014 despite low abundance in 2003 (<1 acre). Site Group C included Mid-Lower Bay and Upper Newport Bay regions within the Transitional Eelgrass Zone. Eelgrass abundances at these sites were highest during the 2003-2004 survey, fluctuated (mostly declining) during the 2006-2007 and 2009-2010 surveys, and increased during between the 2009-2010 and the 2013-2014 surveys. Harbor Island, Linda Isle (outer channels) and Bayshores were a subset within this group that showed higher initial abundances than the other regions in Group C during the 2003-2004 survey. Site Group D locations were characterized by being unvegetated (Lido Peninsula and West Newport), having minor amounts of eelgrass (Dover Shores, and Dunes Marina), or not sampled during all four of the surveys (Lido Peninsula, West Newport, Dover Shores, and Dunes Marina).

Temporal groups include Group 1 (2003-2004), Group 2 (2006-2007 and 2009-2010) and Group 3 (2013-2014). Temporal Group 1 (the first survey) provides the “baseline” for the other three surveys. This temporal group was unique for the low eelgrass abundance in Inner Linda Isle (Group B) and high eelgrass abundance for Harbor Island and Linda Isle Outer Channels (Group C). Temporal Group 2 (2006-2007 and 2009-2010) time periods exhibited fluctuating eelgrass abundances in Site Groups A, B, and C regions. The most evident declines in eelgrass abundance were for Harbor Island and Linda Isle Outer Channel. Lastly, Temporal Group 3 was characterized by increases in eelgrass abundance at all sites and in all groups between 2009-2010 and 2013-2014, and the inclusion of Dover Shores and Dunes Marina and Access Channel which had not been surveyed prior to 2014.

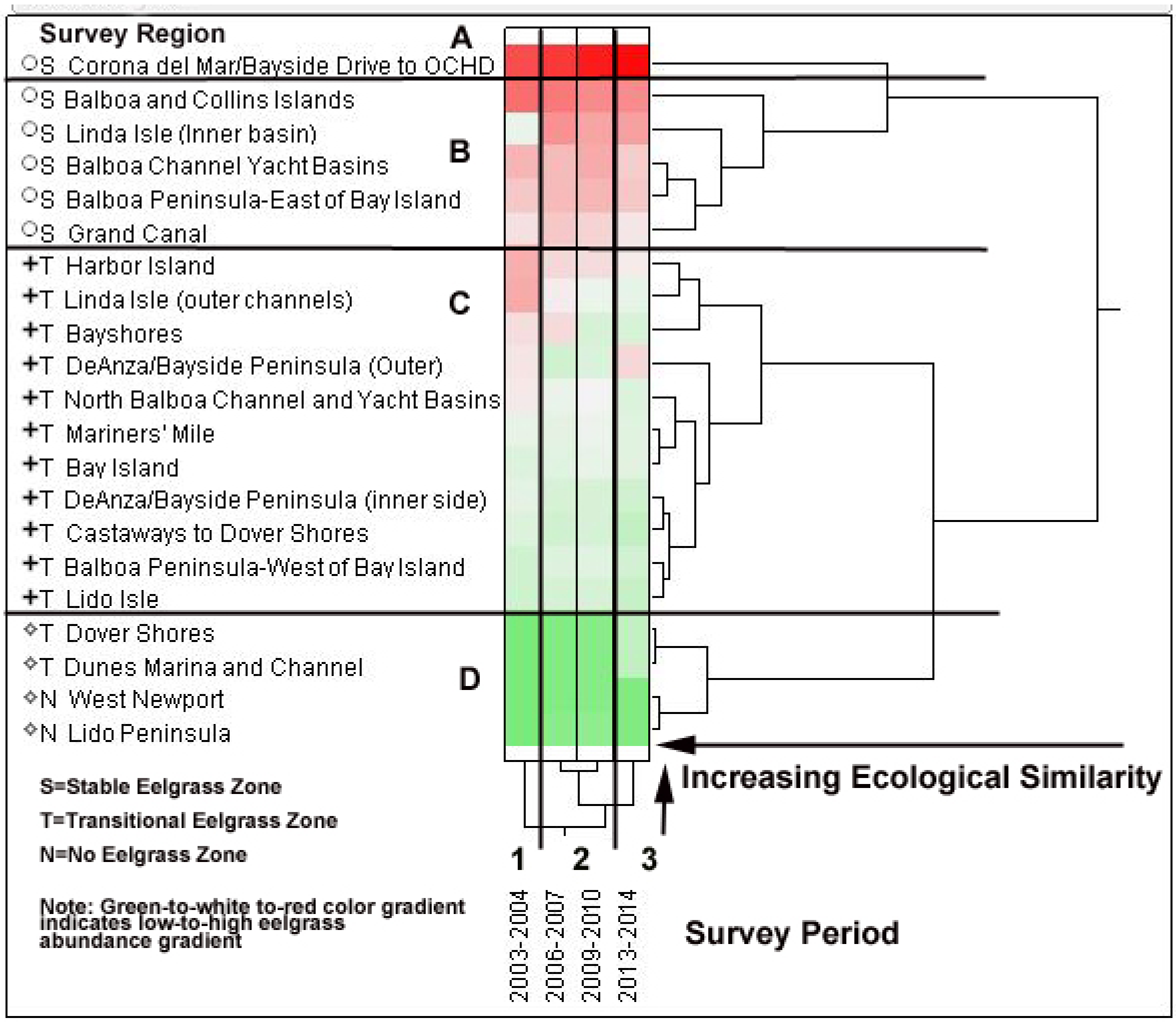


Figure 19. Site Classification Analysis. Eelgrass Distribution and Abundance, 2003-2014
S=Stable Eelgrass Zone; T=Transitional Eelgrass Zone; N=No Eelgrass

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.

Newport Bay eelgrass turion density counts were collected between March 2013 and April 2014. Some sites were visited during summer and winter to provide temporal comparisons. The overall mean (all sites) was 117.7 turions per square meter (sq m) which was 96% of the average density observed in Newport Bay in 2011 (123.5 turions per sq m), 87% of the density in 2008 (136.1 turions per sq m) and 51% of the turion density observed in 2004 (Figure 20). For all four surveys, mean turion density was 160.6 +/- 106 turions per sq m (n=1,697). A summary of eelgrass density data for all surveys conducted between 2004 and 2014 is provided in Appendix 2.

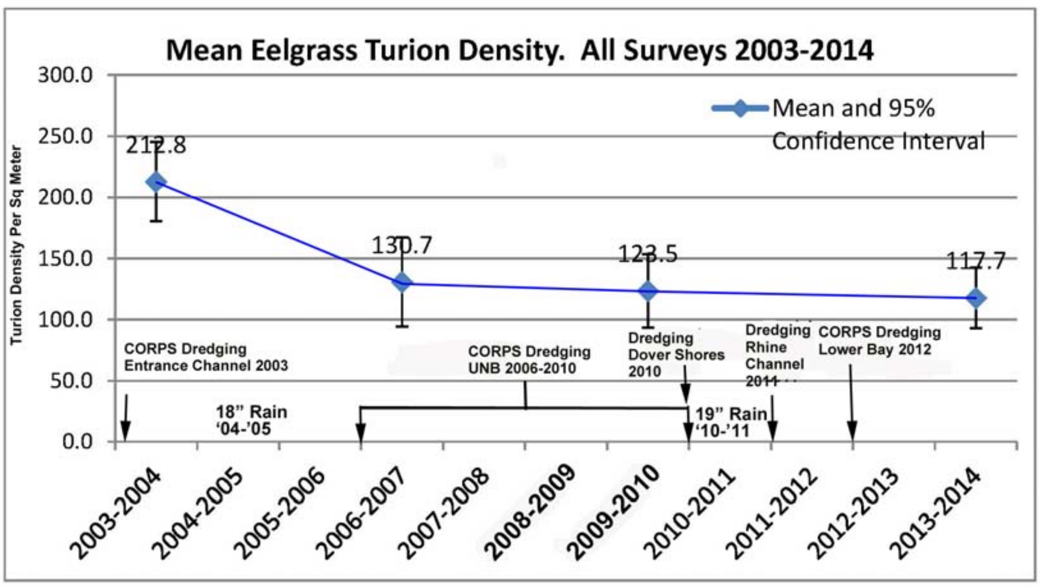


Figure 20.

3.5.1 Eelgrass Density Spatial Trends

Survey results for the 2014 are summarized in Figure 21. Station density varied from 39.1 turions per sq m ("C" Street, Balboa Peninsula, January 2014) to 259.3 turions per sq m (Carnation Cove, January 2014). Sites exhibiting high density included the west side of the Harbor Entrance Channel along Channel Road (185.7 turions per sq m, July 2013), and the west side of Harbor Island during January 2014 (175.5 turions per sq m). Sites with comparatively lower density included the Coast Highway Bridge (50.0 turions per sq m, July 2013), OCC Boat Basin (66.4 turions per sq m, August 2013), China Cove (70.5 turions per sq m, January 2014), and Harbor Island (August 2013). At locations where Summer 2013 and Winter 2014 density counts were taken, there was a noticeable increase during the January 2014 counts compared to July and August 2013 (Figure 20) .

Figure 22 compares the results of the four turion density surveys conducted between 2003 and 2014. Turion density increases were observed at six of the 15 stations in 2013-2014 (West Entrance Channel, Carnation Cove, Harbor Island, Linda Isle, PCH Bridge, Bayshores, and DeAnza/Bayside Peninsula). The West Entrance Channel and Carnation Cove are in the Stable Eelgrass Zone. The latter four sites are within the Transitional Zone. Density declined at all other sites compared to 2009-2010 in both the Stable and Transitional Eelgrass Zones.

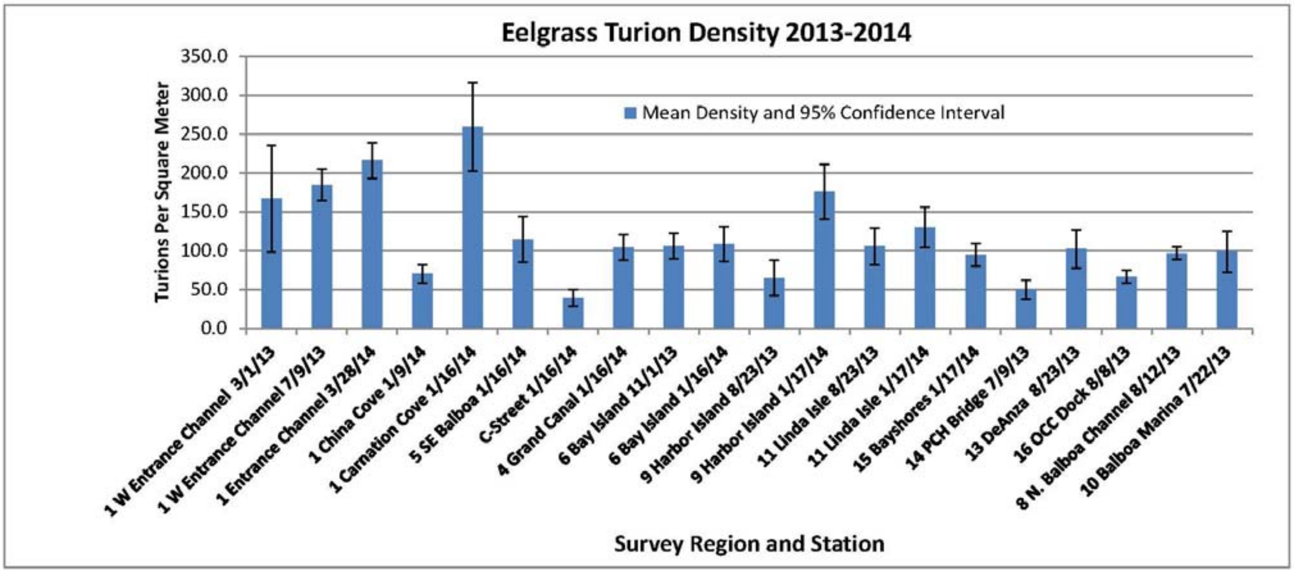


Figure 21.

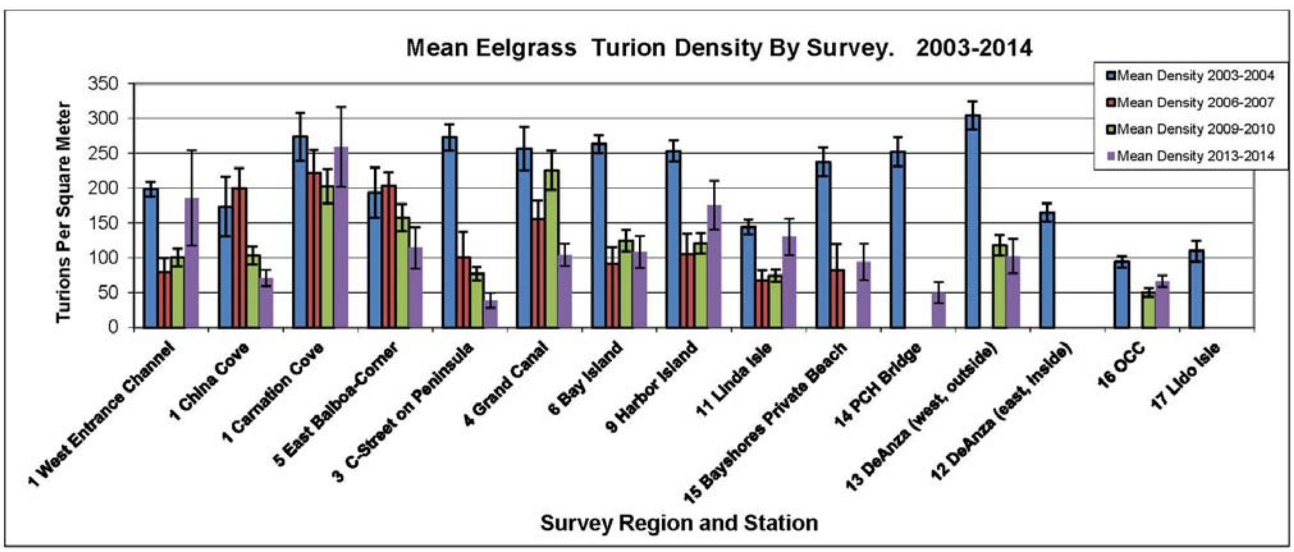


Figure 22.

3.5.2 Eelgrass Density and Depth Relationships

Eelgrass turion density decreased with increasing depth in 2013-2014; $r^2 = 0.39$ (Figure 23). However, the relationship was not as strong as during prior surveys in 2009-2010 ($r^2 = 0.44$), 2008 ($r^2 = 0.72$) or 2004 ($r^2 = 0.72$). The decrease is likely a function of lower density eelgrass beds at low intertidal and very shallow subtidal depths. The density/depth 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). Lower Bay dredging activity took place in 2012 and early 2013 over a 9-month period (prior to the initiation of the 2013-2014 Bay-Wide Survey. Over 600,000 cubic yards of sediment were barged out of the harbor. Some of the areas that were dredged were in channels that were vegetated with eelgrass, including the channels between Harbor Island and Linda Isle and between Linda Isle and Beacon Bay where localized decreases in eelgrass acreage occurred. Stormwater runoff has been excessively low since 2010, with rainfall less than six inches each year since 2010 (County of Orange http://ocwatersheds.com/rainrecords/rainfalldata/historic_data/rainfall_data. Therefore, it is likely that any density reduction is not from stormwater events but more likely a consequence of in-bay activities (i.e., dredging, barge scow and tug movements).

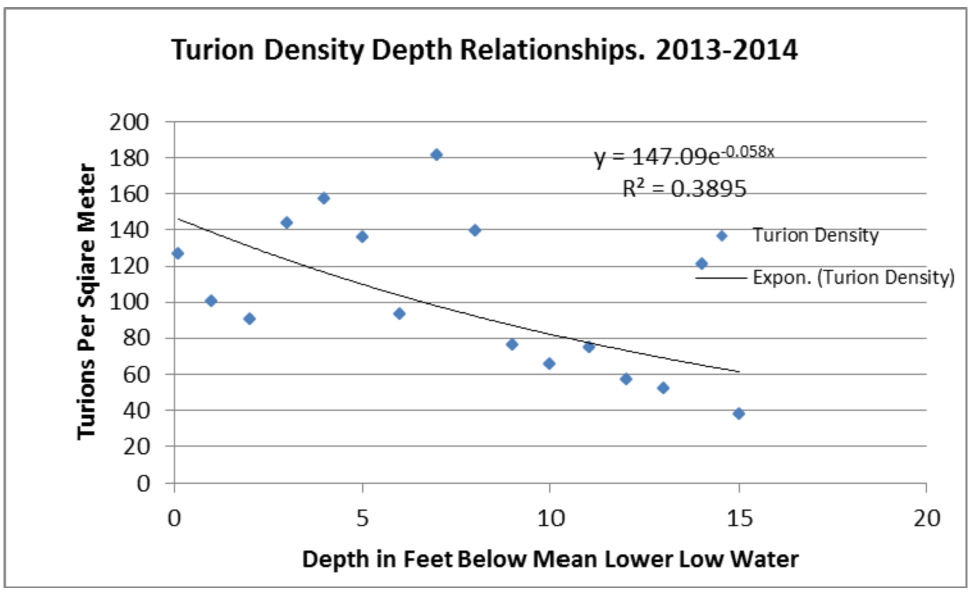


Figure 23. Newport Bay Eelgrass Turion Density/Depth Relationships, 2004-2014

4.0 EELGRASS DISTRIBUTIONAL ZONES IN NEWPORT BAY

Coastal Resources Management, Inc. proposed an eelgrass distributional model predicated upon knowledge obtained during the 2003-2004 and 2006-2007 bay-wide eelgrass surveys, the modeled tidal residence time periods in the bay (Everest International, 2009), and 2008-2009 Newport Bay oceanographic survey results (Coastal Resources Management, Inc., 2010). The model identified three distributional zones (Figure 24). These are:

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 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. Linda Isle Inlet is also grouped into this zone because of the long-term presence, and large amount of eelgrass present between 2006 and 2014.

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. This area will expand or contract depending on growing conditions and other influences.

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 and the Dunes Marina. These areas are characterized by tidal flushing times greater than 14 days.

Eelgrass abundance trends within the Stable and Transitional Eelgrass Zones during the four eelgrass surveys conducted to date are shown in Figure 22. Data for regions within each of the zones, by survey is provided in Appendix 3.

The amount of eelgrass increased throughout the Stable Eelgrass Zone and the Transitional Zone in 2013-2014 (Figure 25). During this period, the total amount in the Stable Zone was 36.539 acres and each of the seven survey regions exhibited areal cover increases. The exceptionally high amount in 2013-2014 compared to previous surveys was partially related to enlarging the Shallow Water Eelgrass Habitat survey area to include the -15 ft contour along Corona del Mar and Balboa Island. Transitional Zone eelgrass acreage increased from 1.58 acres in 2009-2010 to 5.61 acres in 2013-2014. The geographical distribution of eelgrass within the zones during 2013- 2014 was consistent with the Newport Bay Eelgrass Distribution Model. Transitional Zone boundaries fluctuated, as evidenced by eelgrass vegetation extending farther west in the Lido Reach and the Rhine Channel Reach than during any earlier survey (Figures 10, 14, and 23) and secondly, a substantial recovery of eelgrass in the Upper Newport Bay compared to 2006-2007 and 2009-2010 (Figure 12 and 23) .

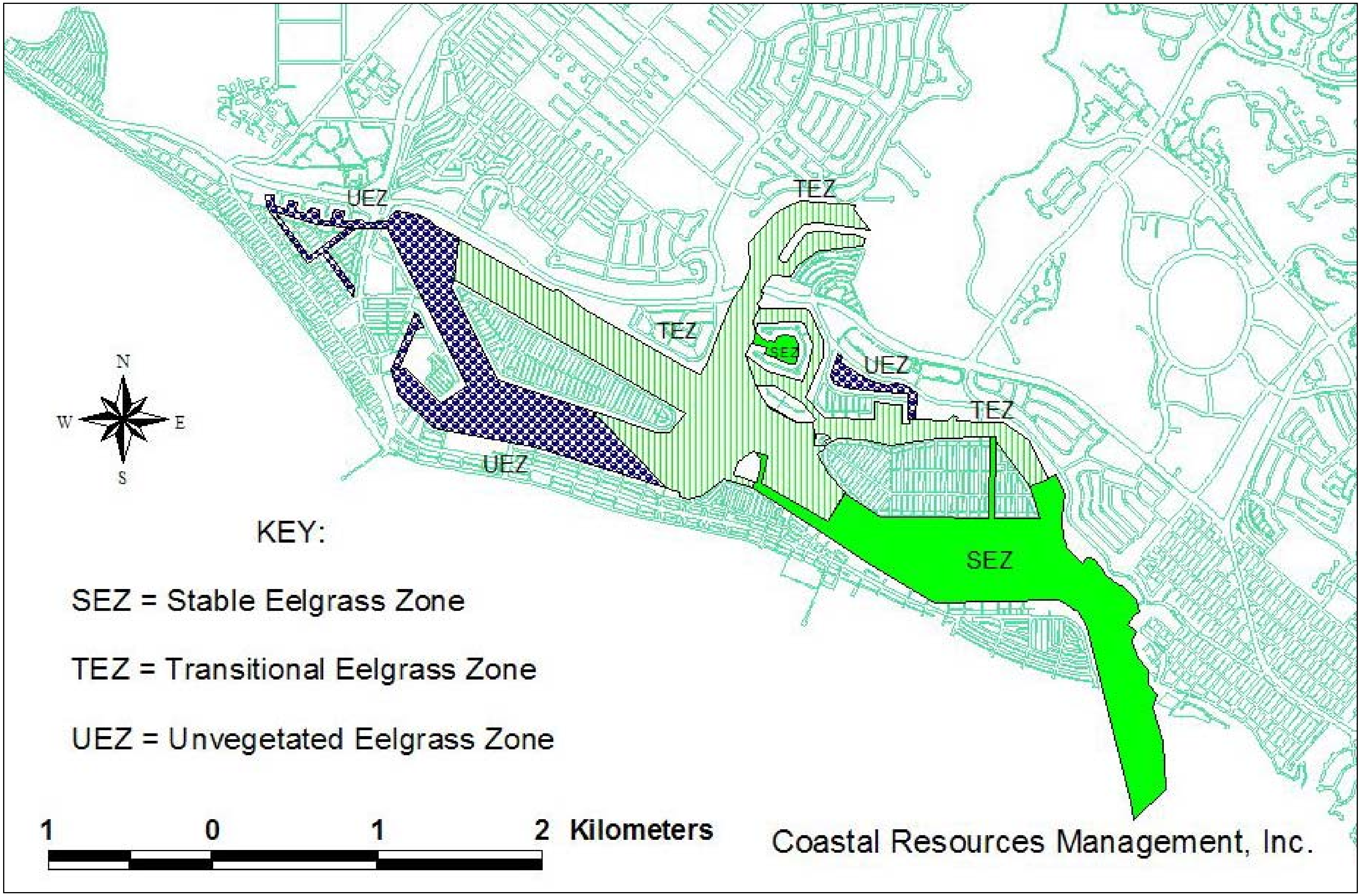


Figure 24. Eelgrass Zones In Newport Bay. Source: CRM 2010

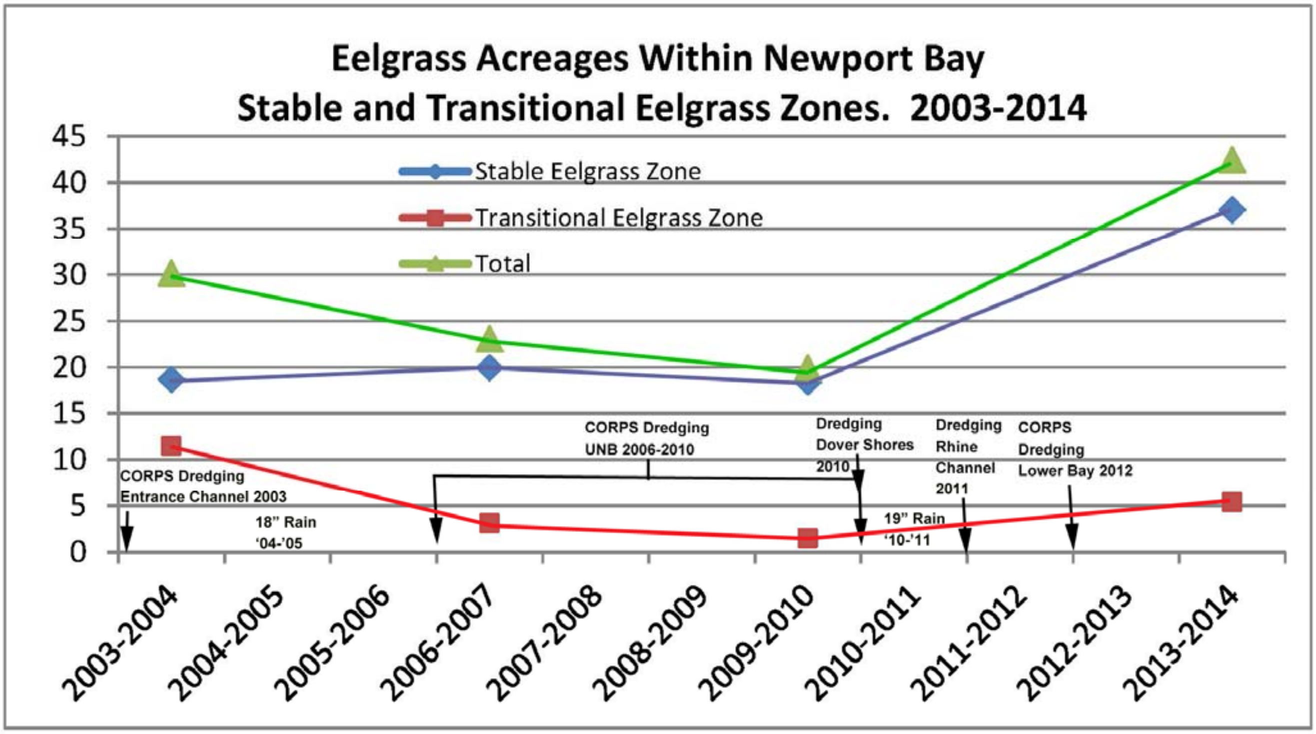

Eelgrass Acreages Within Newport Bay
Stable and Transitional Eelgrass Zones. 2003-2014
Stable Eelgrass Zone
Transitional Eelgrass Zone
Total
45
40
35
30
25
20
15
10
5
0
CORPS Dredging Entrance Channel 2003
18" Rain '04-'05
CORPS Dredging UNB 2006-2010
Dredging Dover Shores 2010
19" Rain '10-'11
Dredging Rhine Channel 2011
CORPS Dredging Lower Bay 2012
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008
2008-2009
2009-2010
2010-2011
2011-2012
2012-2013
2013-2014

Figure 25.

5.0 SUMMARY AND CONCLUSIONS

Eelgrass species (*Zostera marina* and Z. *pacifica*) play an important role in bays and nearshore coastal environments. Among its most important features, eelgrass:

1. Attracts many marine invertebrates and fish to the vegetation's vertical relief and enhances the abundance and the diversity of the marine life compared to areas where the sediments are barren;
2. serves as protective cover for invertebrates and fish;
3. is a fish spawning area and refuge for juvenile fishes including species of commercial and/or sports fish value such as California halibut and barred sand bass;
4. is an important foraging center for seabirds and sea turtles;
5. contributes to the detrital (decaying organic) food web of bays;
6. filters pollutants from the water, absorbs large quantities of the greenhouse gas carbon dioxide from the atmosphere and stores it in the sediments helping to offset carbon emissions; and
7. protects shorelines from erosion by absorbing wave energy.

Shallow Water and Deep Water eelgrass *(Z. marina* and *Z. pacifica*) surveys were conducted in Newport Bay in support of the City of Newport Beach Harbor Area Management Plan (HAMP) between 2012 and 2014. The bay was divided into twenty-one Shallow Water and one Deepwater mapping regions. The results of these surveys indicate eelgrass is common in many parts of Newport Bay and covers 88.27 acres of bottom habitat between the low tide zone to depths of -28.5 feet below Mean Lower Low Water in silt to sandy sediments. The following were key findings of the intensive diver and bioacoustical eelgrass surveys conducted in Lower Newport Bay (Newport Harbor) and Upper Newport Bay between March 2012 and April 2014.

1. A total of 42.35 acres of vegetated Shallow Water Eelgrass Habitat was mapped at depths between 0.0 and -15 feet relative to Mean Lower Low Water.
2. Three regions accounted for 77.6% of all eelgrass in the Bay: Corona del Mar/Bayside Drive (22.372 acres);Balboa and Collins Islands (5.978 acres); and Linda Isle Inner Basin (4.495 acres)
3. Other regions with significant amounts of eelgrass included: Balboa Peninsula east of Bay Island (2.267 acres);Balboa Channel Yacht Basins (2.056 acres);Outer DeAnza/Bayside Peninsula (1.596 acres);Grand Canal (1.062 acres); and Harbor Island (0.991 acre)
4. Lowest eelgrass abundances were found in the western section of Newport Bay in the Lido Reach and Rhine Channel Reach.
5. Eelgrass was absent from the Lido Peninsula and West Newport (west of the Newport Blvd Bridge).
6. Following a period of declining eelgrass abundance in Newport Bay between 2006 and 2010, the amount of Shallow Water eelgrass increased in all regions in Newport Bay to levels not

observed since the initial 2003-2004 survey. Significant recolonization occurred around Balboa/Collins Island, Linda Isle Inlet, the DeAnza Bayside Peninsula in Upper Newport Bay, Balboa Peninsula east of Bay Island. Higher acreages along the Corona del Mar shoreline were in part, due to surveying an expanded area in 2014 to include bayfloor to depths of -15 feet that had been mapped as Deep Water Eelgrass Habitat in 2008 and 2012.

7. Based upon eelgrass distributional patterns observed since 2003, eelgrass grows within a Stable and Transitional Eelgrass Zone. The distribution of eelgrass in Newport Bay followed similar patterns as those observed during the previous 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-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. The fluctuating (and expanding boundary) of eelgrass within the Transitional Zone during the 2013-2014 survey was illustrated by eelgrass being mapped farther west along the Balboa Peninsula (west of Bay Island) in the Rhine Channel Reach, and along Mariners' Mile in the Lido Reach than during any earlier survey.

8. A two-way classification analysis (cluster analysis) was used to identify the relationship between eelgrass abundance within each region and among the four surveys. The results indicated a strong relationship between stations within the Stable Eelgrass Zone and a second strong relationship among Transitional Zone eelgrass regions. Analysis by time interval identified discreet differences between the first survey conducted in 2003-2004; the second and third surveys conducted in 2006-2007 and 2009-2010; and the fourth survey conducted in 2013-2014. This analysis provided additional evidence as to the presence of discreet eelgrass zones within Newport Bay.

9. The changes in eelgrass distribution between 2003 and 2014 illustrate the highly dynamic nature of the eelgrass system and that eelgrass distribution and abundance will contract-and-expand particularly in areas of Newport Bay that are more susceptible to variation in the physical and chemical environment.

10. 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.

11. Eelgrass turion (i.e., shoot) density information was collected at 15 sites between March 2013 and January 2014. Bay-wide turion density in 2013-2014 (117 turions per sq meter) was 95% of the value observed during the 2009-2010 survey and 51% of the value recorded during 2003-2004. Overall, turion density was highest in the Entrance Channel and along the Corona del Mar shoreline. Where density counts were taken at the site during August 2013 and January 2014, higher density counts in January 2014 compared to August 2013 may indicate a regrowth following a period of eelgrass turion density reduction in the Bay.

12. Turion density was moderately correlated to depth. However, the correlation was weaker than in prior surveys particularly at shallower bay depths.

13. Bioacoustical mapping methods using sidescan sonar to map eelgrass on the bayfloor of the Entrance Channel, Corona del Mar Bend, and Balboa Reach in March 2012 quantified 45.92 acres of eelgrass at depths between -15 and -28.5 ft MLLW. This acreage corresponds with the CRM 2008 survey when a total of 45.86 acres of eelgrass was mapped in the same area. Both the wide-bladed form (*Z. pacifica*) and the narrow-bladed form (*Z. marina*) were found in these areas, with *Z. pacifica* primarily occupying the deeper portions of the Entrance Channel and Corona del Mar Bend.

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APPENDIX 1.

Appendix 1.1. Results of 2013-2014 Eelgrass Habitat Mapping Surveys With Regions 1 and 5 Areas **Standardized to Prior Survey Areas.**

Region	Description	Acres	% Total	Sediment Type Source: (CRM 2010)
1	Corona del Mar/Bayside Drive to OCHD	11.812	38.4	Coarse Silt to Medium Sand
5	Balboa and Collins Islands	4.940	16.1	Fine Sand
11	Linda Isle (inner basin)	4.495	14.6	Very Fine Silt
3	Balboa Peninsula East of Bay Island	2.267	7.4	Fine Sand to Medium Sand
2	Balboa Channel Yacht Basins	2.056	6.7	Silt to Fine Sand
13	DeAnza/Bayside Peninsula (outer)	1.596	5.2	Medium Silt, fine sand
4	Grand Canal	1.062	3.5	Fine sands
9	Harbor Island	0.911	3.0	Fine to Coarse Silt
10	Linda Isle (outer channels)	0.393	1.3	Coarse Silt to Fine Sand
16	Mariners' Mile	0.305	1.0	Coarse Silt to Fine Sand
6	Bay Island	0.298	1.0	Coarse Silt to Fine Sand
8	North Balboa Channel and Yacht Basin	0.242	0.8	Coarse Silt to Fine Sand
15	Bayshores	0.156	0.5	Very Fine Sand
7	Balboa Peninsula West of Bay Island	0.102	0.3	Fine Silt to Medium Sand
12	DeAnza/Bayside Peninsula (inner)	0.077	0.3	Medium Silt
17	Lido Isle	0.023	0.1	Coarse Silt to Medium Sand
14	Castaways to Dover Shores	0.010	0.03	Coarse Silt to Medium Sand
20	Dover Shores	0.009	0.03	Medium Silt
21	Dunes Marina and Channel	0.002	0.01	Fine silt to coarse silt
18	Lido Peninsula	0.000	0.00	Medium silt
19	West Newport	0.000	0.00	Silts to fine sands
	All Regions	30.755	100.0	

Appendix 1.2 Comparison of Shallow Water Habitat Eelgrass Acreages, All Surveys
(Regions 1 and 5 Standardized to Prior Survey Areas)

Region	Description	2003-2004 (acres)	2006-2007 (acres)	2009-2010 (acres)	2013-2014 (acres)	Mean (acres)	Difference (acres) between 2003-2014
1	Corona del Mar/Bayside Drive to OCHD	9.521	9.075	10.363	**11.812**	10.193	2.291
5	Balboa and Collins Islands	6.686	4.554	3.052	**4.940**	4.808	-1.746
11	Linda Isle (Inner basin)	0.281	3.218	1.974	**4.495**	2.492	4.214
2	Balboa Channel Yacht Basins	2.469	1.539	1.758	**2.056**	1.956	-0.413
3	Balboa Peninsula-East of Bay Island	1.672	1.557	1.391	**2.267**	1.722	0.595
9	Harbor Island	2.721	0.712	0.446	**0.911**	1.197	-1.810
4	Grand Canal	0.898	1.143	0.623	**1.062**	0.931	0.164
10	Linda Isle (outer channels)	2.916	0.328	0.068	**0.393**	0.926	-2.523
13	DeAnza/Bayside Peninsula (Outer)	0.792	0	0.001	**1.596**	0.597	0.804
15	Bayshores	0.991	0.664	0.000	**0.156**	0.453	-0.835
8	North Balboa Channel and Yacht Basins	0.698	0.115	0.119	**0.242**	0.294	-0.456
16	Mariners' Mile	0.234	0.066	0.070	**0.305**	0.169	0.071
6	Bay Island	0.132	0.051	0.041	**0.298**	0.130	0.166
12	DeAnza/Bayside Peninsula (inner side)	0.209	0.009	0.000	**0.077**	0.074	-0.132
7	Balboa Peninsula-West of Bay Island	0.034	0.03	0.014	**0.102**	0.045	0.068
14	Castaways to Dover Shores	0.132	0	0.000	**0.010**	0.036	-0.122
17	Lido Isle	0.025	0.004	0.000	**0.023**	0.013	-0.002
20	**Dover Shores**	nd	nd	nd	**0.009**	0.009	
21	**Dunes Marina and Channel**	nd	nd	nd	**0.002**	0.002	
18	**Lido Peninsula**	**nd**	0	0.000	**0.000**	0.000	
19	**West Newport**	nd	nd	nd	**0.000**	0.000	
	All Regions	30.411	23.065	19.920	**30.755**	26.038	0.344

APPENDIX 2. EELGRASS TURION DENSITY DATA, 2004, 2008, 2011, and 2013-2014

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
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	100.6	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
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)			

2013-2014

Description	Mean	Std Dev	N	95% CI
West Entrance Channel	166.7	67.3	42.0	68.2
West Entrance Channel	184.4	67.0	33.0	20.4
West Entrance Channel	216.0	41.8	39.0	22.9
China Cove	70.5	32.5	30.0	11.6
Carnation Cove	259.3	148.6	26.0	57.1
East Balboa-Corner	114.3	82.2	30.0	29.4
C-Street on Peninsula	39.1	29.3	30.0	10.5
Grand Canal	104.1	43.3	28.0	16.0
Bay Island	105.8	54.0	57.0	16.0
Bay Island	108.4	63.5	30.0	22.7
Harbor Island	64.9	29.3	18.0	22.7
Harbor Island	175.5	95.0	28.0	35.2
Linda Isle	105.6	54.2	20.0	23.8
Linda Isle	130.0	73.3	30.0	26.2
Bayshores Private Beach	94.5	40.8	30.0	14.6
PCH Bridge	50.0	23.6	15.0	11.9
DeAnza (west, outside)	102.2	53.2	18.0	24.6
OCC	66.4	24.8	34.0	8.3
North Balboa Channel	96.6	62.6	22.0	8.3
Balboa Marina	98.8	29.3	33.0	26.2

APPENDIX 3
EELGRASS ACREAGES BY ZONE IN NEWPORT BAY

(*Shallow Water Habitat-all areas surveyed by Coastal Resources Management, Inc. at depths between 0.7 and -15 MLLW. Includes 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. Sources; CRM 2010; WRA, 2013.

STABLE ZONE	2003-2004	2006-2007	2009-2010	2013-2014	Mean	Std Dev	95% CI
Balboa Island/Collins Isle	4.570	3.550	2.460	4.728	3.827	1.050	1.029
Bay Island	0.120	0.050	0.040	0.170	0.095	0.061	0.060
Corona del Mar (Bayside)	9.500	9.080	10.360	22.372	12.828	6.385	6.257
East Balboa Peninsula	1.630	1.550	1.390	2.269	1.710	0.386	0.378
Grand Canal	0.900	1.140	0.620	1.060	0.930	0.229	0.225
Linda Isle Inner	0.150	3.150	1.940	4.129	2.342	1.714	1.680
Yacht Club/Basins	1.830	1.430	1.590	1.821	1.668	0.194	0.190
TOTAL IN STABLE ZONE	**18.700**	**19.960**	**18.420**	**36.539**	**23.405**	**8.782**	**8.606**
TRANSITIONAL ZONE	**2003-2004**	**2006-2007**	**2009-2010**	**2013-2014**	**Mean**	**Std Dev**	**95% CI**
Balboa Island/Collins Isle	2.1	1	0.58	1.194	1.219	0.641	0.628
Bay Island	0.01	0	0	0.02	0.008	0.010	0.009
Bayshores	0.99	0.66	0	0.154	0.451	0.457	0.448
Castaways	0.13	0	0	0.012	0.036	0.063	0.062
Dover Shores	0	0	0	0.009	0.002	0.005	0.004
Dunes Marina	0	0	0	0.002	0.001	0.001	0.001
Harbor Island	2.94	0.72	0.44	0.912	1.253	1.141	1.118
Lido Isle	0.02	0	0	0.01	0.008	0.010	0.009
Inner DeAnza Peninsula	0.21	0.01	0	0.077	0.074	0.097	0.095
Linda Isle Inner	0.13	0.12	0.03	0.284	0.141	0.105	0.103
Linda Isle Outer	2.9	0.27	0.07	0.472	0.928	1.325	1.298
Mariner's Mile	0.23	0.07	0.07	0.3	0.168	0.116	0.114
North Balboa Channel and Yacht Basin	0.76	0.15	0.21	0.259	0.345	0.280	0.275
West Balboa Peninsula	0.03	0.03	0.01	0.07	0.035	0.025	0.025
Outer DeAnza Peninsula	0.77	0	0	1.596	0.592	0.762	0.746
Yacht Club/Basins	0.6	0.11	0.16	0.24	0.278	0.222	0.217
TOTAL IN TRANSITIONAL ZONE	**11.82**	**3.15**	**1.58**	**5.611**	**5.540**	**4.503**	**4.413**
TOTAL	**30.52**	**23.10**	**19.99**	**42.15**	**28.940**	**9.852**	**9.655**