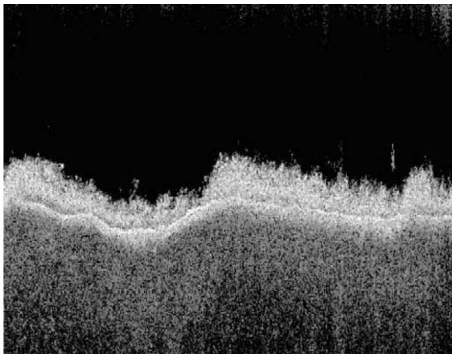
RESULTS OF THE FIFTH EELGRASS (ZOSTERA MARINA) MAPPING SURVEY: STATUS AND DISTRIBUTION IN NEWPORT BAY, NEWPORT BEACH, CALIFORNIA 2016 SURVEY



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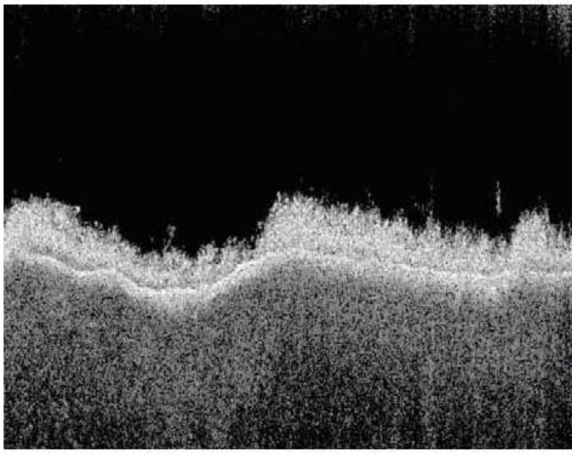

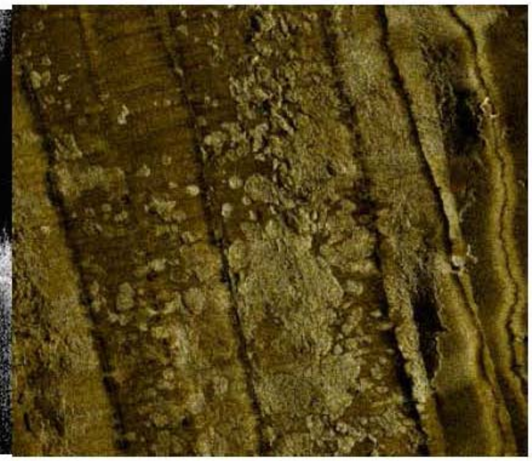

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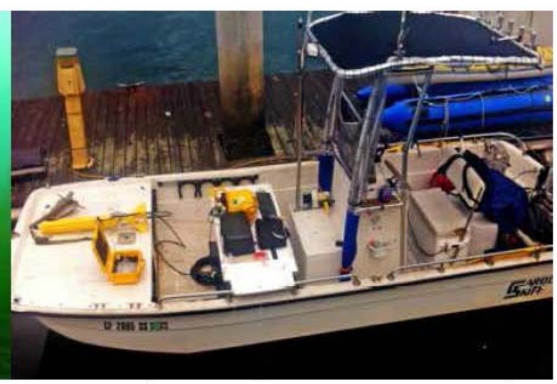


Eelgrass Survey in Progress

CRM/NWS Sidescan Sonar Vessel Setup

1. INTRODUCTION

Coastal Resources Management Inc. (CRM) conducted eelgrass habitat mapping surveys in Newport Bay between June and December 2016. The surveys consisted of mapping Shallow Water Eelgrass Habitat (SWEH) and Deep Water Eelgrass Habitat (DWEH) in support of the City of Newport Beach Harbor Area Management Plan (HAMP). This is the fifth SWEH survey and the third DWEH survey since the program was initiated in 2003. Previous eelgrass habitat assessments were conducted in 2003-2004 (Coastal Resources Management, Inc. 2005), 2006-2008 (Coastal Resources Management, Inc. 2010), 2009-2010 (Coastal Resources Management, Inc. (2012), and 2012-2014 (Coastal Resources Management, Inc. 2015).

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 (Lower Newport Bay) 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). Secondly, the data is being used by the City in support of their Eelgrass Protection and Mitigation Plan for Shallow Waters in Lower Newport Bay: An Ecosystem Based Management Program (City of Newport Beach, 2015), and the City's Regional General Permit (RGP) 54 issued by the U.S. Army Corps of Engineers (USACE, 2015). The public benefits from the data base by being able to determine the environmental constraints that may be a concern for infrastructure improvement projects such bulkhead repair/maintenance, beach nourishment, harbor dredging, and dock and pier construction and maintenance.

1.2 BACKGROUND

2003-2004 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).

2006-2008 Survey Summary. During the second SWEH mapping survey, a total of 23.1 acres of eelgrass was mapped between +0.7 and -12 ft MLLW. Turion density averaged 130.7 turions per square meter and varied between 67.1 and 221.9 turions per square meter (10 stations).

2009-2010 Survey Summary. A total of 19.92 acres of SWEH was mapped between 2009 and 2010. The amount of eelgrass present in 2009-2010 represented a decline of 10.49 acres (34%) of SWEH 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 Lower Newport Bay using sidescan sonar and mapped 45.4 acres of deep water eelgrass to depths of -28 ft MLLW.

2012-2014 Survey Summary. Eelgrass was common in many parts of Newport Bay and covered 88.27 acres of bottom habitat between the low tide zone and depths of -28.5 feet below Mean Lower Low Water in silt to sandy sediments. A total of 42.35 acres of vegetated SWEH was mapped at depths between 0.0 and -15 feet relative to Mean Lower Low Water. 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). 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. 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.

Three eelgrass stability zones were identified in Newport Bay as a result of these surveys: (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 has not documented between 2003 and 2014.

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- Lower Newport Bay and Upper Newport Bay. In recent history, Lower Newport Bay 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 USACE. A June 2008 survey of the channel conducted by the USACE 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

Figure 1. Regional Setting

the bay, as well as ongoing runoff from the surrounding watershed. Subsequently, Lower Newport Bay 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 Lower Newport Bay near Corona del Mar.

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 (https://cms.ocgov.com/gov/pw/watersheds/programs/ourws/wmaareas/wmacentraloc/default.asp)

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 USACE Ecological Restoration Project. 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 4.5 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 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., 2002, 2005, 2008, 2010, 2012, 2015).

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 et al, 1997). Seagrass beds absorb large quantities of the greenhouse gas carbon dioxide from the atmosphere (carbon sequestration) and store it, thus decreasing the effects of global warming (carbon storage). Eelgrass vegetated areas are "carbon sinks" and contain large stores of carbon accumulated over hundreds to thousands of years.

On a local level, eelgrass is also extremely important because it provides 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, while uncommon in Newport Bay, likely utilize eelgrass as a food source in Anaheim Bay, Sunset Bay, Huntington Harbour, Alamitos Bay, and the Cerritos Channel where green sea turtles more frequently been sighted.

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 Wildlife, 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. The fishery value of Lower 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 such as rock fish within the Pacific Groundfish Fisheries Management Plan (Pacific Fishery Management Council, 2008).

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, 2008).

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 California Eelgrass Mitigation Policy (CEMP) (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 improved mitigation effectiveness since its initial adoption in 1991 (National Marine Fisheries Service, 1991 as amended).

1.5.3 California Department of Fish and Wildlife Regulations

2014 Department of Fish and Wildlife 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 Wildlife. 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 2015, the City of Newport Beach adopted a Newport Bay-specific eelgrass mitigation plan entitled "***Eelgrass Protection and Mitigation Plan for Shallow Waters in Lower Newport Bay: An Ecosystem Based Management Program***" (City of Newport Beach, 2015a). 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 (Weston Solutions Inc., et al., 2010) The HAMP established goals and best management practices (BMPs) to ensure a healthy eelgrass population within Lower Newport Bay. The Plan serves the principal goals of protecting and promoting a long-term sustainable eelgrass population while serving Lower Newport Bay's navigational and recreational beneficial uses, particularly maintenance dredging activity associated with minor maintenance dredging under and adjacent to private, public, and commercial docks, floats, and piers currently authorized under the City's RGP 54 from the USACE. Dredging depth is not to exceed -10 feet mean lower low water (MLLW; plus 2 feet of allowable over depth).

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.

Exclusions from the Plan. The demolition, repair and in-kind replacement of docks (including piers, gangways, floats, and piles), bulkheads, and piles with similar structures are excluded from the current approved RGP 54 program. Eelgrass impacts as a result of beach replenishment or disposal of dredged material in front of an existing bulkhead are not covered under this Plan. All other activities that affect eelgrass fall under the governance of the California Eelgrass Mitigation Policy (See Section 1.5.2).

2.0 METHODS AND MATERIALS

2.1 PROJECT STAFF

The CRM eelgrass survey team included CRM Senior Marine Biologist Rick Ware (Principal Investigator/Senior Marine Biologist, M.A. Biology); Nick DaSilva (Marine Biologist, B.A, Aquatic Biology); Tom Gerlinger (Marine Biologist, M.A. Biology); Amanda Bird (Marine Biologist, B.S. Biology), and Rick Hollar (Senior Hydrographic Engineer, Nearshore and Wetland Surveys, M.S. Engineering). Mr. Ryan Stadlman (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 (WRA Associates) and Adam Gale (Anchor QEA, LLC) provided additional GIS and technical assistance. Chris Miller (City of Newport Beach Harbor Resources Manager) managed the project for the City of Newport Beach and provided logistical support. Mr. Doug Webb (City of Newport Beach Harbor Commissioner) also provided guidance to the program.

2.2 PROJECT LOCATION

Studies were conducted in Newport Bay, located within Newport Beach, Orange County, California (Figure 2). The survey area included the intertidal and subtidal soft bottom habitats of Newport Bay 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 -29 ft MLLW that included the Newport Bay Entrance Channel and Balboa Reach located in the Federal Navigational Channel. For acreage accounting purposes, the Bay was originally divided into 21 SWEH mapping regions (Figure 2). An additional survey region was added to the SWEH surveys during the 2016 survey, and included the North Star Beach area in Upper Newport Bay (Region 22). Newport's DWEH is identified as Region 23.

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

All but one of the SWEH mapping surveys was conducted between June 13th and October 16th, 2016. Region 22 (North Star Beach area) was added to the program by the City of Newport Beach on December 8th, 2016 and surveyed on December 13th, 2016. SWEH turion density surveys were conducted on September 14th, October 20th, and October 21st, 2016.

DWEH sidescan and downlooking sonar surveys were conducted on September 29th, 30th, and October 1st, 2016 and focused sonar target verification using remote cameras was conducted on October 1st and October 15th, 2016.

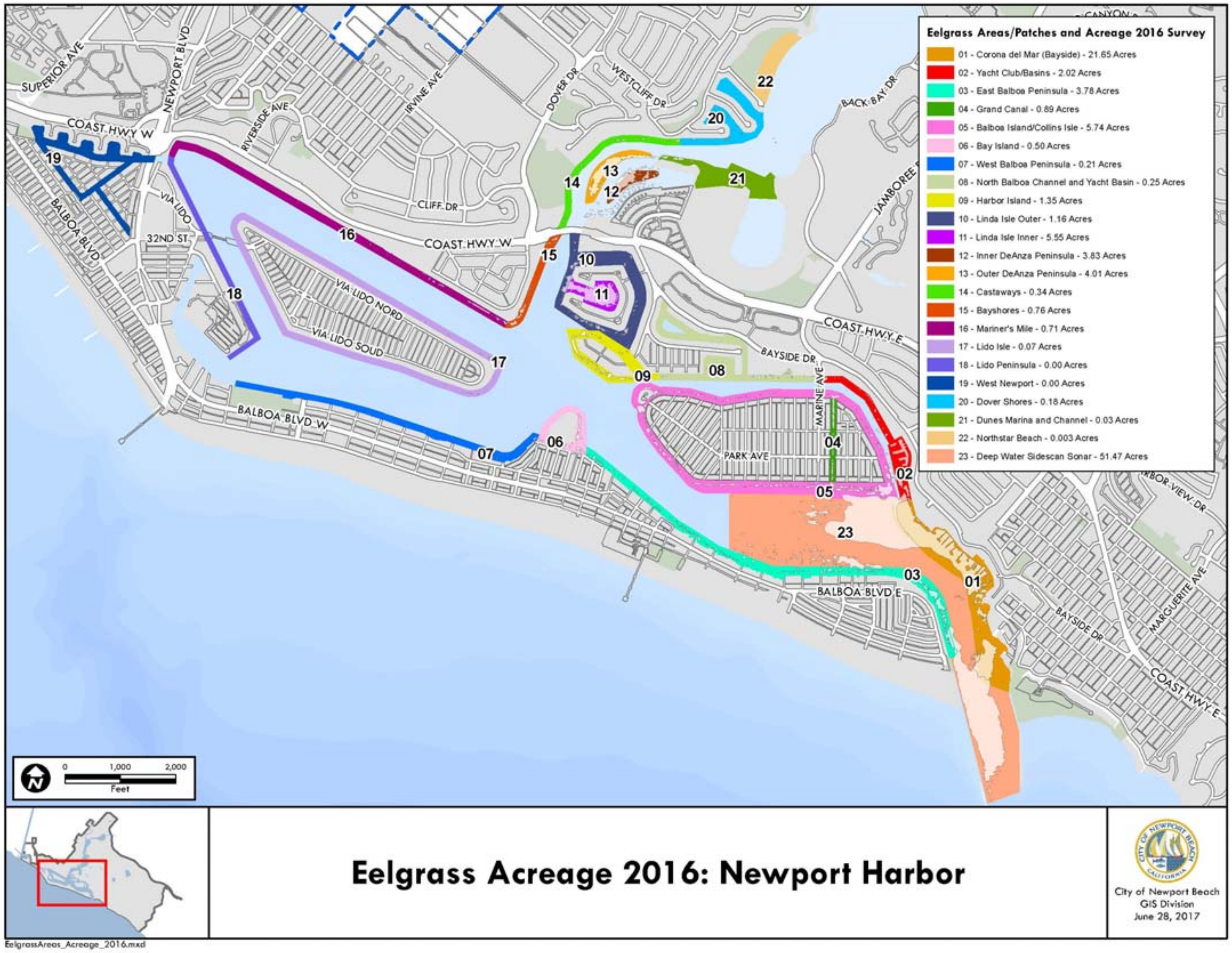

Eelgrass Areas/Patches and Acreage 2016 Survey
01 - Corona del Mar (Bayside) - 21.65 Acres
02 - Yacht Club/Basins - 2.02 Acres
03 - East Balboa Peninsula - 3.78 Acres
04 - Grand Canal - 0.89 Acres
05 - Balboa Island/Collins Isle - 5.74 Acres
06 - Bay Island - 0.50 Acres
07 - West Balboa Peninsula - 0.21 Acres
08 - North Balboa Channel and Yacht Basin - 0.25 Acres
09 - Harbor Island - 1.35 Acres
10 - Linda Isle Outer - 1.16 Acres
11 - Linda Isle Inner - 5.55 Acres
12 - Inner DeAnza Peninsula - 3.83 Acres
13 - Outer DeAnza Peninsula - 4.01 Acres
14 - Castaways - 0.34 Acres
15 - Bayshores - 0.76 Acres
16 - Mariner's Mile - 0.71 Acres
17 - Lido Isle - 0.07 Acres
18 - Lido Peninsula - 0.00 Acres
19 - West Newport - 0.00 Acres
20 - Dover Shores - 0.18 Acres
21 - Dunes Marina and Channel - 0.03 Acres
22 - Northstar Beach - 0.003 Acres
23 - Deep Water Sidescan Sonar - 51.47 Acres
SUPERIOR AVE
NEWPORT BLVD
COAST HWY W
RIVERSIDE AVE
IRVINE AVE
DOVER DR
WESTCLIFF DR
BACK BAY DR
JAMBOREE
CLIFF DR
VIA LIDO
32ND ST
BALBOA BLVD
VIA LIDO NORD
VIA LIDO SOUD
COAST HWY E
BAYSIDE DR
MARINE AVE
PARK AVE
BALBOA BLVD W
BALBOA BLVD E
HARBOR VIEW DR
MARGUERITE AVE
0
1,000
2,000
Feet
Eelgrass Acreage 2016: Newport Harbor
City of Newport Beach
GIS Division
June 28, 2017
EelgrassAreas_Acreage_2016.mxd

Figure 2

2.4 EELGRASS SURVEY METHODS

Three methods were used to map eelgrass. 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 SWEH bed formed a continuum with the deeper Navigational Channel eelgrass bed.

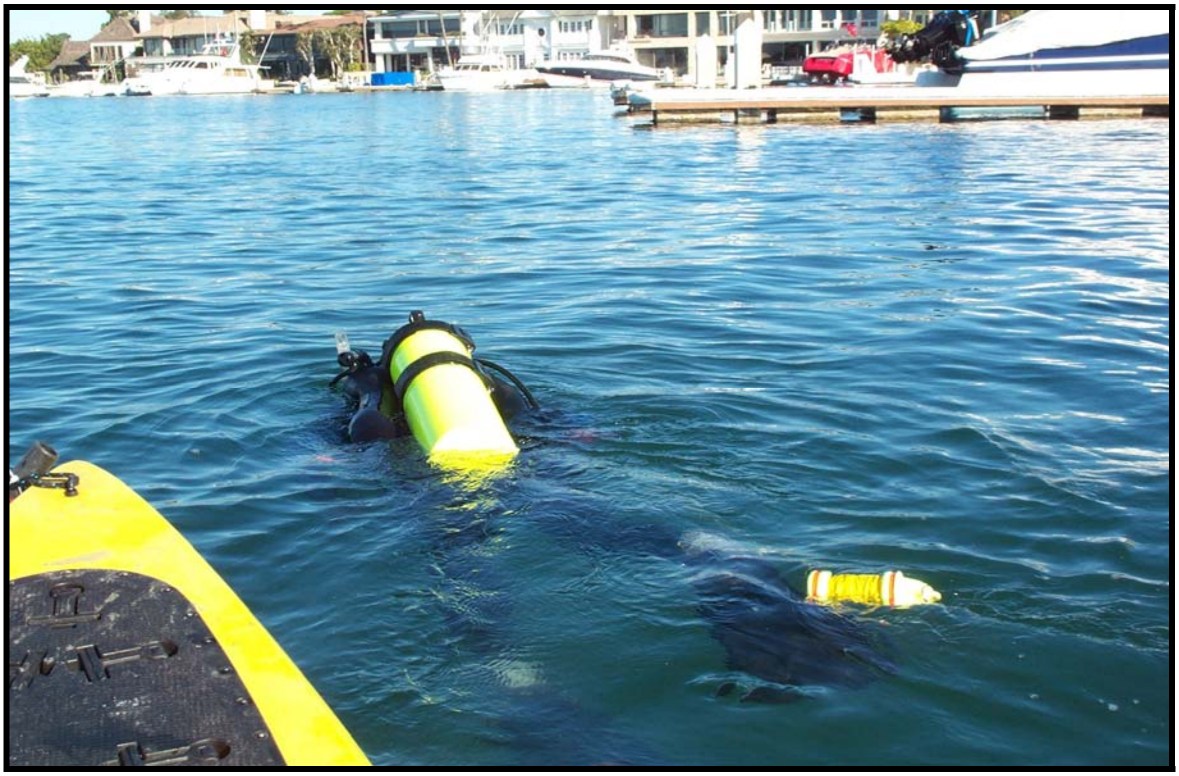
Remote sensing techniques (downlooking and sidescan sonar) were also used to survey for eelgrass. Downlooking sonar was used to augment the SWEH surveys within the -6 to -15 ft contours in the Main Channel along shorelines of Balboa Island, Corona del Mar, within the Linda Isle Basin, and in Upper Newport Bay where diver survey areas were either extremely large and/or where dive conditions were considered hazardous due to currents or vessel traffic. Sidescan sonar and downlooking sonar surveys were conducted in Deep Water Habitat (>15 ft in depth) in the Newport Bay 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 0.1 square meter 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, between 22 and 32 eelgrass turion counts were made at each of 20 stations throughout the study area by



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

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. The coordinates of the 20 surveyed sites are listed in Appendix 2.

2.4.3 Extralimital Observations

Other background information collected during eelgrass habitat mapping surveys included horizontal water visibility, secchi disk water clarity readings, bottom water temperature, water depth, and plants and animals observed in the eelgrass beds during the survey.

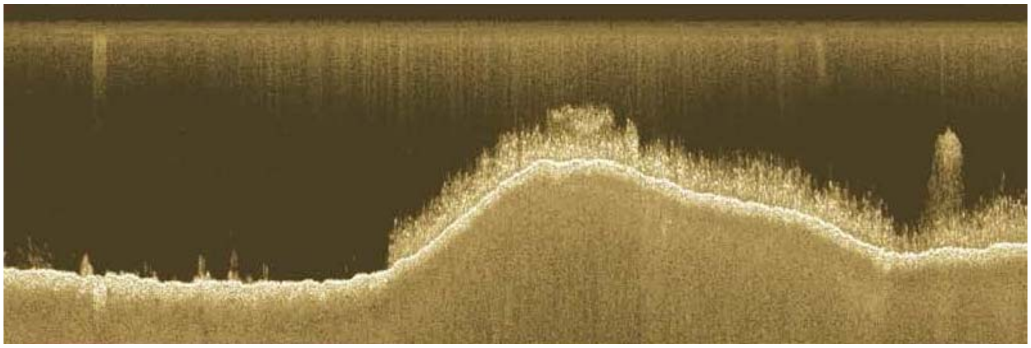
2.4.4 SWEH Habitat Downlooking Sonar Survey Field Methods

Downlooking methods 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, 2, 5, 11, 12, 13). CRM's Lowrance HDS-12 Gen2 Touch Chartplotter/Ecosounder was used to acoustically collect data on bottom depth and plant height from the unit's 200-kilohertz (kHz) transducer acoustic signal associated with a Wide Area Augmentation System (WAAS)-corrected global positioning system (GPS) position. In addition, a 455/800 kHz transducer and power module with dual channels (Structurescan and downlooking) provided a 180 degree view and a downlooking view of the seafloor (data were logged on the 800-kHz channel).

Acoustic beam angle for the 200-kHz signal on the 83/200-kHz dual frequency transducer (standard transducer on HDS units) was 20 degrees; the beam coverage for the 455/800 dual frequency transducer was 180 degrees with side lobe angles of 0.9 degree and the down-looking lobe of 1.1 degrees. This narrow elliptical beam essentially "scans" seafloor bottoms. Ping rates were set at 15 per second. Pulse width was dynamic and varied depending on depth, which varied between 2 and 30 feet. Acoustic data were collected at the Lowrance default of 3,200 bytes per second. The range window on the unit was set to Auto, which maximized the resolution of the acoustic envelope at the full range of depths sampled (approximately 2 and 30 feet).

GPS positions were recorded every one second, and bottom features from pings that elapsed between positional reports were averaged for each coordinate/data point. Therefore, the attribute value (e.g., depth and plant height) of each data point along a traveled path comprised a summary of 5 to 30 pings. Each ping went through a quality test to determine whether features could be extracted and, if so, was sent on to feature detection algorithms. Those failing quality assurance tests were removed from the set considered for summarization.

A representative downlooking sonar view is shown in Photograph 6. Data were logged on the 800 kHz channel. Acoustic (traditional, downlooking, and sidescan) and GPS signals were logged to data storage cards (.sl2 format).



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

2.4.5 Deep Water Eelgrass (DWEG) Sidescan Sonar Field Methods

Sidescan sonar methods were used to document the DWEH within the deeper channels of Newport Bay in the Entrance Channel, Balboa Reach, and the East Balboa Channel. This was designated as Region 23.

The following sidescan sonar equipment was used during the survey:

- Trimble DMS 232 Differential Global Positioning System (DGPS) Receiver,
- Edgetech 4125D Sidescan Sonar System with 400/900 kHz Towfish,
- Odom Hydrographic Hydrocrack II Depth Sounder,
- AMD Sound Velocity Recorder, and
- Hypack Max Hydrographic Data Acquisition and Processing Software.

Positioning. Horizontal positioning for the survey was achieved using a real time DGPS positioning system. Differential Corrections, broadcast by US Coast Guard were used to correct the raw GPS data. The horizontal datum was North American Datum of 1983 (NAD83), epoch 2011.0, the projection was California State Plane Coordinate System Zone V, and the units were US Survey feet. The vertical datum was Mean Lower Low Water (MLLW), epoch 83-01 based on recorded water level data from the National Oceanic and Atmospheric Administration (NOAA) Outer Los Angeles Harbor tide gauge and corrected for Newport Bay).

To minimize turns during data collection, the survey area was divided in three overlapping sub-regions that were covered with straight line segments. Using the navigation display of the Hypack online software, the vessel was steered along pre-planned shore-parallel tracklines spaced 100 ft apart. Vessel track lines and eelgrass target verification video surveys are shown in Appendix 1.

Photograph 7. CRM's Research Vessel Showing Set Up for Sidescan Sonar Surveying

Photograph 8a and 8b. Towfish Positioning and Deployment on the Starboard Side of the Vessel

Photograph 9. Hypack Navigation Software Used by Nearshore and Wetland Surveys for Steering Vessel Along Tracklines. Steering Position Was Relayed Via Monitor to Skipper.

The Edgetech 4215D Sidescan Sonar System with the 400/900 kHz towfish was operated at the 30 meter (100 ft) range (each channel) providing 100% data overlap. Sidescan sonar and DGPS data were recorded using the Edgetech Discover software and processed using the Hypack Software to produce a compilation of rectilinear corrected composite image mosaics.

The position of the towfish was determined by applying an offset to the vessel's position based on a layback as resolved from the vessel's heading and the amount of sonar tow cable laid out. Towfish altitude above the seabed was recorded continuously and used for data slant range correction. Sounding data were obtained at the same time as the sidescan sonar data.

Target Verification and Ground Truthing. While the DWEH sidescan and downlooking sonar survey lines were being run, GPS waypoints were marked at locations that depicted the potential presence of Submerged Aquatic Vegetation (SAV) based on the real-time downlooking sonar views (See Photograph 6). These waypoints were then used to conduct follow-up video target surveys.

The target verification survey was conducted by Remote Underwater Video (RUV). An Ocean Systems Deep Blue "Splash Cam" coupled with a GoPro 4 camera was used to view the seafloor in real time, and video record bottom observations at GPS locations that were selected for target verification. The video unit was deployed from the vessel's davit. Run times were standardized to approximate 30 second bottom times. The Splash Cam video monitor was viewed real-time onboard the survey vessel while the GoPro concurrently recorded the same view for later download and office analyses. Survey information (date, time, positioning, and depth) was recorded in field notes to assist in matching sidescan/downlooking sonar data with the GPS location of identified vegetation and organisms. Underwater video was recorded at 42 locations throughout the survey area (Appendix 1).

Photograph 10. Splash Cam and Remote Video Unit

2.5 DATA PROCESSING

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).

2.5.1. Vegetation Recorded During Diver Surveys. GPS data were collected in WGS 84 horizontal datum on removable SD cards. Each afternoon following the survey, the data from the SD cards were uploaded to a desktop computer and imported into Thales Mobile Mapper Office software. These files were then post-processed using NOAA National Geodetic Survey (NGS) Continuously Operating Reference Site (CORS) position correction information to obtain differential GPS corrections that reduced the satellite positioning error. In the majority of cases, the positioning error was reduced to less than 1 meter. Once the post-processing positioning information was applied to the individual files, they were then combined into daily files for each survey area. These data files were then checked for accuracy and any outlier data removed. Following the completion of a survey region, each of the daily file sets were combined into a region eelgrass habitat map and uploaded into ESRI ArcGIS 10.1 for producing final eelgrass habitat maps of each region and calculating eelgrass areal extent within each region.

2.5.2 Vegetation Detection Using Downlooking Sonar Methods

Vegetation Detection. Data analyses were performed using cloud- based software models and statistical algorithms incorporated into Navico BioBase software developed by Contour Innovations, LLC, St. Paul, Minnesota (Contour Innovations LLC 2013; http://www.cibiobase.com).

Acoustic signals from HDS 200-kHz transducers travel through submerged aquatic vegetation (SUV) on their way to bottom. Seafloors typically register a sharper echo return than the vegetation above. The distance between the seafloor acoustic signature and top of the plant canopy was recorded as the plant height for each ping. In the study area, depth profile and vegetation information were collected on soft- bottom features. On sandy and mud bottom habitats both echo returns may register eelgrass (*Zostera* spp.) and red algae such as *Gracilariopsis* spp. Thus, the need to verify, via remote camera, whether the sidescan sonar returns represent eelgrass or other types of vegetation.

Plant height data included for analysis was limited to a minimum detection limit of 1% of bottom depth. Thus, at a three foot depth, minimum plant height detection was 0.4 inches whereas along the offshore tracklines at 20 foot depths, minimum plant height was is the approximate range of 2.4 inches. Any vegetation detections within this range were considered “present” in vegetation calculations and modeling.

Processed acoustical signal depth and vegetation point features were uploaded to the BioBase ordinary point kriging algorithm that predicted values in unsampled locations based on the geostatistical relationship of the input points. The kriging algorithm is an “exact” interpolator in locations where sample points are close in proximity and do not vary widely. Kriging smooths bottom feature values where the variability of neighborhood points is high. Using this technique, a kriging-generated map was produced to provide an eelgrass map of vegetation probability distribution based on detected acoustical SAV height returns. Eelgrass polygons were then traced around the perimeter of the eelgrass map and exported from the Biobase Program into ArcGIS 10.1 to illustrate the distribution of eelgrass quantified by these acoustical data collection methods.

2.5.3 Vegetation Detection Using Sidescan Sonar Methods

All data (sidescan sonar, vessel position and heading, and towfish layback) were recorded using the Hypack Navigation and Data Acquisition System. The data were then merged and processed using the Hypack *Hyscan processing module*. The sidescan sonar data were corrected for amplitude, across-track slant range, and along-track speed variation. The adjusted data were merged with the vessel position and heading data and the layback offset applied. Individual trackline mosaics were produced for both low and high frequency channels. These data were then checked for errors, and the processed data from the individual tracklines were then digitally merged into seven (7) area mosaics (Scale 1 inch=100 feet) as illustrated in Figure 8. Data from both the low and high frequency channels were used to produce geo-referenced, rectilinearly correct photo mosaics of the nearshore habitat.

2.5.4 Eelgrass Habitat Map Production

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, 23 eelgrass "regions" (Figure 2) were developed; 22 regions were SWEH; one was DWEH. Eelgrass acreage, by region, was calculated upon the combined areas of eelgrass polygons and eelgrass patches within each region. Eelgrass acreage is reported in English (acre) units. Combined with the results of diver and downlooking sonar, and video target verification, the 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.

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

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

2.5.5 Hierarchical Cluster Analysis of Eelgrass Distribution in Newport Bay

Two-way classification analysis using hierarchical clustering techniques (SAS, 2009) was used to visually display relationships between the attributes (eelgrass acreages) and each of the survey regions within and between each of the five survey periods. The analysis was performed using Ward's Minimum Variance Cluster Method methods and Principal Component Analysis (PCA). The resulting cluster dendrogram was viewed using an ecological distance scaling method. Graphics and statistics were prepared with Excel 2003, and SAS JMP 8 Statistical Discovery Graphics and Statistics Package software.

2.5.6 Eelgrass Turion Density Analysis

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.

3.0 EELGRASS HABITAT MAPPING SURVEY RESULTS AND DISCUSSION

Eelgrass habitat mapping surveys were conducted during 50 field days between June 13th and October 3rd, 2016. An additional field day was added on December 13th, 2016 at the request of the City to document eelgrass conditions in the vicinity of North Star Beach. Approximately 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. Habitat survey maps for previous CRM eelgrass habitat mapping surveys conducted between 2003 and 2010 are provided in Coastal Resources Management, Inc. (2005, 2010, 2012, and 2015) and are also available online along with the current survey maps at the City of Newport Beach's website at:

http://nbgis.newportbeachca.gov/NewportHTML5Viewer/?viewer=publicsite

3.1 UNDERWATER VISIBILITY AND TEMPERATURE MEASUREMENTS

3.1.1 Underwater Visibility

Mean bottom water visibility during the 2016 survey was 6.5 feet (ft) +/- 4.7 ft, ranging between one (1) ft in the OCC School of Sailing and Seamanship basin) and 19.3 ft along Bayside Drive in Corona del Mar (n=46 daily observations). Underwater visibility in the Newport Bay Entrance Channel and along the West Balboa Peninsula was also excellent during the 2016 survey (Figure 3a). Notably, underwater visibility in Upper Newport Bay was 7 to 8 ft along Castaways and the DeAnza/Bayside Peninsula, and was greater than 16 other stations in Lower Newport Bay.

Mean water column transparency (measured by Secchi disk methods) was 6.6 ft +/-2.4 ft (n=43 observations), mirroring the mean bottom water horizontal visibility conditions. The 2016 survey underwater visibility mean was the highest of the five surveys to date (Figure 3b). Underwater visibility during the prior four surveys (2003 to 2014) varied between 3.3 ft in 2006-2008 and 5.5 ft in 2003-2004. Analysis of inter-survey mean visibility (Figure 3b) and mean underwater visibility data within locations (Figure 3c) illustrate the high variability within region and over the five surveys.

3.1.2 Water Temperature

The mean bottom water temperature as recorded by the dive team between June 13th and December 13th, 2016 was 70.3 +/-3.5 (n=43) degrees Fahrenheit (F) and ranged from 64 to 76 degrees F. By area, (Figure 3d) bottom temperatures were lowest along Corona del Mar and the East Balboa Peninsula during August (64 and 66 degrees F respectively), and at North Star Beach in December (66 degrees F). Highest water temperatures were recorded along Mariners' Mile and Castaways (76 degrees F), and Inner Linda Isle (74 degrees F) in August.

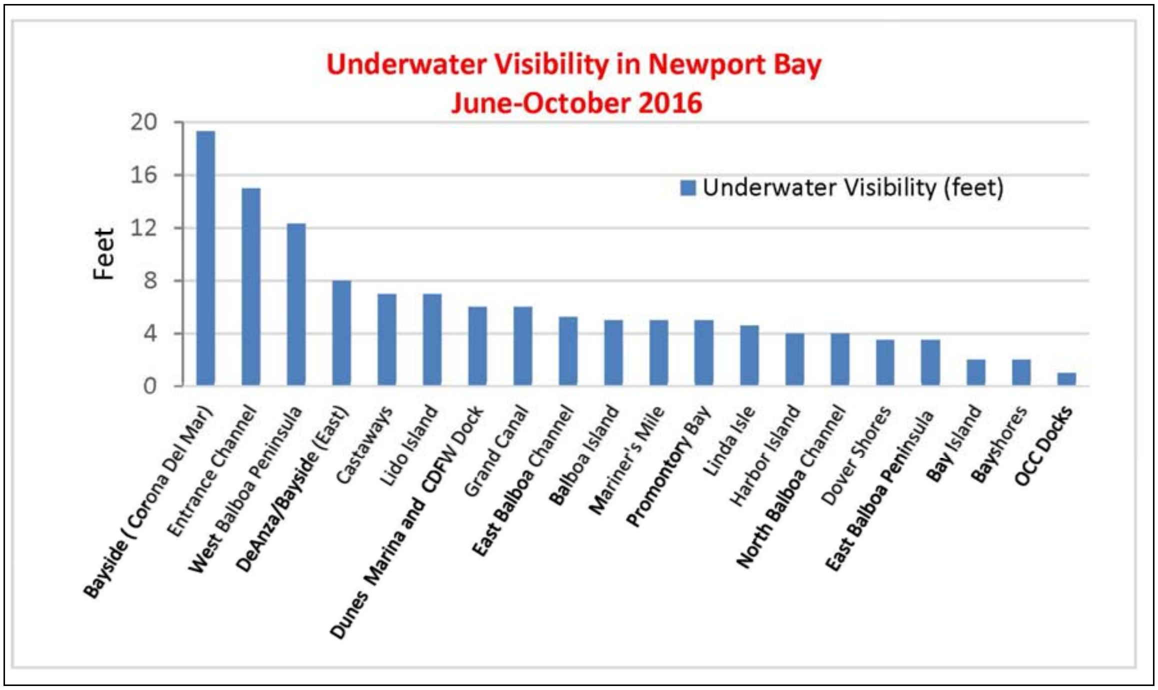


Figure 3a

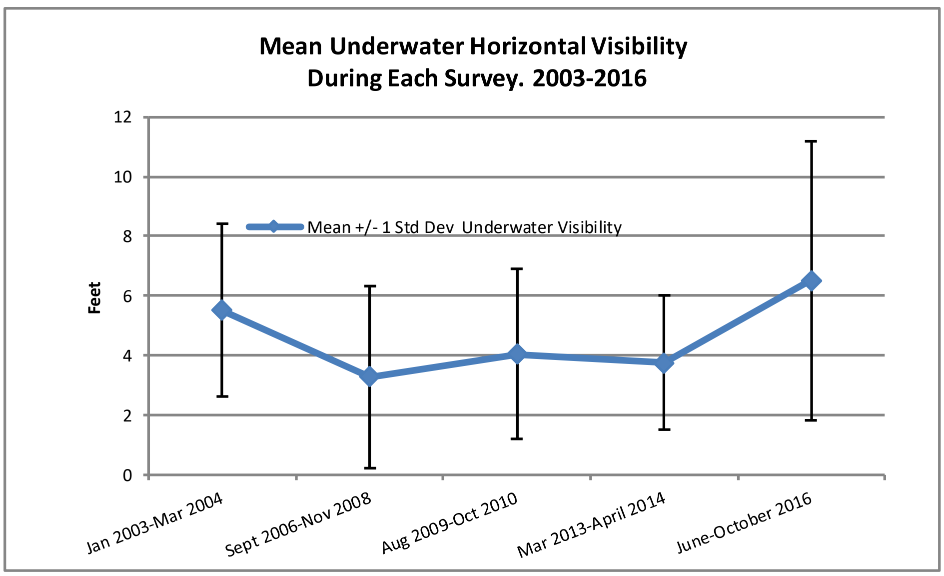


Figure 3b

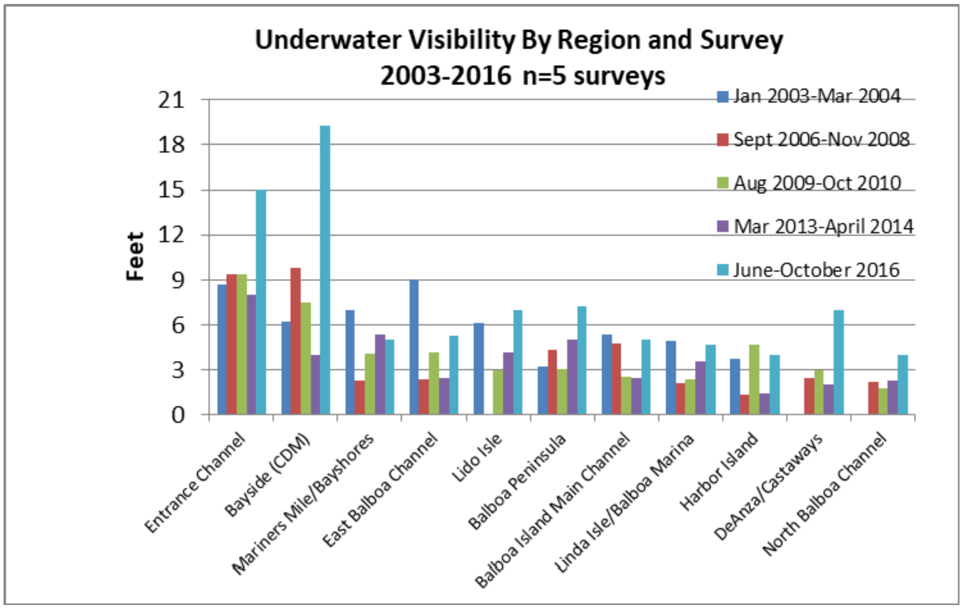


Figure 3c.

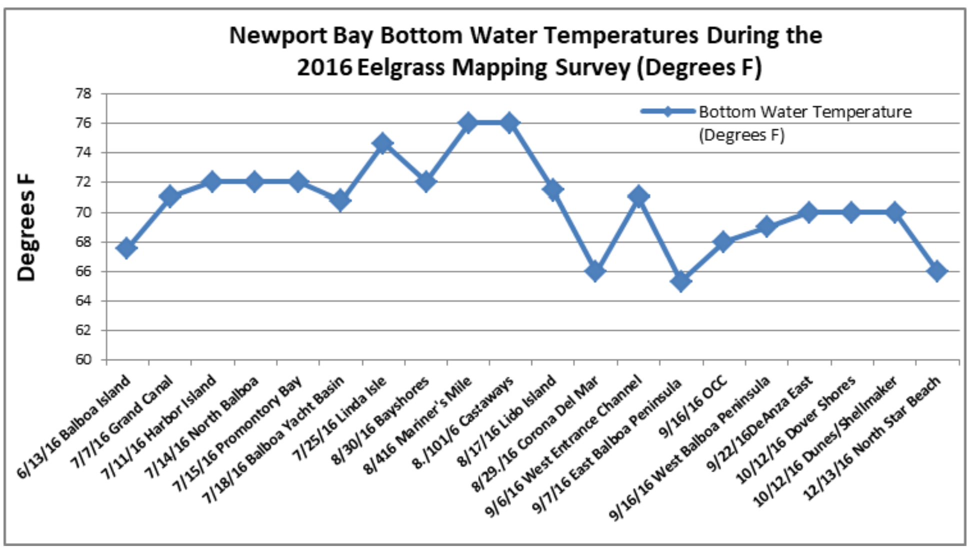


Figure 3d.

3.2 EELGRASS DISTRIBUTION AND ABUNDANCE SUMMARY

A summary overview survey map of both SWEH and DWEH is provided in Figure 4. A total of 104.5 acres of eelgrass was mapped in Newport Bay during 2016. This included 53 acres of SWEH and 51.5 acres of DWEG.

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 53 acres of SWEG eelgrass using a combination of diver/GPS tracking methods and downlooking sonar survey methods. Eelgrass covered 4.8 % of the Newport Bay soft bottom habitat survey area in 2016 (Figure 5) compared to 3.4 % during the 2003-2004 survey, 2.6% in 2006-2007, 2.2 % in 2009-2010, and 4.8 % n 2013-2014. Two species of eelgrass were found in SWEH. The most widespread throughout the bay was the narrow-bladed *Zostera marina* typically associated with shallow embayments. The wide-bladed *Zostera pacifica* was typically found at depths beginning at about -10 ft along Corona del Mar and the periphery of the Entrance Channel.

3.2.2 Deep Water Eelgrass Habitat

Deep Water eelgrass was mapped using sidescan sonar and downlooking sonar. The amount of eelgrass mapped was 51.5 acres, concentrated in the Entrance Channel and in Balboa Reach (Figure 4). Channel-occurring eelgrass was mapped at depths between -15 and -29.5 ft MLLW, although some areas, along the channel periphery and beneath mooring fields were as shallow as -8 to -10 ft MLLW. DWEH accounted for 5.8% of the Newport Bay soft bottom habitat during the 2016 survey (Figure 5). Both species of eelgrass were found in DWEG but there was a higher dominance of the wider, deeper-occurring species *Z. pacifica*, particularly in the Entrance Channel.

3.2.3 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, 1981). 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.

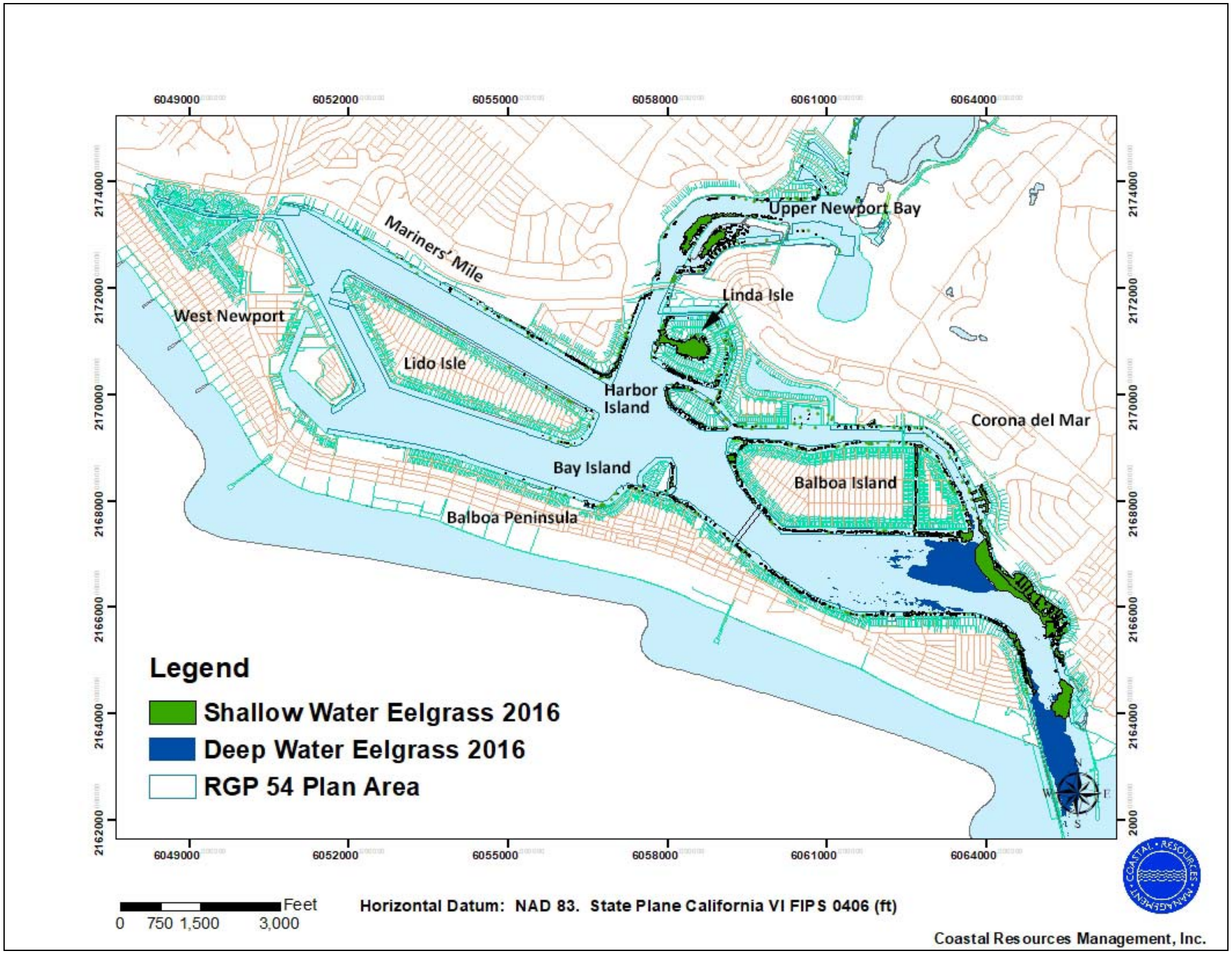


Figure 4. Shallow Water and Deep Water Eelgrass Habitat Map. 2016 Survey.

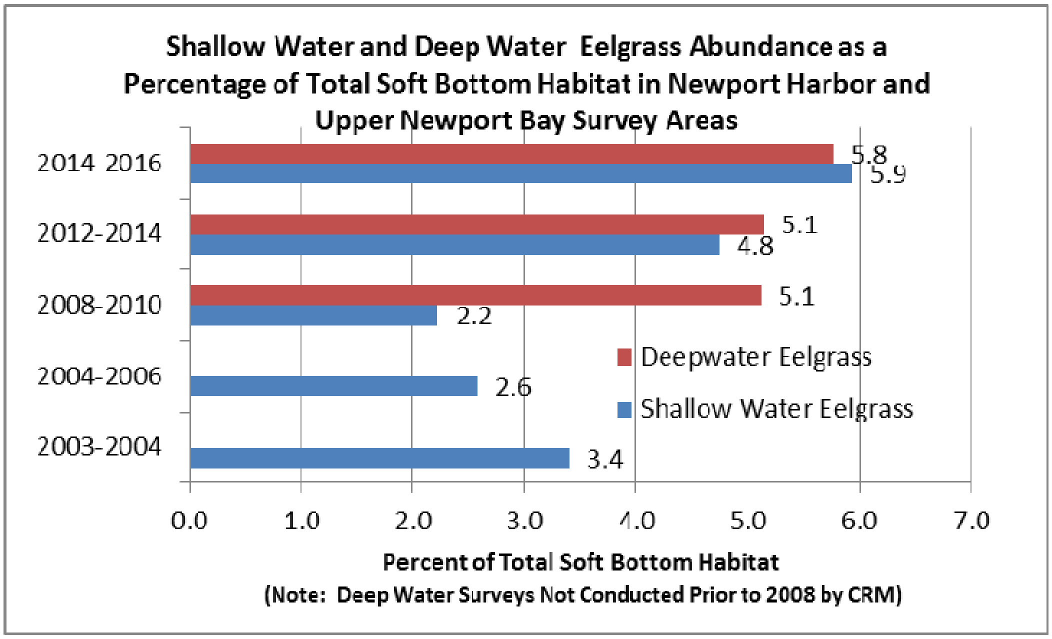


Figure 5.

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 SWEH abundance in Newport Bay along with periods of rainfall and dredging events that occurred between 1993 and 2016 are illustrated in Figure 6. Both SWEG and DWEG temporal trends are shown in Figure 7. SWEH 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 by CRM for the City of Newport Beach mapped between a low of 19.9 acres in 2006-2007 to a high of 51.5 acres in 2016. 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 through 2016. Although the correlation is not clear, the increase in eelgrass acreage has since 2012, been during a five-year period of low rainfall ranging between 4 and 7.5 inches/year.

DWEH (Figure 7) increased from 45.7 to 51.5 acres during the three CRM DWEH surveys and overall, has remained rather stable compared to the changes observed in SWEG.

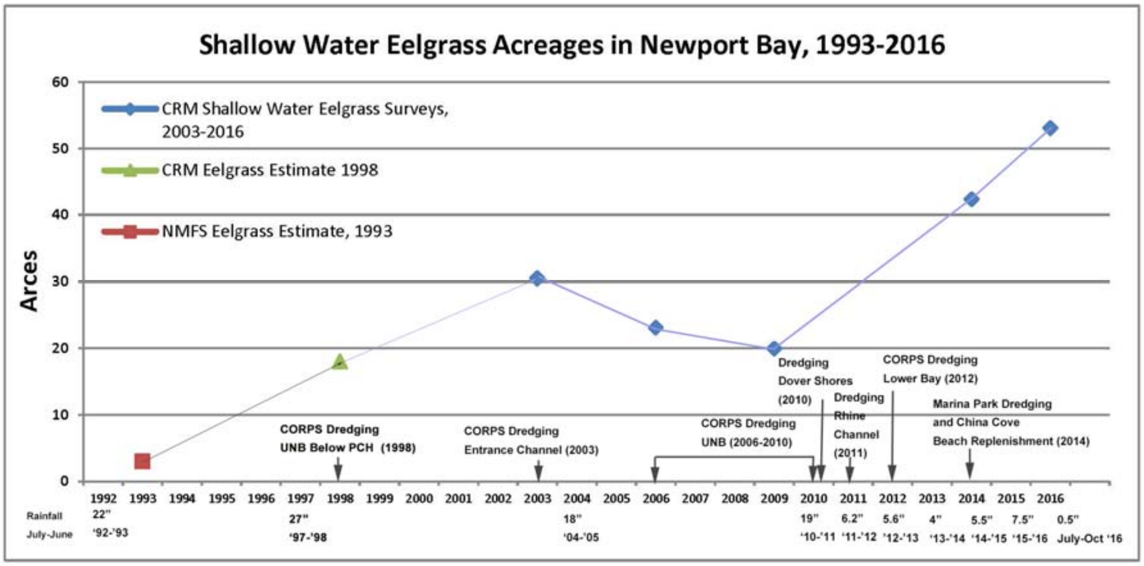


Figure 6. Shallow Water Eelgrass (SWEH)

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.

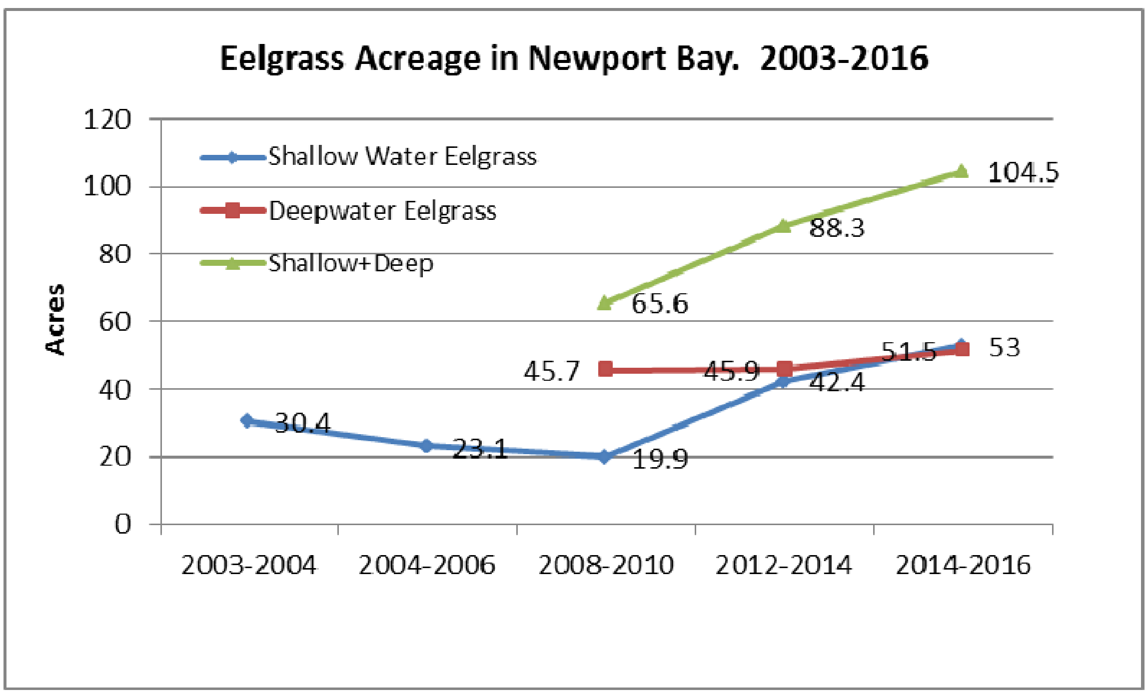


Figure 7.

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3.2.4 Shallow Water Eelgrass Distribution By Region

Table 1 summarizes eelgrass distribution and abundance within the 22 shallow water regions and the one deep water navigational channel eelgrass region in 2016. Eelgrass acreage by survey region compared to prior surveys is presented in Table 2. SWEH 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.

Three regions accounted for 62.1% of all eelgrass in the Bay:

1. Region 1- Corona del Mar/Bayside Drive (21.651 acres);
2. Region 5- Balboa and Collins Islands (acres 5.736 acres); and
3. Region 11- Linda Isle Inner Basin (5.548 acres)

During the prior survey conducted in 2013-2014, these three regions accounted for a greater proportion of the total (77.7%).

Other regions with significant amounts of eelgrass included:

1. Region 13- DeAnza/Bayside Peninsula, Main Channel (west) (4.006 acres);
2. Region 12- DeAnza/Bayside Peninsula, east side (3.834 acres); and
3. Region 3- Balboa Peninsula East of Bay Island (3.782 acres).

Eelgrass acreages in other regions of the Bay ranged between 0.003 acres (North Star Beach) and 2.018 acres (East Balboa Channel Yacht Basins). Four regions exhibited slight reductions in eelgrass areal cover compared to the 2013-2014 surveys: Region 1,Corona del Mar; Region 5, Balboa and Collins Islands; Region 2, East Balboa Channel and Yacht Basins; and Region 4, Grand Canal (Table 1). Increases in eelgrass acreages occurred within all of the other regions. Compared to the 2013-2014 survey, the net increase in eelgrass habitat was greatest for Upper Newport Bay Regions 12 and 13 DeAnza/Bayside Peninsula (East and West), where the net gain between the two surveys was 2.411 and 3.757 acres, respectively. Increases of over one acre were observed in Linda Isle Inner Basin (Region 11) and along the eastern shoreline of the Balboa Peninsula, between Bay Island and the Harbor Entrance Channel (Region 3).

Deep Water Eelgrass Habitat (DWEH)

Region 23-Deep Water Eelgrass acreage is summarized in Table 3. The amount of eelgrass mapped by bioacoustical was 51.5 acres in the vicinity of SWEG Regions 1, 3, and 5. In 2012, the acreage was 45.92 acres, and in 2008, the acreage was 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 1. Regional Breakdown of Shallow Water Eelgrass Habitat (SWEH) in 2016

Region	Description	Survey Method	Acres	% Total
1	Corona del Mar/Bayside Drive to OCHD	DS, DLS	21.651	40.8
5	Balboa and Collins Islands	DS, DLS	5.736	10.8
11	Linda Isle (inner basin)	DS, DLS	5.548	10.5
13	DeAnza/Bayside Peninsula (West,Outer)	DLS	4.006	7.6
12	DeAnza/Bayside Peninsula (East,Inner)	DS, DLS	3.834	7.2
3	Balboa Peninsula East of Bay Island	DS, DLS	3.782	7.1
2	East Balboa Channel Yacht Clubs/Basins	DS	2.018	3.8
9	Harbor Island	DS	1.352	2.6
10	Linda Isle (outer channels)	DS	1.155	2.3
4	Grand Canal	DS	0.889	1.7
15	Bayshores	DS	0.760	1.4
16	Mariners' Mile	DS	0.710	1.3
6	Bay Island	DS	0.496	0.9
14	Castaways to Dover Shores	DS	0.340	0.6
8	North Balboa Channel, Balboa Yacht Basin, and Promontory Bay	DS	0.245	0.5
7	Balboa Peninsula West of Bay Island	DS	0.212	0.4
20	Dover Shores	DS	0.176	0.3
17	Lido Isle	DS	0.074	0.1
21	Dunes Marina and CDFW Dock	DS	0.026	0.04
22	North Star Beach Area	DS	0.003	0.01
19	West Newport**		-	-
	All Regions		53.015	100.000

*DS=Diver Survey DLS=Downlooking Sonar
** No Survey

Table 2. Comparison of Shallow Water Habitat Acreages By Survey

Region	Description	2003-2004 (acres)	2006-2007 (acres)	2009-2010 (acres)	2013-2014 (acres)	2016 (acres)	Mean (acres)	Change (acres) between 2014-2016
1	Corona del Mar/Bayside Drive to OCHD	9.521	9.075	10.363	22.372	21.651	14.596	-0.721
5	Balboa and Collins Islands	6.686	4.554	3.052	5.978	5.736	5.201	-0.242
11	Linda Isle (Inner basin)	0.281	3.218	1.974	4.495	5.548	3.103	1.053
3	Balboa Peninsula-East of Bay Island	1.672	1.557	1.391	2.267	3.782	2.134	1.515
2	East Balboa Channel Yacht Clubs/ Basins	2.469	1.539	1.758	2.056	2.018	1.968	-0.038
13	DeAnza/Bayside Peninsula (West,Outer)	0.792	0.000	0.001	1.596	4.006	1.279	2.411
9	Harbor Island	2.721	0.712	0.446	0.911	1.352	1.228	0.441
10	Linda Isle (outer channels)	2.916	0.328	0.068	0.393	1.155	0.972	0.762
4	Grand Canal	0.898	1.143	0.623	1.062	0.889	0.923	-0.173
12	DeAnza/Bayside Peninsula (East, Inner)	0.209	0.009	0.000	0.077	3.834	0.826	3.757
15	Bayshores	0.991	0.664	0.000	0.156	0.760	0.514	0.604
8	North Balboa Channel and Yacht Basins	0.698	0.115	0.119	0.242	0.245	0.284	0.003
16	Mariners' Mile	0.234	0.066	0.070	0.305	0.710	0.277	0.406
6	Bay Island	0.132	0.051	0.041	0.298	0.496	0.204	0.198
14	Castaways to Dover Shores	0.132	0.000	0.000	0.010	0.340	0.096	0.329
20	Dover Shores	nd[1]	nd	nd	0.009	0.176	0.093	0.167
7	Balboa Peninsula-West of Bay Island	0.034	0.030	0.014	0.102	0.212	0.078	0.110
17	Lido Isle	0.025	0.004	0.000	0.023	0.074	0.025	0.051
21	Dunes Marina and Channel	nd	nd	nd	0.002	0.026	0.014	0.024
22	North Star Beach Area	nd	nd	nd	nd	0.003	0.003	0.003
18	Lido Peninsula	nd	0.000	0.000	0.000	0.000	0.000	0.000
19	West Newport (not surveyed in 2016)	nd	nd	nd	0.000	nd	0.000	0.000
	All Regions	30.411	23.065	19.920	42.353	53.015	33.753	10.661

[1]nd=no data (no survey)

Table 3. Deep Water Eelgrass Acreage. 2003-2016

Region/Time Period	Description	2003-2004 (acres)	2008 (acres)	2008-2010 (acres)	2012 (acres)	2016 (acres)	Increase or decrease (acres) between 2016 and 2012
23	Lower Newport Bay Navigational Channels	90.3[a]	45.86[b]	No Survey	45.92[c]	51.5	5.98

[a] National Marine Fisheries Service, 2003
[b] Coastal Resources Management, Inc., 2010
[c] Coastal Resources Management, Inc., 2014
2016 Data: This study

3.3 EELGRASS DISTRIBUTION BY REGION

The amount of eelgrass within each of the survey regions during the 2016 survey is presented in this section along with a summary of the data recorded during the four prior surveys between 2003 and 2014. The five-survey project summary, by region is provided in Figure 8.

3.3.1 Region 1-Corona del Mar-Bayside Drive including Coast Guard/O.C. Harbor Patrol Facilities (21.651 acres).

Refer to Figure 9. 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 generally extended between the low intertidal and -15 ft MLLW, particularly in Carnation Cove. 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. Some shallow subtidal dredging does occur, particularly within the Channel Reef dock system. Beach nourishment also occurs on the China Cove beaches.

The amount of eelgrass within Region 1 declined from 22.372 acres in 2013-2014 to 21.551 acres in 2016 (0.721 acre). The bulk of this decrease occurred within the China Cove eelgrass bed. This loss was observed along the intertidal and shallow subtidal inshore edge of the 2013 bed (Reference photograph below). In 2016, the inshore intertidal eelgrass receded seaward to a depth of between -6 and -8 ft MLLW. CRM biologists noted a wide, unvegetated intertidal and shallow subtidal shelf extended to a depth of -4 ft MLLW. This transitioned to a steep 45 degree unvegetated slope between -4 and -8 ft MLLW. Eelgrass was established at the bottom of the slope and extended to a depth of -13.9 ft MLLW.

As in prior surveys, the cover of intertidal eelgrass was low around the storm drain at Bayside Place within Carnation Cove. However, both intertidal and subtidal eelgrass beds between Channel Reef and the Orange County Harbor Patrol were extensive between pier structures, in some cases beneath pier structures, and out past the piers to a depth of -15 ft MLLW. Eelgrass accounted for slightly less of the total amount of eelgrass in Newport Bay in 2016 (40.8%) compared to 2013-2014 (52.8%) but still constituted the largest portion of the eelgrass in Newport Bay. (Table 1, Figure 9). Eelgrass in this region consisted of both the deeper-occurring wide bladed species (*Zostera pacifica*) and the narrower bladed bay form common throughout Newport Bay (*Zostera marina*). Eelgrass reproductive/flowering shoots were observed in this region during the survey.

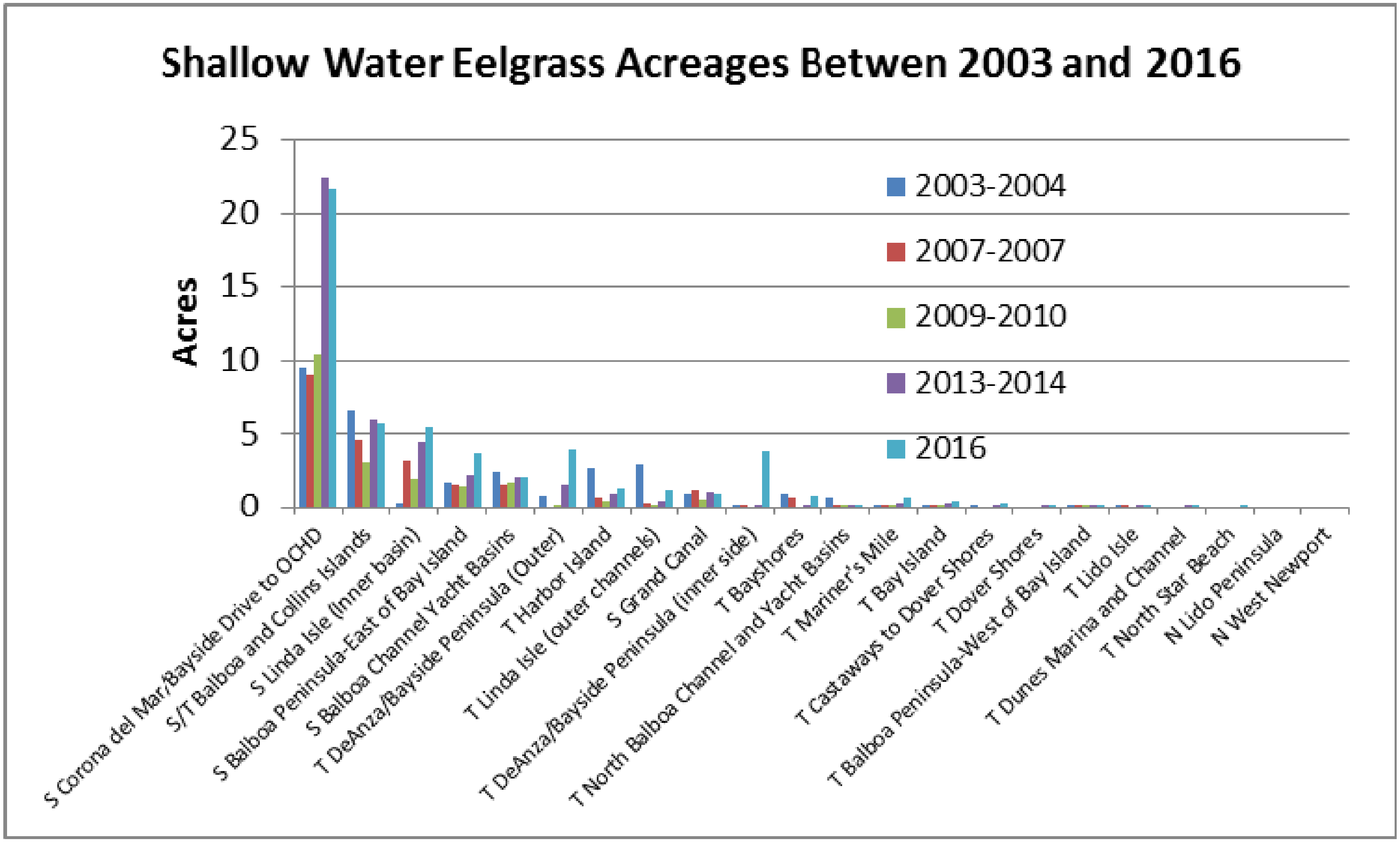
Shallow Water Eelgrass Acreages Betwen 2003 and 2016
Acres
25
20
15
10
5
0
2003-2004
2007-2007
2009-2010
2013-2014
2016
S Corona del Mar/Bayside Drive to OCHD
S/T Balboa and Collins Islands
S Linda Isle (inner basin)
S Balboa Peninsula-East of Bay Island
S Balboa Channel Yacht Basins
T DeAnza/Bayside Peninsula (Outer)
T Harbor Island
T Linda Isle (outer channels)
S Grand Canal
T DeAnza/Bayside Peninsula (inner side)
T Bayshores
T North Balboa Channel and Yacht Basins
T Mariner's Mile
T Bay Island
T Castaways to Dover Shores
T Dover Shores
T Balboa Peninsula-West of Bay Island
T Lido Isle
T Dunes Marina and Channel
T North Star Beach
N Lido Peninsula
N West Newport

Figure 8.

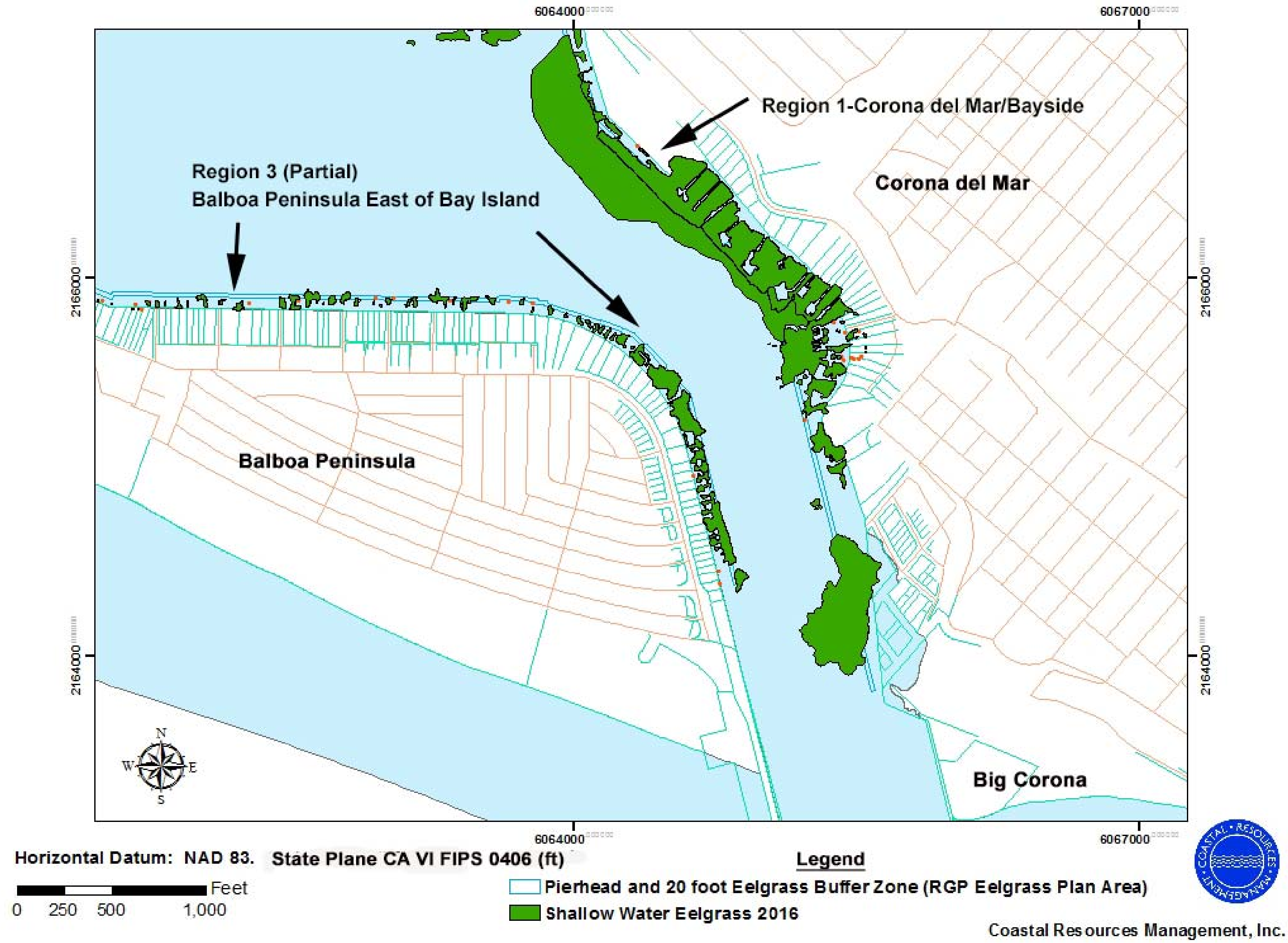

Figure 9. 2016 Eelgrass Habitat Map. Region 1 {Corona del Mar/Bayside) and Region 3 (Partial). See Figure 11 for Remainder of Region 3

3.3.2 Region 2-Yacht Club Basins and Marinas between the Orange County Harbor Department and the Balboa Bridge along Bayside Drive (2.018 acres)

Refer to Figure 10. As in previous years, eelgrass was common throughout this region's boat basins extending from the Balboa Yacht Club to the Balboa Island Bridge at depths from +0.5 ft along the bulkheads to -11 ft MLLW seaward of the docks. The total amount of eelgrass within this region (2.018 acres) was the 5th highest amount during 2016. A high proportion of this region's eelgrass was located in The Bahia Corinthian Yacht Club boat basin, the Balboa Yacht Club basin, and the Bayside Marina. This region accounted for 3.8% of all eelgrass mapped in 2016 (Table 2) and exhibited a slight decrease in areal cover compared to 2016 (Table 3). Sediments varied from sand/silt near the bulkheads to silt in the channel. Eelgrass reproductive/flowering shoots were observed in this region.

3.3.3 Region 3- Balboa Peninsula-East of Bay Island (3.72 acres)

Refer to Figures 9 and 10. Region 3 includes the shallow water zone between the bulkhead and the seaward ends of docks from the Entrance Channel to, but not including 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 -2 ft and -14 ft MLLW in the Entrance Channel and between -0.5 and -9 ft in the Bay. The amount of eelgrass increased by 1.515 acres compared to the 2013-2014 survey (Table 3). This region accounted for 7.1% of the vegetated SWEH in Newport Bay during the 2016 survey. Sediments were typically sandy along the inshore edge and graded to silt along the offshore edges of the beds.

3.3.4 Region 4-Grand Canal (0.889 acre)

Refer to Figure 10. The Grand Canal separating "Little Balboa" and "Balboa Island" was vegetated along most of its entire length at depths between 0.0 and –5.3 ft MLLW and at both the north and south entrance channels extending to -7 ft MLLW. Eelgrass accounted for 1.7 % of the SWEH in Newport Bay (Table 2) and exhibited a decrease of 0.173 acre compared to the 2013-2014 survey. The decrease was generally confined to the area between Park Street and Marina Street. Noticeable cuts in the beds were observed from anchor lines and chains throughout the Canal. Sediments were compact sands against the bulkhead and sands to silt in the center of the Canal. During the survey, eelgrass reproductive/flowering shoots were observed.

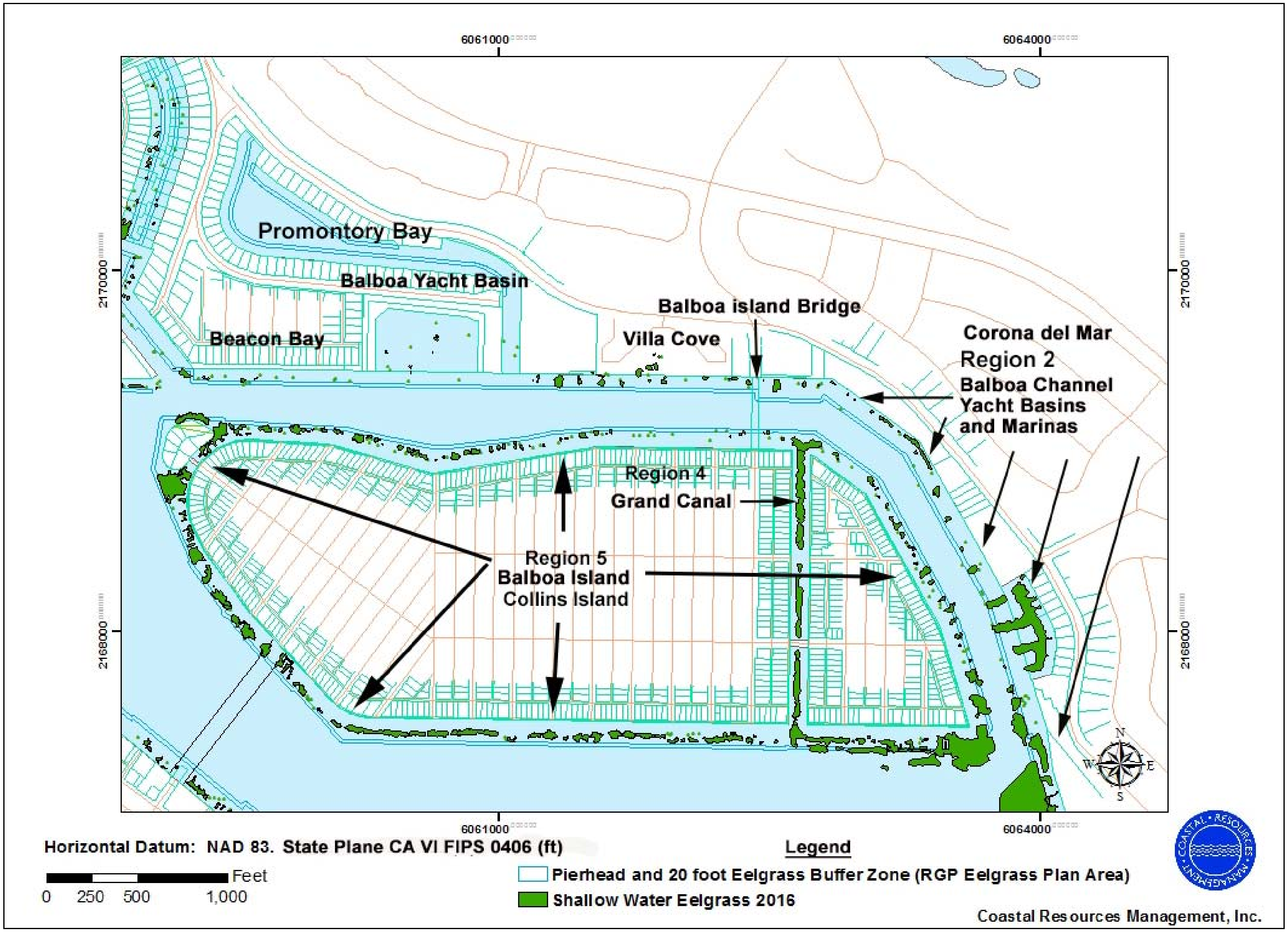

Figure 10. 2016 Eelgrass Habitat Map. Regions 2, 4, and 5

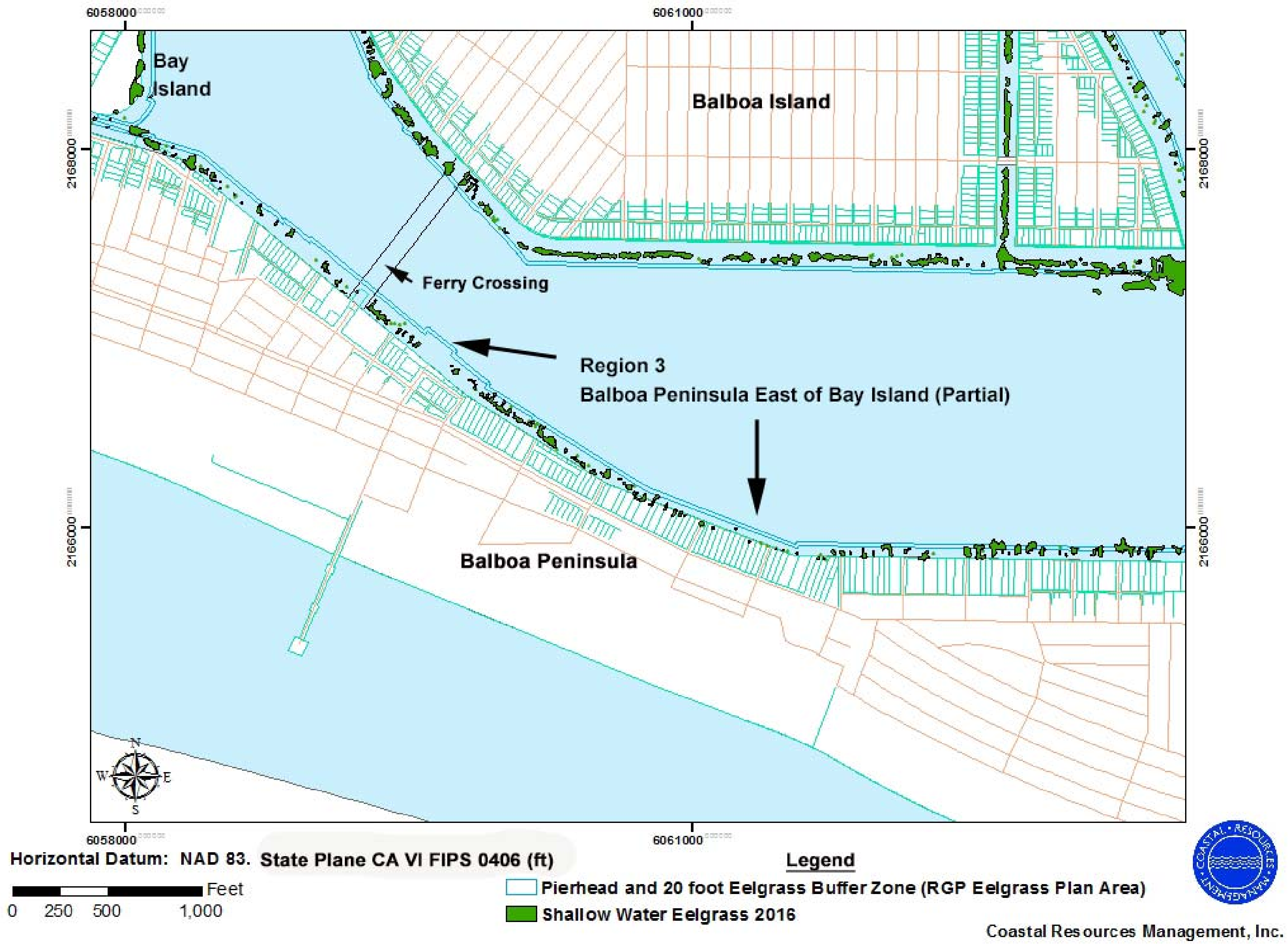

Figure 11. 2016 Eelgrass Habitat Map. Region 3 (Partial)

3.3.6 Region 6-Bay Island (0.496 acre)

Refer to Figure 12. Bay Island eelgrass covered 0.498 acre and accounted for 0.9% of the Bay's eelgrass (Table 2). Areal cover increased 0.198 acre since the last survey. Similar to previous years, most of the eelgrass was present along the east-facing beach. Noticeable regrowth had occurred along the shoreline of the shallow channel separating Bay Island from the Balboa Peninsula since the 2014 survey. The depth range for eelgrass around Bay Island varied from +0.5 to -7 ft MLLW. Most of the eelgrass was established in fine sands to silty sediments.

3.3.7 Region 7-West Balboa Peninsula (0.212 acre)

Refer to Figure 12. Eelgrass extended from Lindo Avenue west of the Bay Island Bridge to 11th Street. The amount of eelgrass doubled in size compared to the previous survey (0.212 acre in 2016, 0.012 acre in 2014) and accounted for 0.4% of all eelgrass in Newport Bay. As in previous surveys most eelgrass was mapped in the Newport Harbor Yacht Club Basin, but several small beds were new between Lindo Avenue and the Newport Harbor Yacht Club. Eelgrass bed depths varied between 0.0 and -7 ft MLLW. Sediments were typically sandy inshore and silty at the offshore edge of the beds.

3.3.8 Region 8-North Balboa Channel (North Side) from the Balboa Bridge to Beacon Bay, including Promontory Bay (0.245 acre)

Refer to Figure 13. Eelgrass accounted for 0.5% of the SWEH (Table 2). The largest beds were mapped in the fairways of the Villa Cove Marina. Other small beds and patches were located in the Balboa Yacht Basin, the channel entrance to Promontory Bay, and along the Beacon Bay shoreline. Eelgrass in this region experienced a substantial decline in 2006, particularly between Beacon Bay and the Balboa Yacht Basin. Recovery has been slow but slow but steady since that time (Table 3).

3.3.9 Region 9-Harbor Island (1.352 acre)

Refer to Figure 13. Eelgrass around Harbor Island accounted for 2.6 % of the Bay's eelgrass, and concentrated along the south, west, and northwest sides the island (Table 2). Nearly three times as much eelgrass was present around Harbor Island in 2016 (1.552 acres) than during the 2013-2014 survey (0.446 acre), but the amount is only half as much as recorded during the first survey in 2003-2004. The channel between Beacon Bay and Harbor Island to the east of the bridge connecting Harbor Island to Beacon Bay and Promontory Bay has still not recovered. The depth range of eelgrass around Harbor Island varied from +1 to -9 ft MLLW. Eelgrass was found in sediments ranging from compact sands near the bulkhead to silt at the offshore edges of the beds. During the survey, eelgrass reproductive/flowering shoots were present throughout the survey area.

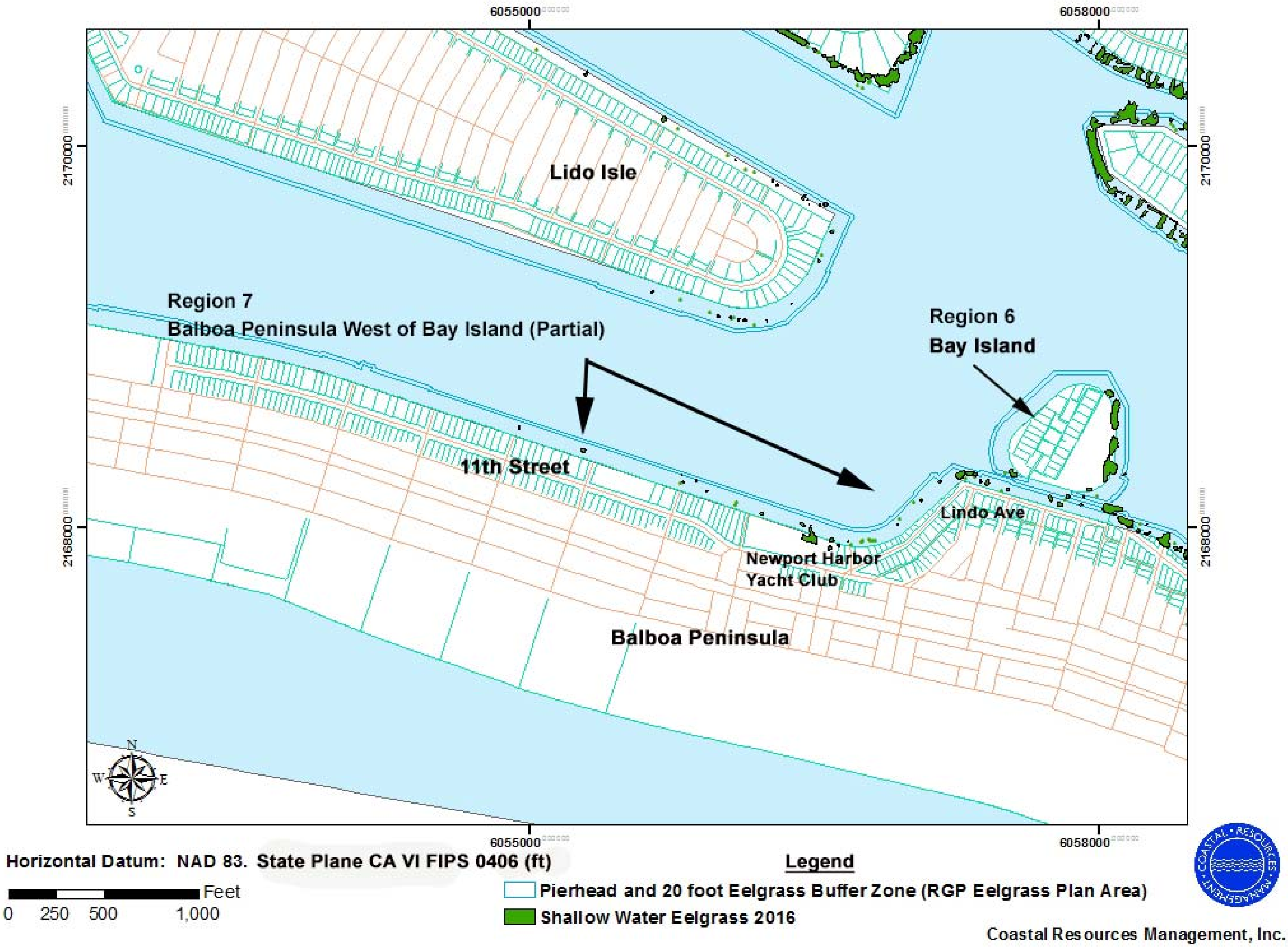

Figure 12. 2016 Eelgrass Habitat Map. West Balboa Peninsula. Region 6 Bay Island and Region 7 Balboa Peninsula West of Bay Island (Partial). See Figure 15 for Remainder of Region 7.

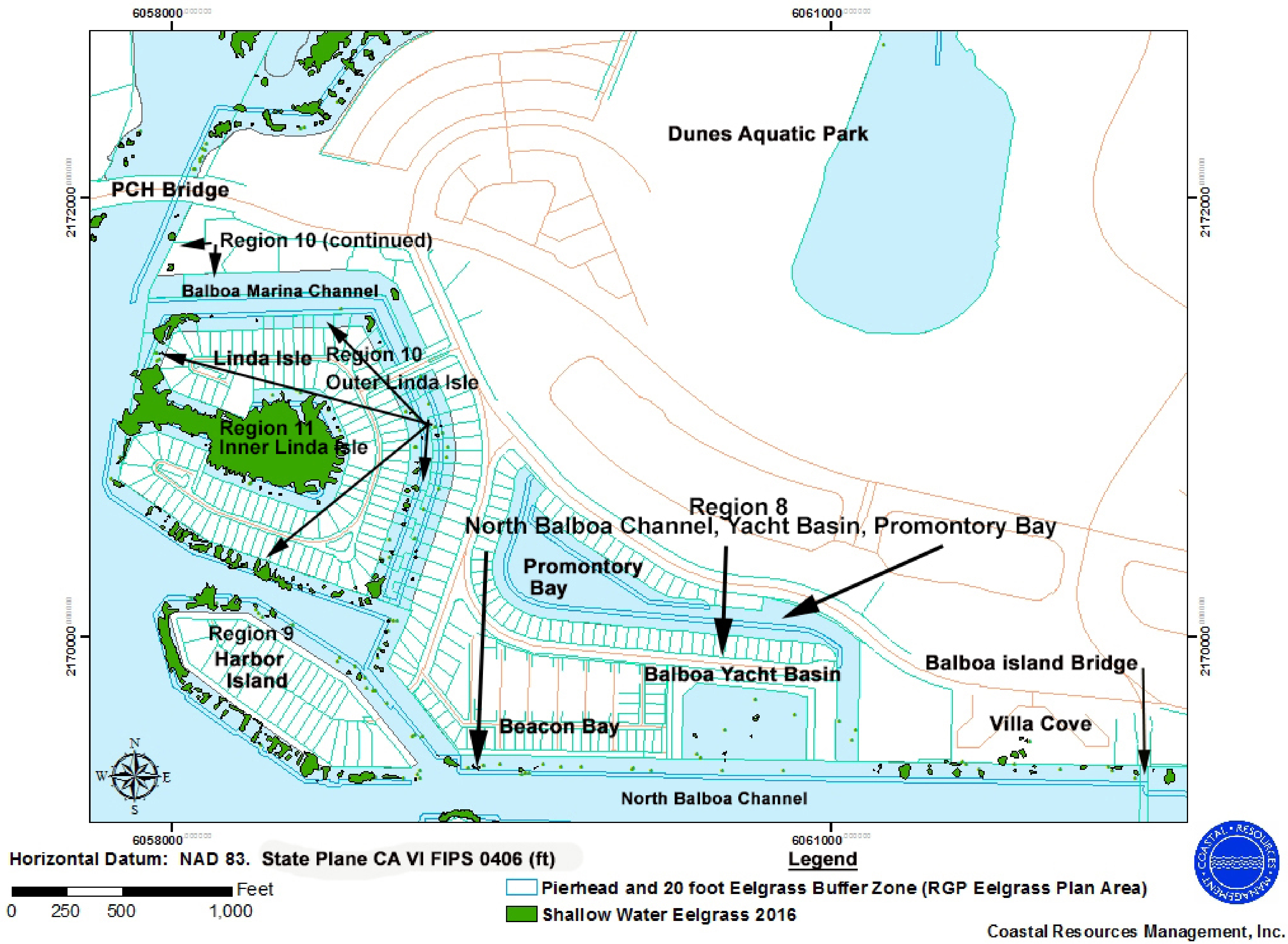

Figure 13. 2016 Eelgrass Habitat Map. Regions 8, 9, 10, and 11

3.3.10 Region 10-Outer Linda Isle Channels (1.155 acres)

Refer to Figure 13. This region encompasses the outer perimeter of Linda Isle, Balboa Marina Channel, and the Balboa Marina (East and West). The total amount of eelgrass in Region 10 was 1.115 acres, or 2.6% of the Bay's eelgrass (Table 2). Eelgrass habitat expanded by 0.762 acre between 2014 and 2016 (Table 3). A large part of the recovery was observed around the south and east perimeter of Linda Isle, where the dredging had occurred in 2012. Many small patches were located in the channel on the east side of Linda Isle, suggestive of continual habitat recovery. Eelgrass was growing in silty sediments throughout the area at depths between -0.5 and -8.6 ft MLLW.

3.3.11 Region 11-Linda Isle Inner Basin (5.548 acres)

Refer to Figure 13. Linda Isle Inner Basin (Linda Isle Inlet) ranked third in eelgrass abundance behind Corona del Mar and Balboa Island (Table 2) and accounted for 10.5 % of all of the eelgrass mapped during the 2016 survey. Eelgrass continued to expand its distribution within the Basin, adding 1.053 acres between 2014 and 2016. The expansion occurred within the entrance of the Basin and unoccupied boat slips. Since 2006, most 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 eelgrass depth range varied between -0.5 and 5 ft MLLW. The amount of eelgrass mapped in 2016 was the highest of the five surveys to date. Eelgrass was reproducing at the time of the survey.

3.3.12 Region 12-DeAnza/Bayside Peninsula, Inner (East) Area (3.834 acres)

Refer to Figure 14. Eelgrass accounted for 7.2% of the eelgrass in the Bay in 2016 and this region ranked fifth in total eelgrass acreage encompassing 3.834 acres (Table 2). It formed a wide, elongated bed between DeAnza Bayside Peninsula and the Bayside Village Marina after disappearing in 2009-2010 from a die-off that was first observed during the 2006-2007 survey (Table 3). Between 2014 and 2016, eelgrass expansion was notable (3.757 acres). Its expansion was notable throughout the area, amongst open water areas of the Bayside Village Marina dock system. Vegetation was mapped at depths between -0.6 and -8 ft MLLW in primarily in very silty sediments. A small bed of *Ruppia maritima* (ditch weed) was located near the Bayside Village swimming beach.

3.3.13 Region 13-DeAnza/Bayside Peninsula, Outer (West) Area, Main Channel of Upper Newport Bay (4.006 acres)

Refer to Figure 14. The DeAnza/Bayside Marsh Peninsula eelgrass bed encompassed 4.006 acres (7.6%) in 2016 (Table 2) and the bed expanded 2.41 acres since the 2014 survey (Table 3). Vegetation extended from the southern tip of the peninsula and north to the beginning of the Dunes Marina. It formed a nearly continuous, wide meadow on a shallow shoal between the intertidal mudflats and the top of the Main Channel's dredge slope, decreasing in width as it approached the Dunes Marina. A portion of vegetation, particularly north of the cut that separates the two portions of the peninsula, is the result of restoration efforts made by Orange County Coastkeepers during their Upper Newport Bay Eelgrass Restoration Project that was initiated in June 2012 (Orange County Coastkeeper, 2015).

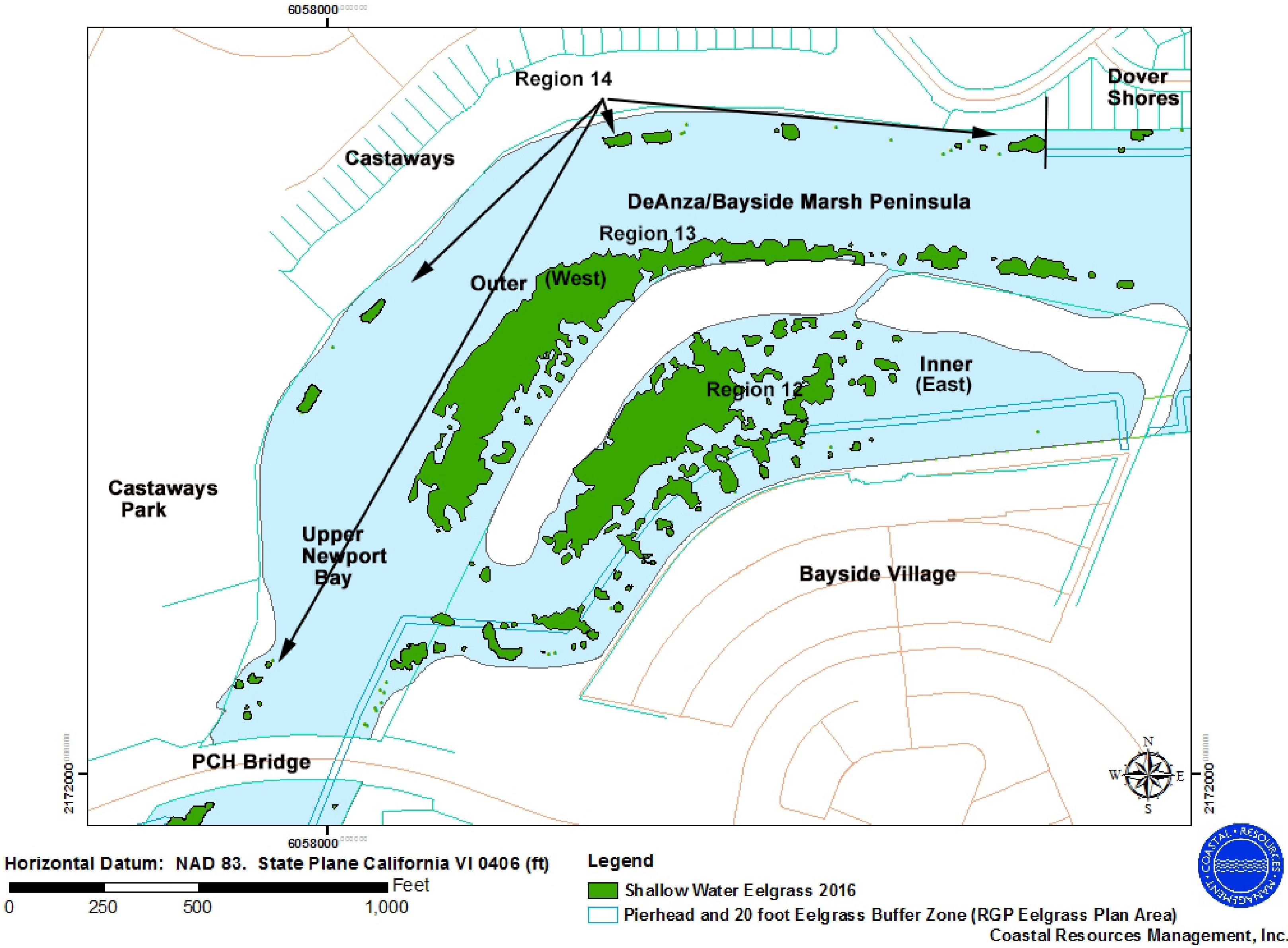

Figure 14. 2016 Eelgrass Habitat Map. Regions 12, 13, and 14

The amount of eelgrass along the peninsula has fluctuated widely since the first survey was conducted in 2003. It was less than one acre in size in 2003, absent to nearly absent between 2006 and 2010, and then began to expand again prior to the 2013-2014 survey. Historically, this wide fluctuation in eelgrass abundance in the Upper Bay has been documented since 1969, when about three acres of eelgrass was lost in the vicinity of the Bayside Peninsula following 1969 storm events. In 2016, eelgrass was mapped between the depths between 0.0 and -6 ft MLLW in silty sediments.

3.3.14 Region 14-Castaways to Dover Shores, Upper Newport Bay (0.340 acre)

Refer to Figure 14. The shallow subtidal habitat between the Coast Highway Bridge and Dover Shores on the west side of the Upper Newport Bay Main Channel supported 0.340 acre of eelgrass in 2016, or 0.6% of the total eelgrass in Newport Bay. Small beds were present near the Coast Highway Bridge and along the shoreline between Castaways and Dover Shores. Since 2014, the amount of eelgrass has increased by 0.329 acre. Fifty-three percent is attributable to Orange County Coastkeeper eelgrass transplants established in 2015. These are the beds that are located midway along the shoreline between Coast Highway Bridge and Dover Shores (Figure 14). Unlike the beds along the DeAnza Bayside Peninsula on the opposite side of the Main Channel, these beds located on a narrow shelf at depths between -1 and -4 ft MLLW. Eelgrass located in front of the old Castaways Marina near the PCH Bridge extended to -6 ft MLLW and occurred over a slightly wider shallow subtidal area. This bed, near the PCH Bridge, has also been present since at least 1992 (Coastal Resources Management, 1992) but has also disappeared following periods of heavy rainfall and stormwater flows in Upper Newport Bay.

3.3.15 Region 15-Bayshores (0.760 0.156 acre)

Refer to Figure 15. This region extends from the PCH Bridge to the junction of the Lido Reach along and the Bayshores Apartment and Newport Marina. Region 15 eelgrass totaled 0.760 acre, and accounted for 1.7% of the bay's eelgrass. The largest beds were located on the shoal in front of the Bayshore Apartments and Newport Marina near the PCH Bridge, and near the community swimming beach at the south end of the region. Eelgrass in the mid-section was growing between the bulkhead and dock headwalks. The depth range of eelgrass was -0.3 to -8 ft MLLW. Like many other areas, this region's eelgrass system has continued to make a strong comeback following declines in the eelgrass population documented during the 2010 survey (Table 3). Sediments ranged between compact sands along the inshore edges grading into silts along the offshore edges of the beds. Divers also noted an unusually large amount of debris (i.e., a sunken dingy, tarps, and plastic Christmas trees/lights, etc.) beneath one of the docks south of the community swimming beach.

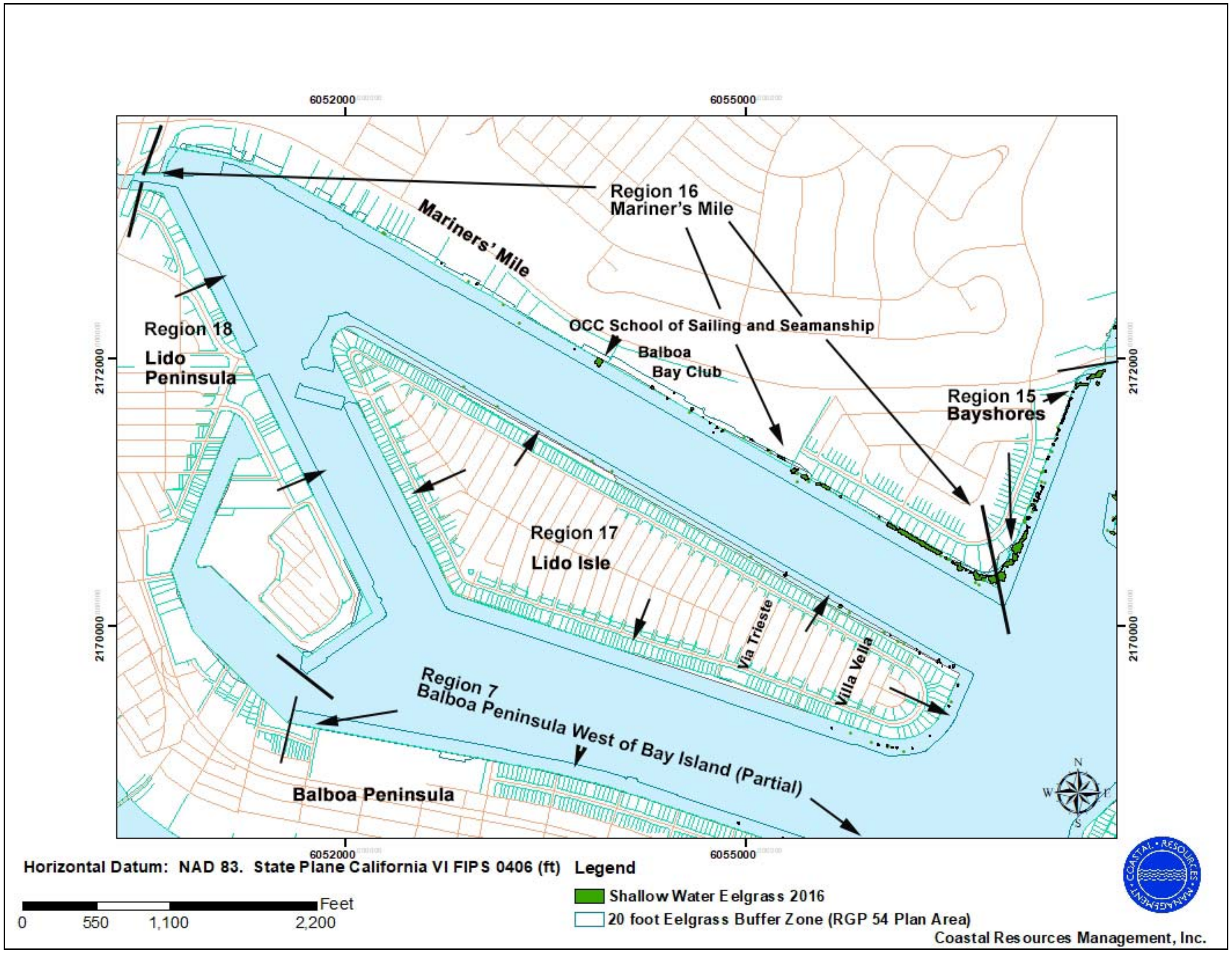

Figure 15. 2016 Eelgrass Habitat Map. Regions 7 (Partial), 15, 16, 17, and 18.

3.3.16 Region 16-Mariners' Mile (0.710 acre)

Refer to Figures 15. Eelgrass located along the Bayshores Marina and Mariners' Mile accounted for 1.2 % (0.710 acre) of eelgrass in Newport Bay (Table 2) between depths of 0.0 and -10 ft MLLW. Most eelgrass grew between the bulkhead and docks of the Bayshores Marina and in the Orange Coast College School of Sailing and Seamanship Boat Basin. A lesser amount of eelgrass was found within the Balboa Bay Club Basin, and in boat basins between the OCC Boat Basin and the boat basin at 2537 West Coast Highway. The amount of eelgrass present during the 2016 was double the amount observed during the 2014 survey. However, the amount in 2016 was also one-third the amount recorded during the 2013 survey when this region's eelgrass totaled 0.234 acre.

3.3.17 Region 17-Lido Island (0.074 acre)

Refer to Figure 15. Lido Isle was the 3rd least abundant eelgrass region in Newport Bay, totaling 0.074 acre (Table 2), and 0.1% of the Bay's eelgrass. Most of the vegetation was concentrated around the eastern tip between *Via Vella* on the southern side of Lido Isle to the tip, to approximately *Via Trieste* on the north side. New eelgrass patches were also found along the northern side of Lido Isle in front of the community beach. The amount of eelgrass on Lido Isle increased 0.051 acre between 2014 and 2016. Eelgrass was growing in fine, silty sediments at depths between -0.4 and -8 ft MLLW.

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.

3.3.19 Region 19- West Newport (Not surveyed)

Refer to Figure 16. Eelgrass surveys were not conducted in West Newport, per the direction of the City of Newport Beach. No eelgrass was located in this region during the prior 2014 survey.

3.3.20 Region 20-Dover Shores (0.176 acre)

Refer to Figure 17. First surveyed for the City during the 2014 mapping project, eelgrass expanded its distribution to include multiple beds along the main channel of Upper Newport Bay. Several small beds and patches were also located in the two Dover Shores inlets (Dover Shores North and Dover Shores South) although most vegetation was concentrated near the mouth of the two inlets. The total amount of eelgrass during the 2016 survey was 0.176 acre, an increase of nearly 20 times since the 2014 survey. 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). Eelgrass was growing in silty sediments at depths between 0.5 to -5.4 ft MLLW.

3.3.21 Region 21-Dunes Marina and CDFW Boat Dock (0.014 acre)

Refer to Figure 17. This region supported the second lowest amount of eelgrass during the 2016 survey (0.026 acre). Several small patches were found in the Dunes Marina at depths of -1.4 to -7.4 ft MLLW that accounted for 0.1% of the eelgrass in Newport Bay. Sediments where eelgrass was growing consisted of fine silts. One additional small bed was located behind the California Department of Fish and Wildlife Boat Dock on Lower Shellmaker Island.

3.3.22 Region 22-Added Region in 2016. North Star Beach

Refer to Figure 17. Eelgrass surveys were conducted along North Star Beach in Upper Newport Bay for the first time in December 2016. Several small patches of eelgrass and one small eelgrass bed were located totaling 0.003 acre of eelgrass habitat. This vegetation was growing along the shoreline at depths between -2 and -5 ft MLLW in silty sediments.

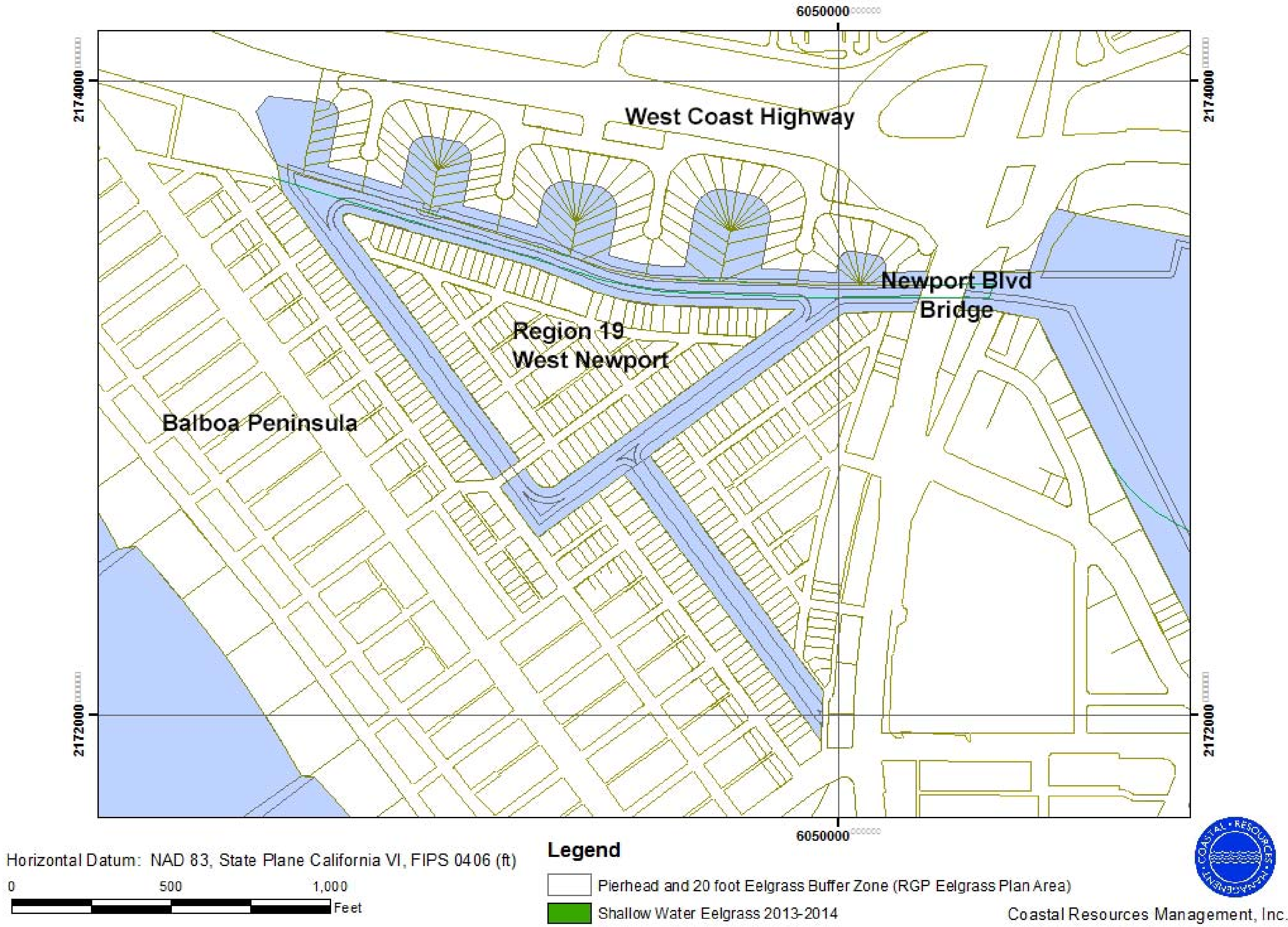

Figure 16. 2016 Eelgrass Habitat Map. Region 19 (not surveyed; no eelgrass in 2014)

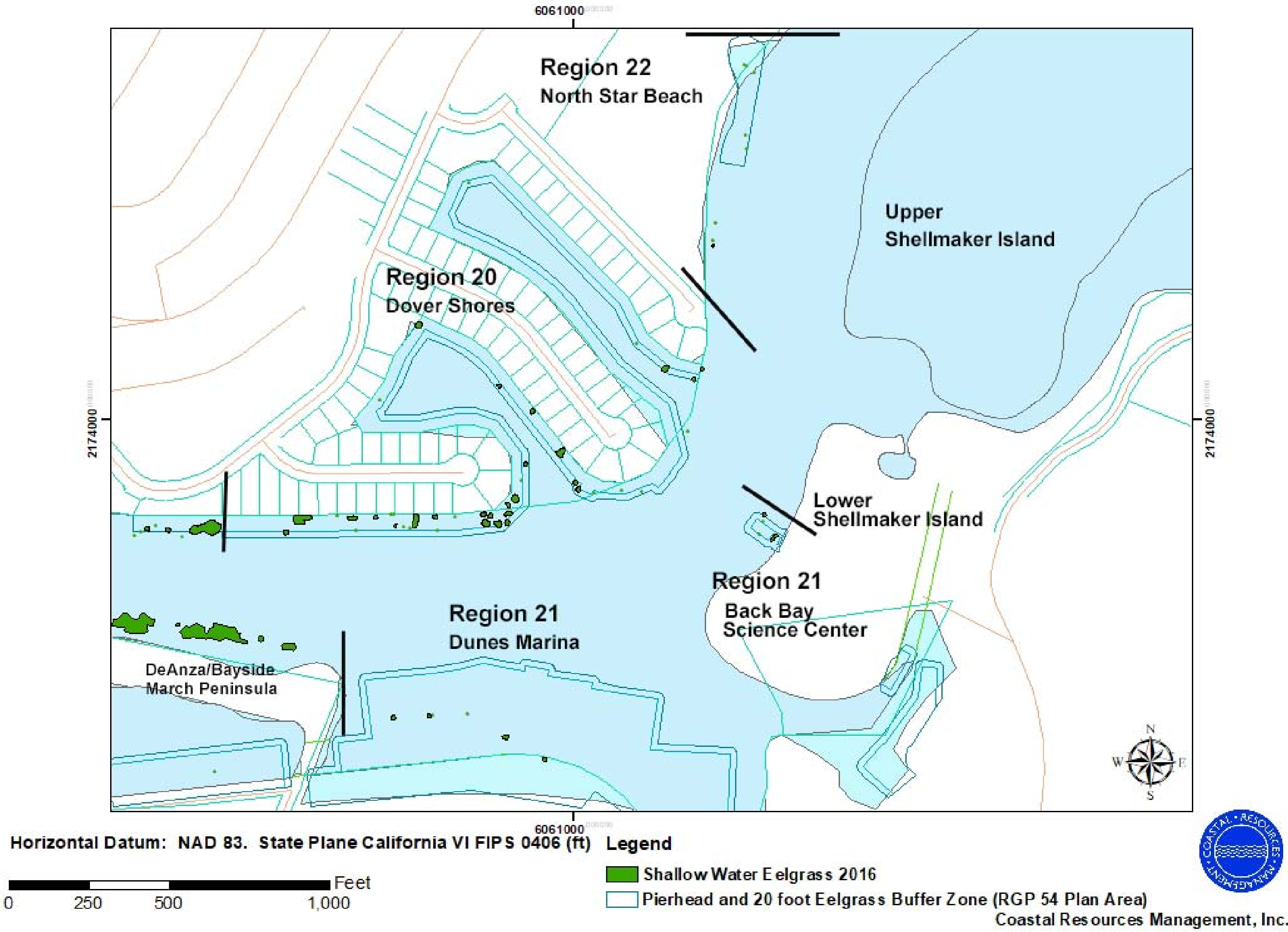

Figure 17. 2016 Eelgrass Habitat Map. Regions 20, 21, and 22

3.3.23 Deep Water Eelgrass Habitat (51.5 acres)

Refer to Figure 18. A detailed sidescan and downlooking sonar survey was conducted in September 2016 to identify the extent of DWEH eelgrass vegetation in the Newport Bay Entrance Channel and Balboa Reach. The results of the survey indicated that significant amounts of eelgrass vegetation were present in both areas. A total of 51.5 acres of eelgrass was mapped at depths from -10 to -29.5 ft MLLW in the Entrance Channel, and at depths between -10 and -15 ft MLLW in Balboa Reach. Depth contours in the DWEH survey areas are provided in Appendix 3. In Balboa Reach, eelgrass was found in-and-around the periphery of Mooring Fields BYC, B, and AI. Both the narrow bladed species of eelgrass (*Zostera marina*) and the wide bladed species (*Zostera pacifica*) were found in the Entrance Channel beds.

The amount of DWEG has ranged between 45.8 acres in 2008 to 51.5 acres in 2016. In 2003, a total of 90.3 acres of eelgrass was mapped in by the National Marine Fisheries Service. The discrepancy between the 2003 NMFS survey and the 2008, 2012, and 2016 CRM surveys is partially related to survey techniques rather than actual changes in habitat size.

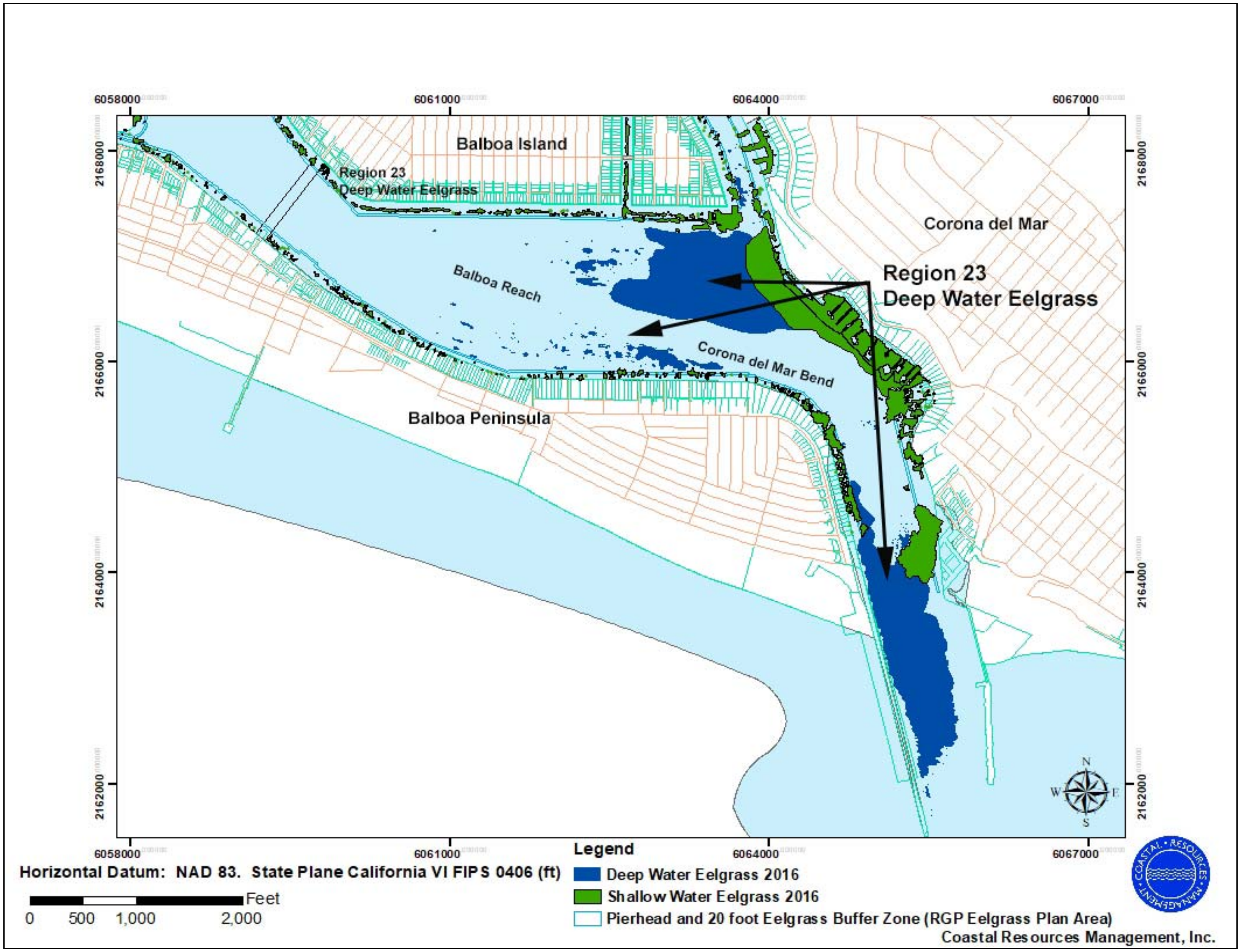

Figure 18. 2016 Eelgrass Habitat Map. Region 23 Deep Water Eelgrass

3.4 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 19). 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 six 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 2016.

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 five eelgrass surveys conducted to date are shown in Figure 20. Data for regions within each of the zones, by survey is provided in Appendix 4.

During this period, the total amount in the Stable Zone was 37.04 acres, an increase of 0.50 acres since the 2014 survey. These small gains were observed along the East Balboa Peninsula (east of Bay Island) and Linda Isle Inner (Linda Isle Inlet). The jump in eelgrass acreage in 2013-2014 and 2014-2016 compared to previous surveys was partially related to enlarging the SWEH survey area to include the -15 ft contour along Corona del Mar and Balboa Island.

Transitional Zone eelgrass increased by a factor of three between 2012-2014 and 2014-2016, and the amount of eelgrass in this zone is the highest of the five-survey period. The amount of eelgrass increased from 5.54 acres in 2012-2014 to 15.88 acres in 2016. Gains occurred in 16 of 17 regions, and the one region that exhibited a decrease (North Balboa Channel and Yacht Clubs) only decreased by 0.02 acre.

Transitional Zone boundaries identified by the Eelgrass Zone Model were similar to 2012-2014, when eelgrass vegetation was mapped farther west in the Lido Reach and the Rhine Channel Reach than during any earlier survey. Additionally, the range extent of eelgrass in the Upper Newport Bay extended to North Star Beach in 2016. Of all of the Transitional Zone regions, Upper Newport Bay made the most dramatic eelgrass habitat recovery than any of the Transitional Zone regions.

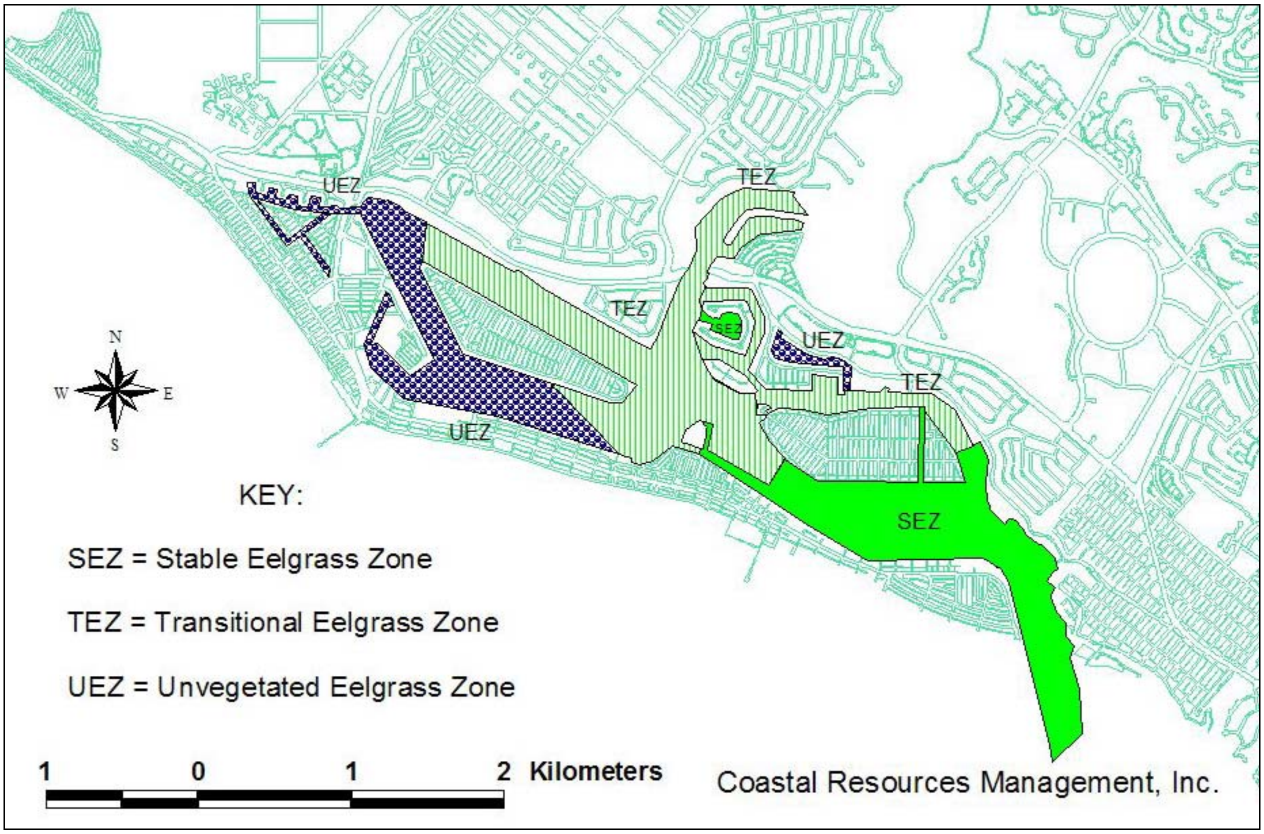

Figure 19. Eelgrass Zones In Newport Bay. Source: CRM 2010

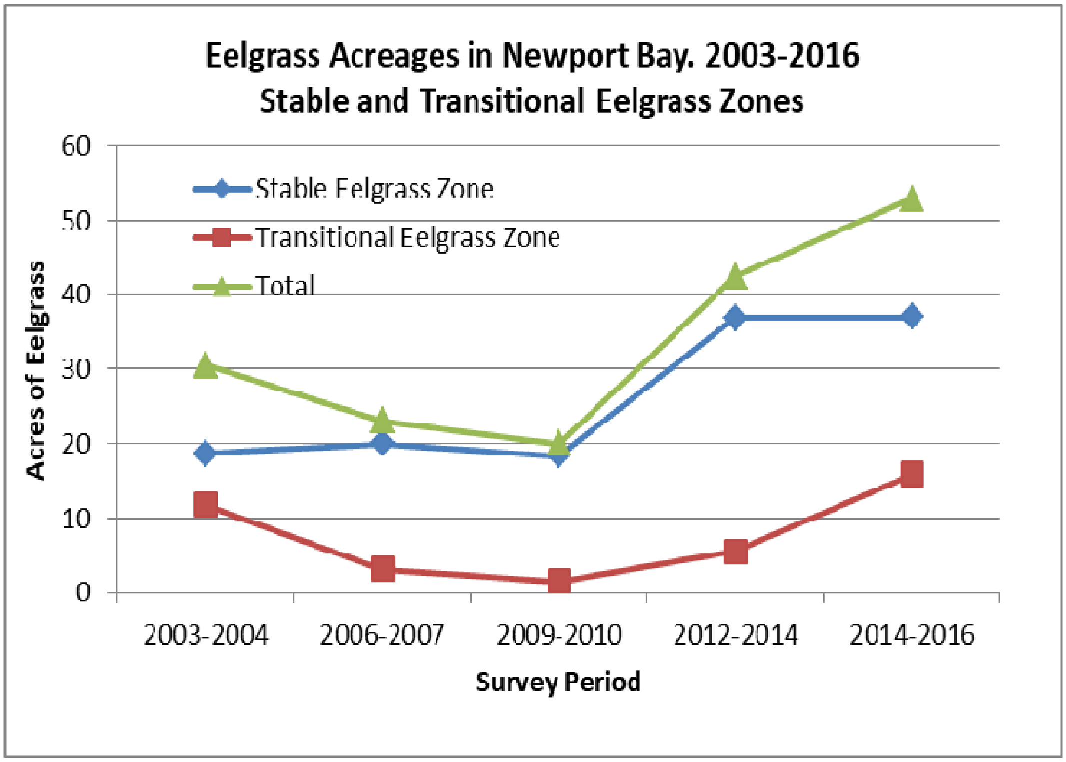

Figure 20.

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

Figure 21 illustrates the relationship between eelgrass abundance among the 22 SWEH regions between 2003 and 2016. This analysis groups together (clusters) eelgrass survey regions based upon their respective eelgrass acreage similarity coefficient (attributes) over time. The more closely related regions exhibit higher similarity coefficients. West Newport, Dunes/CDFW dock, and Dover Shores were not included because they were not sampled during all of the surveys.

The results indicate the presence of two major eelgrass site groups (A and B) and three temporal groups (Temporal Groups 1-3). The greatest degree of separation detected was between the Group A Transitional Eelgrass Zone regions and the Group B Stable Eelgrass Zone Regions. Group A could be further classified into three Transitional sub-groups (A1, A2, and A3) while Cluster Group B could be further classified into 2 Stable Zone subgroups (B2 and B2).

The one exception to the distinct separation of the Transitional and Stable Region clusters was the cross-over of Grand Canal, a Stable Eelgrass region, into the Transitional Eelgrass Zone cluster A2.

3.5.1 Transitional Subgroups

Site Group A1 included Transitional eelgrass regions that had comparatively lower acreages of eelgrass than the other subgroups and did not display substantial changes in size over time. These regions were scattered throughout the Lido Reach, Rhine Channel Reach, between the PCH Bridge and Dover Shores in Upper Newport Bay, and in the North Balboa Channel/Balboa Yacht Basin/Promontory Bay areas. Site Group A2 regions were located in Upper Newport Bay around the DeAnza Bayside Peninsula and displayed an impressive eelgrass growth spurt between 2014 and 2016.

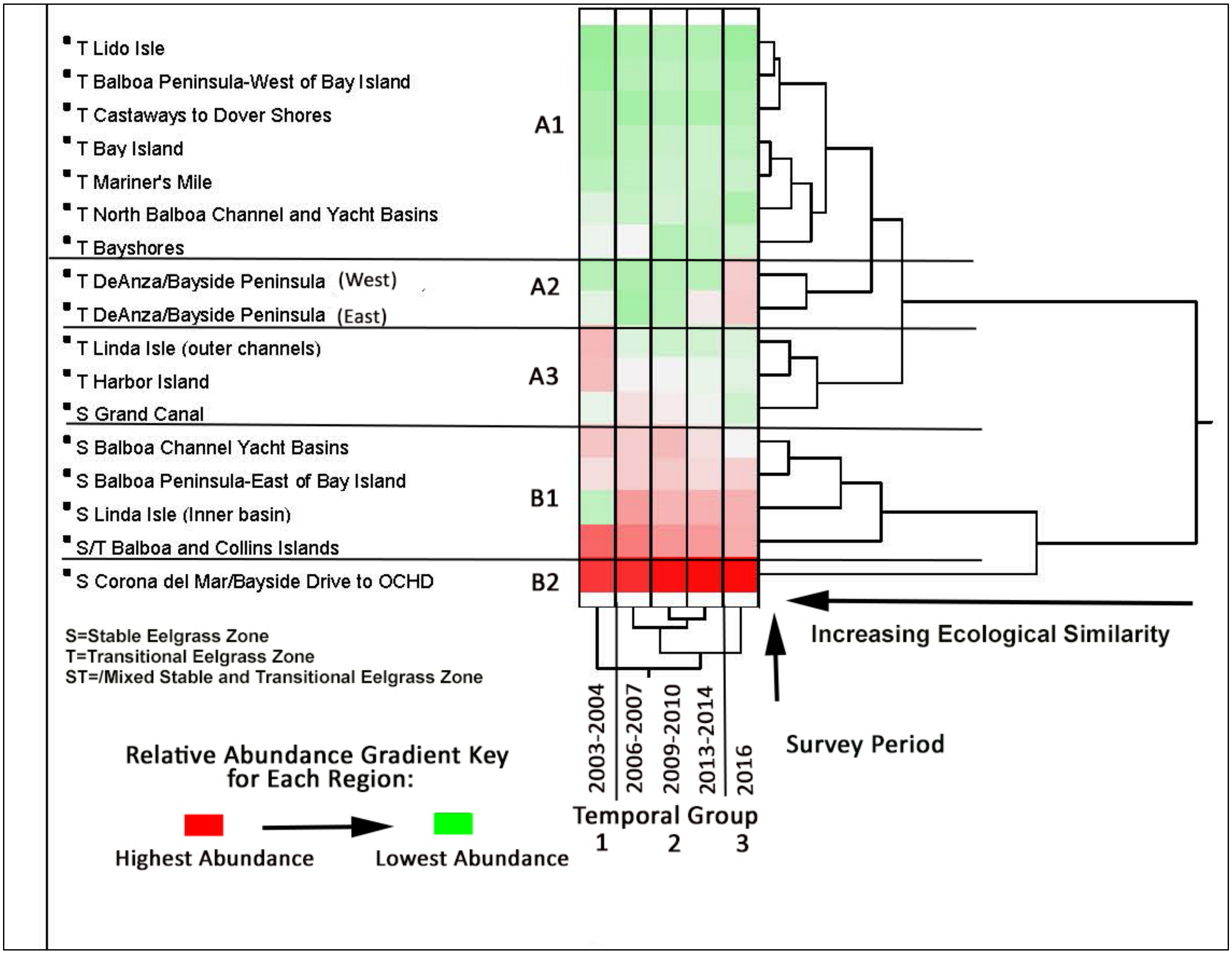

Figure 21. Site Classification Analysis. Eelgrass Distribution and Abundance, 2003-2016

Site Group A3 included Mid-Harbor Transitional regions centered on Harbor Island and Linda Isle, as well as the Stable Transition site outlier region, Grand Canal. Grand Canal's inclusion in this grouping may partially be related to how dissimilar it was to other Stable Eelgrass sites relative to total acreage and a its decrease in eelgrass acreage since 2014. Other Stable Eelgrass Zone regions supported more than two acres of eelgrass whereas Grand Canal (due to its finite size) could never support much more than an about an acre of eelgrass. Site Group 3 members also had more eelgrass during the first or second survey and lower eelgrass abundance later particularly during the 2016 survey.

3.5.2 Stable Zone Subgroups

Site Group B1 included four Stable Eelgrass Zone regions; three were centered on Balboa Island and one along Bayside Drive in Corona del Mar across the channel from Balboa Island. The western section of Balboa Island (past the Ferry Crossing) and all of Collins Island are within the Transitional Eelgrass Zone. Linda Isle is also included in this group. Although it is within the Stable Eelgrass Zone, it is geographically separated from the other regions and it is located at the juncture of Lower and Upper

Newport Bay. Its inclusion in Site Group B1 was related to its consistent, high abundance (>1 acre) between 2006 and 2016 despite low abundance in 2003 (<1 acre).

Site group B2 included a singular member (Corona del Mar/Bayside) that is the long-term dominant eelgrass region within Newport Bay consistently had more eelgrass than any other region since 2003.

3.5.3 Temporal Site Groupings

The classification analysis identified three temporal groups: Group 1 (2003-2004); Group 2 (a combination of the 2006-2007 and 2009-2010, and 2013-2014 surveys); and Group 3 (2016). Temporal Group 1 (the first survey) provided the "baseline" for the other four surveys. This temporal group was unique for the distinctly greater eelgrass abundance at Harbor Island and Linda Isle Outer Channels (Group A3) than the other groups. Temporal Group 2 (2006-2007, 2009-2010, and 2013-2014) were periods of substantial acreage variation between 2006 and 2010 followed by increases in eelgrass abundances of many sites in both Groups A and B during 2014. Lastly, Temporal Group 3 was defined by the substantial increase in eelgrass acreage around the DeAnza Bayside Peninsula (Group A2 regions) in 2016.

3.6 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 at 20 stations between September and October 2016 at the end of the eelgrass growing season. After a three-survey period of declining eelgrass turion density, turion density increased to a mean of 163.5 turions per square meter in 2016 (Figure 22). However, the 2016 mean density was still 25% less than the highest density recorded in 2003-2004. A summary of eelgrass density data for all surveys conducted between 2004 and 2016 is provided in Appendix 5.

3.6.1 Eelgrass Density and Temporal Spatial Trends

2016 Spatial Trends. Eelgrass turion density spatial trends are illustrated in Figure 23. Station density varied from 86.8 turions per sq m (Harbor Island, West Side) to 287.7 turions per sq m (Grand Canal). The sites with the very high densities (>over 200 turions per sq meter) included three Stable Eelgrass Zone regions (Grand Canal, Entrance Channel at the Public Fishing Dock on Channel Road, Carnation Cove (Corona del Mar), and one Transitional Eelgrass Zone region (Bayshores Community Beach). High density areas (between 150-200 turions per square meter) included China Cove, C Street, Newport Harbor Yacht Club, Bay Island, and the PCH Bridge. Moderately dense areas (between 100 and 150 turions per square meter included East Balboa, Southeast Balboa, Linda Isle, Lido Isle, West Harbor Island, OCC Boat Basin, and Balboa Marina. A single low eelgrass turion density site (less than 100 turions per square meter) was on the west side of Harbor Island site.

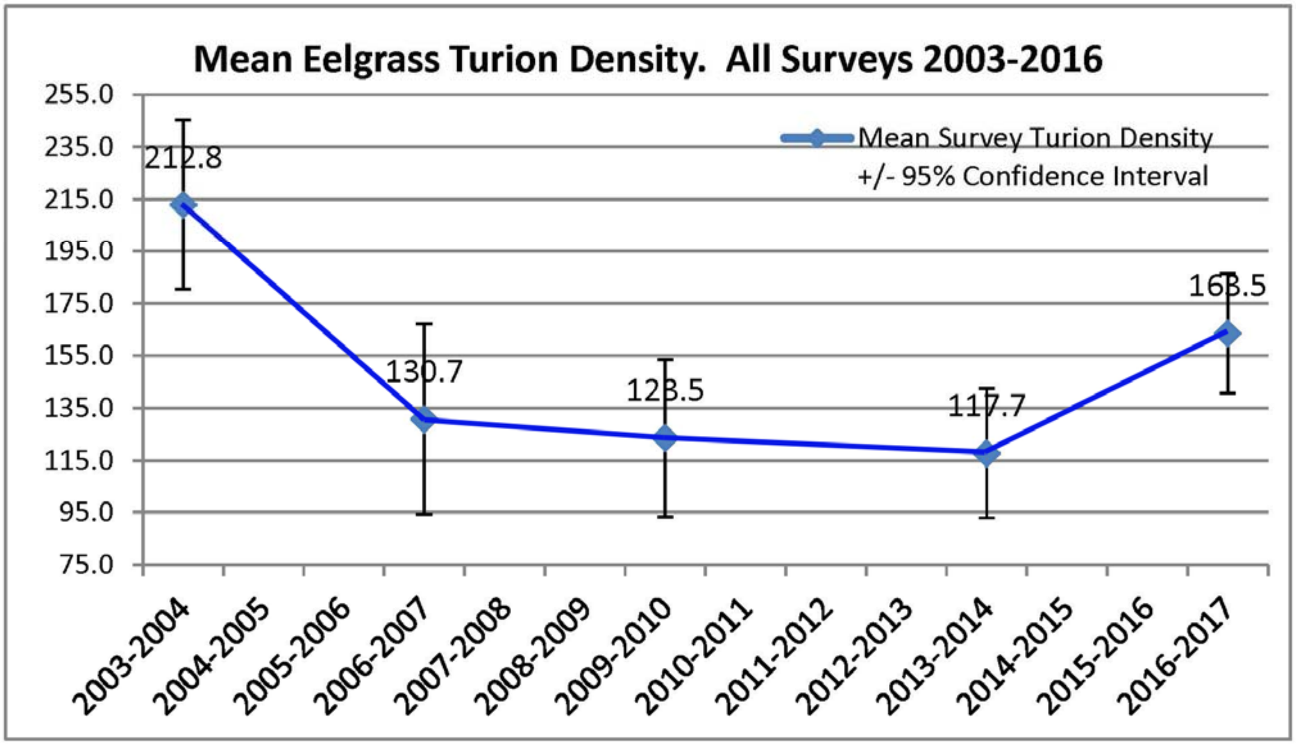

Figure 22

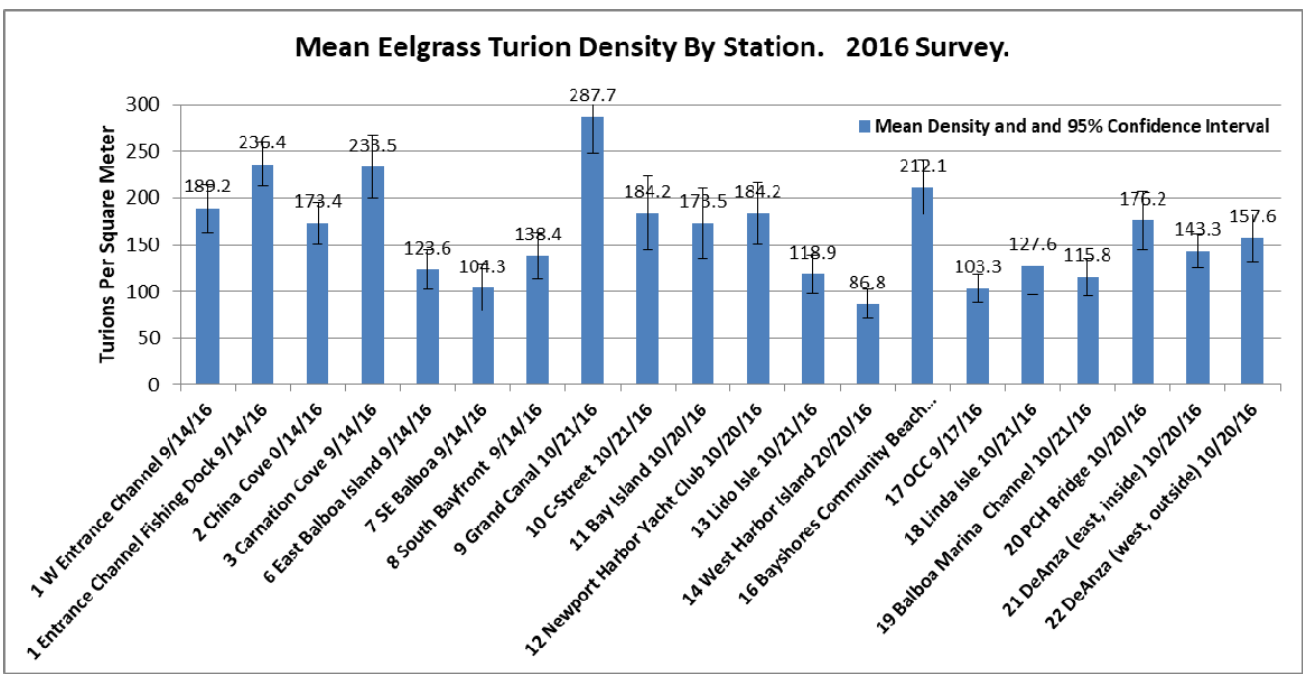

Figure 23.

Temporal Trends. Figure 24 compares the results of the five turion density surveys conducted between 2003 and 2016. Most stations exhibited density increases in 2016 compared to 2013-2014. The only stations where turion density decreased were Southeast Balboa (corner), East Balboa, Carnation Cove, and West Harbor Island. Of these, the only one that exhibited a substantial decrease was West Harbor Island.

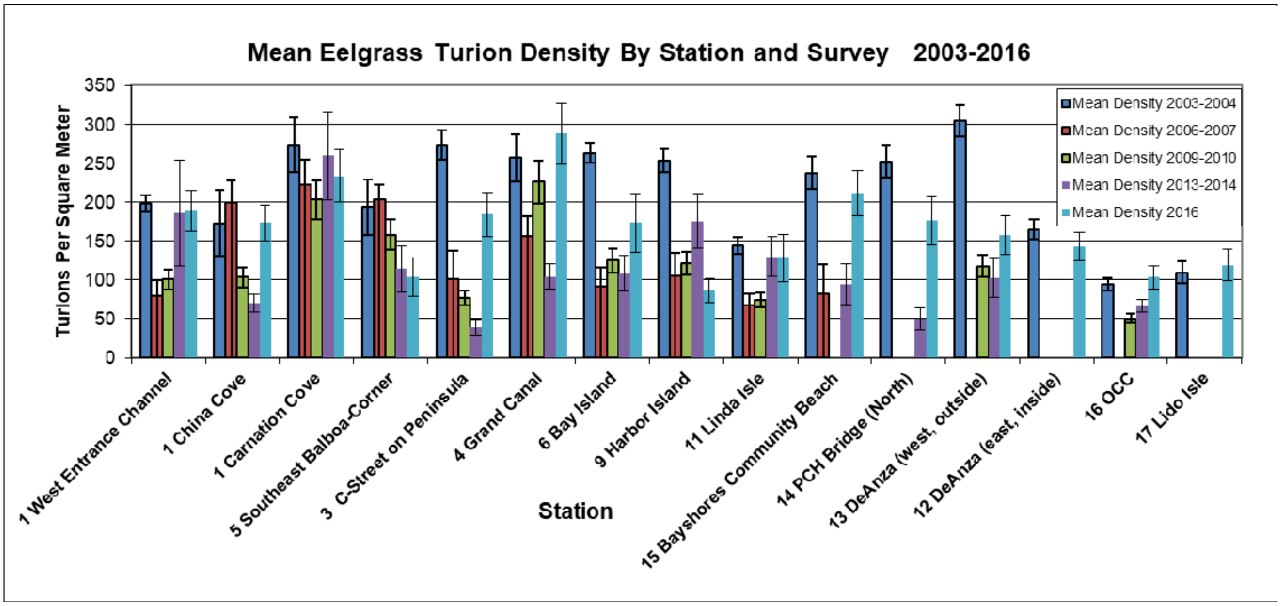

Figure 24.

4.0 OTHER MARINE LIFE

4.1 MARINE LIFE OBSERVED DURING THE SURVEY

Appendix 6 lists the types of plants and animals observed during eelgrass bed surveys 2016 survey. A total of 121 types of plants, invertebrates, and fishes were documented during the survey including (Table 4). The composition included bacteria matts (2%), algae (15.7%), seagrasses (3.3%, invertebrates (48.6%), and fishes (30.6%). In addition, two marine mammals (the California Sea Lion and the Bottlenose Dolphin) and seven species of marine birds (Surf Scoter, Western Grebe, California Brown Pelican, Brandt's Cormorant, California gull, Great Blue Heron, and Snowy Egret).

Besides the two species of eelgrass documented during the survey, two additional species were found; Ditchgrass (*Ruppia maritima*) was found in the vicinity of the Bayside Village swimming beach and surfgrass (*Phyllospadix torreyi*) was found between the Entrance Channel and Carnation Cove. The benthic soft-bottom habitat (vegetated and unvegetated bottom) in both Lower and Upper Newport Bay was colonized heavily by the invasive Asian Mussel (*Musculista senhousia*). Dense mats were observed in 13 of the 22 SWEH Regions. Along the south side of Lido Isle, *Thalamoporella* and the algae *Chaetomorpha* covered up to 90% of the bayfloor in some areas. Between Bay Island and the Rhine Channel, the green algae *Ulva* spp., and the bryozoan *Thalamoporella californica* formed dense mats in the shallow subtidal depths. The brown algae *Dictyopteris* covered an extensive portion of the bottom between the bulkhead and docks of the Lido Marina. This algae was attached to gravel/cobble underlying sandy sediments. While not uncommon in southern California, this bed appeared to take on the qualities of a patch reef that in the absence of eelgrass was a distinctive habitat type in Newport Bay particularly in the western portion of the Bay. In Upper Newport Bay, the bryozoan *Thalamoporella californica* and zooanthid anemones formed large mats over the bayfloor in the vicinity of Castaways at shallow depths. Oyster reefs were also common along the shoreline, as well as near Dunes Marina and Bayside Village marina. In the Dover Shores area, high bottom cover of the red algae *Gracilariopsis* was noted.

Plankton feeders (topsmelt, blacksmith, and señorita), and black surfperch ("pickers") were often seen schooling above eelgrass vegetation throughout the Bay. Ambush predators such as spotted sand bass (*Paralabrax maculatofasciatus*), barred sand bass (*P. nebulifer*) were associated with the deeper fringes lining the navigational channels. Benthic foraging round string rays (*Urolophus halleri*), turbot, (P*leuronichthys* spp) and juvenile California halibut (*Paralichthys californicus*) were observed in barren patches within beds or along the fringes.

Many of the type of fishes observed in the Entrance Channel and Corona del Mar eelgrass beds are nearshore reef and kelp bed associates (i.e., kelp bass *(P. clathratus*). blacksmith (*Chromis punctipinnis*), giant kelp fish (*Heterostichus rostratus*), garibaldi (*Hypsypops rubicundus*), senorita (*Oxyjulis semicinctus),* and halfmoon (*Medialuna californiensis*) that are attracted to the eelgrass beds for similar ecological functions as reefs- i.e., foraging, protection, and cover. Numerous juveniles of many species were observed in association with eelgrass throughout the Bay.

Two species of fish uncommon to California were observed during August and September 2016. A single Pacific Seahorse (*Hippocampus californicus*) was sighted along the Castaways shoreline in Upper Newport Bay within dense bryozoan (*Thalamoporella*) beds (Photograph 11) and a single Bullseye Puffer (*Sphoeroides annulatus)* was observed swimming in the Newport Bay Entrance Channel eelgrass beds along the channel's western bulkhead (Photograph 12). Both are semi-tropical to tropical species that followed warm water currents up from Mexico during the 2016 El Nino event.

Table 4. Species Composition of Marine Organisms Observed During the Survey

Taxonomic Group	Number of Taxa	% Total
Bacillariophyceae	2	1.7
Chlorophyta (green algae)	4	3.3
Phaeophtya (brown algae)	8	6.6
Rhodophyta (red algae)	7	5.8
Zosteracea (seagrasses)	4	3.3
Porifera (sponges)	2	1.7
Cnidaria (hydroids sea pens, anemones, gorgonians)	10	8.3
Platyhelminthes (flatworms)	2	1.7
Annelida (segmented worms)	2	1.7
Mollusca (octopus, snails, and clams)	23	19.0
Arthropoda (crustaceans)	10	8.3
Echinodermata (sea cucumbers, sea stars, urchins)	4	3.3
Ectoprocta (bryozons)	4	3.3
Urochordata (sea squirts)	2	1.7
Pisces (fish)	37	30.6
Total	**121**	100.0

Photograph 11. Pacific Sea Horse in Dense Bryozoan Beds in Upper Newport Bay
(Photo by: Amanda Bird)

Photograph 12. Bullseye Putter in the Newport Bay Entrance Channel
Photo by: Amanda Bird

4.2 (NOXIOUS ALGAE) *CAULERPA TAXIFOLIA*

Caulerpa (Photograph 13) is a potential threat to southern California marina ecosystems. This species, originally found in the Mediterranean, can be extremely harmful to marine ecosystems because it invades, out-competes, and eliminates native algae, seagrasses, kelp forests and reef systems by forming a dense blanket of growth on mud, sand, or rock surfaces It can grow in shallow coastal lagoons as well in deeper ocean waters and can grow rapidly up to nine feet in length. *Caulerpa* was initially found in Agua Hedionda Lagoon in North San Diego County in 2000 and in Huntington Harbour in 2001 but was eradicated following heavy treatment with chlorine. Test results indicate that the *Caulerpa taxifolia* in both areas is genetically identical to the aquarium strain. Releases from aquaria, either

directly into the water body, or indirectly through a storm drain, are most likely sources of both Southern California infestations.
http://www.westcoast.fisheries.noaa.gov/habitat/aquatic_invasives/caulerpa_taxifolia.html

Photograph 13. *Caulerpa taxifolia* (with eelgrass in the background)
http://www.westcoast.fisheries.noaa.gov/publications/habitat/caulerpa_taxifolia/training_binder_online_1_.pdf

The ecological consequences of the spread of this invasive alga can be extremely serious and can result in a significant loss of plant and animal productivity.

Surveys for this invasive are conducted as part of continued concern that this species may re-appear in southern California embayments, and are mandated by the California Coastal Commission and U.S. Army Corps of Engineers. Noxious algae has not been found in Newport Bay since focused survey for Caulerpa were first conducted in 2002 under the auspices of the National Marine Fisheries Service's *Caulerpa Survey Protocol*.

CRM conducted extensive *Caulerpa* surveys for City of Newport Beach RGP 54 permits at 15 locations in June 2016 (Coastal Resources Management, Inc. 2016). None was found. In addition, the CRM survey team did not document the presence of *Caulerpa* during the 2016 SWEH and DWEH bay-wide diver and remote sensing mapping surveys.

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 June and December 2016. This was the fifth in a series of surveys conducted since 2003.

The bay was divided into 22 Shallow Water and one Deep Water mapping regions. The results of these surveys indicate eelgrass is common in many parts of Newport Bay and covers 104 acres of bottom habitat between the low tide zone and depths to -29.5 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 and Upper Newport Bay between June and December 2016.

Shallow Water Eelgrass Habitat (SWEH)

1. SWEH 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. 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.

2. Three regions accounted for 62.1% of all eelgrass in the Bay- Region 1, Corona del Mar/Bayside Drive (21.651 acres); Region 5, Balboa and Collins Islands (acres 5.736 acres); and Region 11, Linda Isle Inner Basin (5.548 acres)

3. Other regions with substantial amounts of eelgrass included Region 13, Outer DeAnza/Bayside Peninsula (4.006 acres); Region 12, DeAnza/Bayside Peninsula, east side (3.834 acres); and Region 3, Balboa Peninsula East of Bay Island (3.782 acres).

4. Four regions exhibited slight reductions in eelgrass areal cover compared to the 2013-2014 surveys: Region 1, Corona del Mar; Region 5, Balboa and Collins Islands; Region 2, East Balboa Channel and Yacht Basins; and Region 4, Grand Canal.

5. Increases in eelgrass acreages occurred within all of the other regions. Compared to the 2013-2014 survey, the net increase in eelgrass habitat was greatest for Upper Newport Bay Regions 12 and 13 DeAnza/Bayside Peninsula (East and West), where the net gain between the two surveys was 2.411 and 3.757 acres, respectively.

6. Increases of over one acre of eelgrass were observed in Linda Isle Inner Basin (Region 11) and along the eastern shoreline of the Balboa Peninsula, between Bay Island and the Harbor Entrance Channel (Region 3).

7. The changes in eelgrass distribution observed between 2003 and 2016 illustrate the highly dynamic nature of the Newport Bay eelgrass ecosystem 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. This was particularly evident in 2016 where eelgrass recovery was evident in areas that had experienced substantial declines in eelgrass acreages between 2006 and 2010.

Deep Water Eelgrass Habitat (DWEH)

1. Bioacoustical mapping methods using sidescan sonar and downlooking sonar to map eelgrass on the bayfloor of the Entrance Channel, Corona del Mar Bend, and Balboa Reach in September 2016 quantified 51.5 acres of eelgrass between the depths of -15 and -29.5 ft MLLW...

2. 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.

Eelgrass Habitat Zones

1. Based upon eelgrass distributional patterns observed since 2003, eelgrass grows within a Stable and Transitional Eelgrass Zone. The distribution of eelgrass in Newport Bay in 2016 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.

2. While the amount of eelgrass in the Stable Eelgrass Zone was relatively stable compared to 2014, there was a substantial increase in the abundance of eelgrass within the Transitional Eelgrass Zone-a gain of nearly three times the amount observed during the 2014 survey. The gain in eelgrass habitat within the Transitional Eelgrass Zone represents a continued recovery of eelgrass habitat that had been in a period of decline between 2006 and 2010.

Classification Analysis

1. 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, and fourth surveys conducted in 2006-2007, 2009-2010, 2013-2014; and the fifth survey conducted in 2016. This analysis provided additional evidence as to the presence of discreet eelgrass zones within Newport Bay.

Eelgrass Turion Density

1. Eelgrass turion (i.e., shoot) density information was collected at 20 sites between September and October 2016. Following a period of turion density decline between 2006 and 2014, bay-wide turion density increased in 2016. However, the bay-wide density was still 25 % less than the highest baywide density recorded in 2003-2004. Highest turion densities were recorded in the Grand Canal and at the Bayshores Community Beach. Lowest eelgrass turion density was recorded at the West end of Harbor Island.

Other Marine Life Observations

1. A total of 121 marine plants, invertebrates, and fishes were observed during the 2016 eelgrass habitat mapping survey. Algae constituted 15.7% of the total; invertebrates accounted for 48.8%, and fish contributed 30.6% of the total.
2. Four species of seagrasses were observed; two species of eelgrass (*Zostera marina; Z. pacifica*,), ditchgrass (*Ruppia maritima*), and surfgrass (*Phyllospadix torreyi*)
3. Two species of marine mammals (Bottlenose Dolphin and California Sea Lion) and six species of waterbirds were also observed on-the-water during the surveys.
4. The soft-bottom habitat in unvegetated and vegetated areas was extensively colonized by the invasive Asian Mussel (*Musculista senhousia*) in both Lower and Upper Newport Bay. Dense mats were observed in 13 of the 22 SWEH regions.
5. Dense mats of the bryozoan *Thalamoporella californica* were found in Upper Newport Bay along the Castaways shoreline and along the Balboa Peninsula west of Bay Island.
6. The brown algae *Dictyopteris* covered an extensive portion of the bottom between the bulkhead and docks of the Lido Marina. This algae was attached to gravel/cobble underlying sandy sediments. While not uncommon in southern California, this algae appeared to take on the qualities of patch reef vegetation that in the absence of eelgrass was a distinctive habitat type in Lower Newport Bay particularly in the western portion.
7. Two species of fish uncommon to California were observed-the Pacific Seahorse (*Hippocampus californicus*) and the Bullseye Puffer (*Sphoeroides annulatus*). The seashore was recorded along the Castaways shoreline in Upper Newport Bay; the Bullseye Puffer was recorded in the Newport Bay Entrance Channel eelgrass beds along the western bulkhead. Both species are tropical species that followed warm water currents up from Mexico during the 2016 El Nino event.
8. Noxious algae (*Caulerpa taxifolia*) was not found in Newport Bay.

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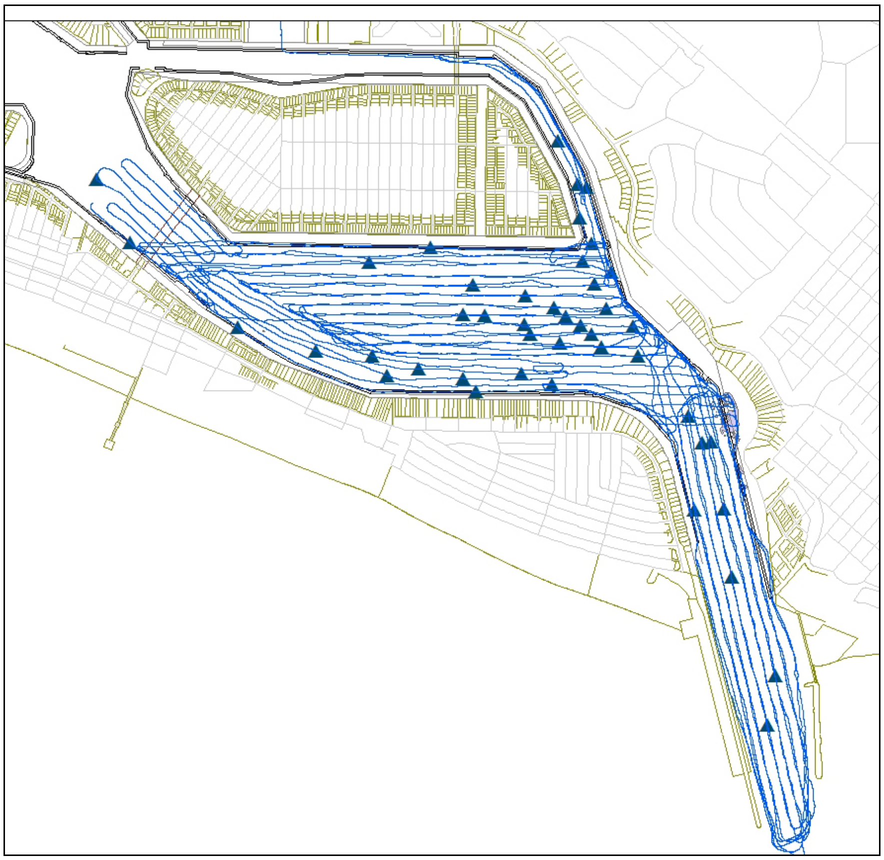
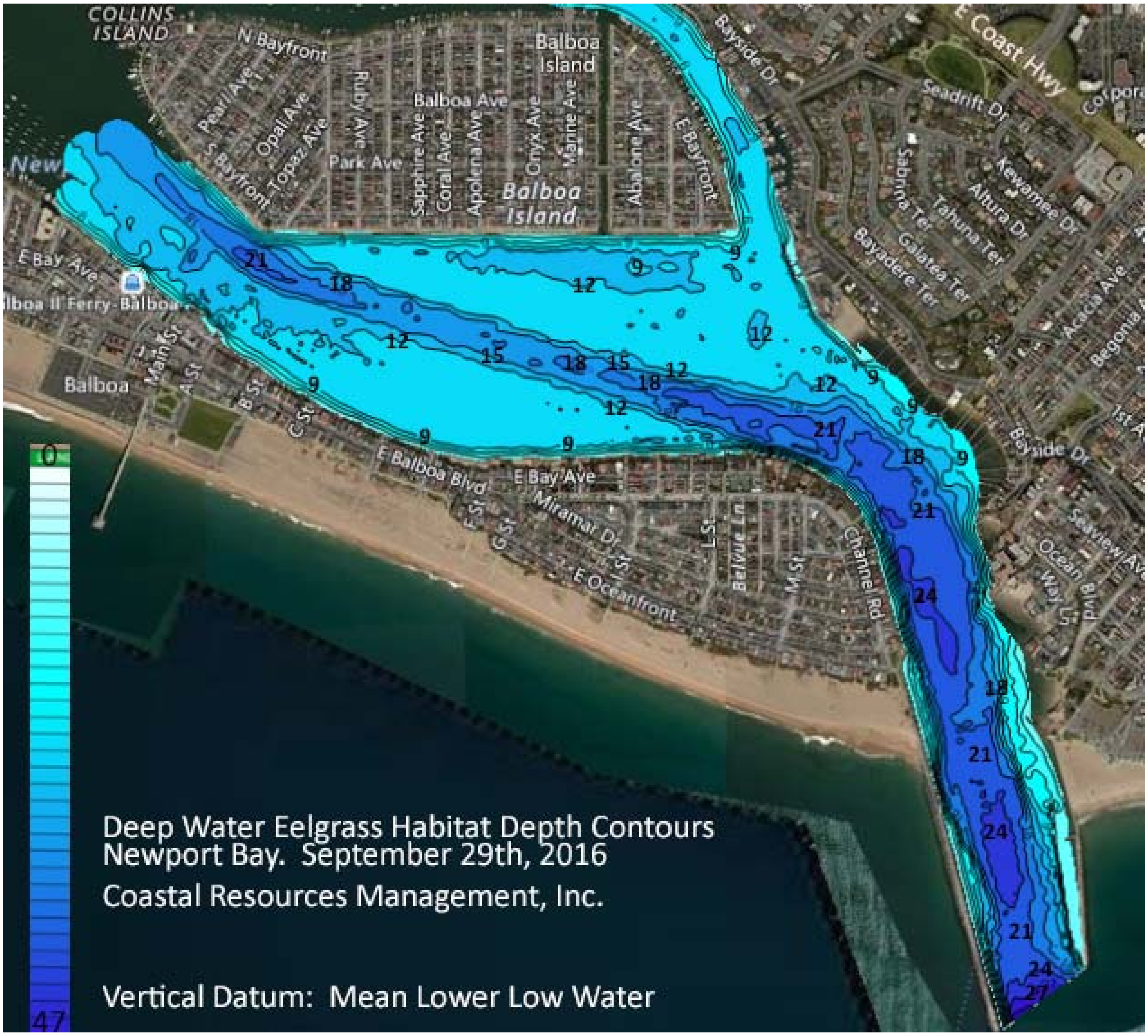
APPENDIX 1.
SIDESCAN SONAR TRACK LINES AND REMOTE VIDEO TARGET VERIFICATION LOCATIONS FOR DEEP WATER EELGRASS SURVEYS SEPTEMBER 2016



APPENDIX 2. EELGRASS DENSITY STATION LOCATIONS

Site Number	Location	Survey Date	Latitude/Longitude
1	West Entrance Channel	09/14/16	33.592840 N, 117.880592 W
2	China Cove	09/14/16	33.596587 N, 117.879442 W
3	Carnation Cove	09/14/16	33.597999 N, 117.879818 W
4	West Entrance Channel-Public Fishing Dock	09/14/16	33.598423 N, 117.882489 W
6	East Balboa Island	10/20/16	33.606817 N, 117.886636 W
7	SE Balboa Island Corner	09/14/16	33.604294 N, 117.886001 W
8	South Bay Front	09/14/16	33.604223 N, 117.888158 W
9	Grand Canal South	10/21/16	33.604947 N, 117.888987 W
10	C Street	10/21/16	33.601144 N, 117.895761 W
11	Bay Isle	10/20/16	33.606528 N, 117.904124 W
12	Newport Harbor Yacht Club	10/20/16	33.605404 N, 117.909194 W
13	Lido Island	10/21/16	33.608551 N, 117.910051 W
15	West Harbor Island	10/20/16	33.611161 N, 117.904473 W
16	Bayshore Private Beach	10/21/16	33.612576 N, 117.907480 W
17	Orange Coast College	09/17/16	33.616435 N, 117.917911 W
18	Inner Linda Isle	10/21/16	33.613955 N, 117.903144 W
19	Balboa Channel	10/20/16	33.615076 N, 117.901432 W
20	PCH Bridge	10/20/16	33.616334 N, 117.905826 W
21	DeAnza, east, inside	10/20/16	33.619460 N, 117.901740 W
22	DeAnza, west, outside	10/20/16	33.602040 N, 117.902768 W

APPENDIX 3. DEEP WATER EELGRASS HABITAT DEPTH CONTOURS



APPENDIX 4
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 USACE Regional General Permit (RGP) 54. Does not include deep water navigational channels. Sources; CRM 2010; City of Newport Beach 2013 and 2016 (in progress)

STABLE	2003-2004	2006-2007	2009-2010	2012-2014	2014-2016	MEAN (acres)	STANDARD DEVIATION
Balboa Island/Collins Isle	4.57	3.55	2.46	4.83	3.67	3.82	0.94
Bay Island	0.12	0.05	0.04	0.27	0.42	0.18	0.16
Corona del Mar (Bayside)	9.50	9.08	10.36	22.37	21.62	14.59	6.79
East Balboa Peninsula	1.63	1.55	1.39	2.30	3.78	2.13	0.99
Grand Canal	0.90	1.14	0.62	1.06	0.89	0.92	0.20
Linda Isle Inner	0.15	3.15	1.94	4.28	4.92	2.89	1.91
Yacht Club/Basins	1.83	1.43	1.59	1.82	1.73	1.68	0.17
Stable Eelgrass Zone	18.70	19.95	18.40	36.93	37.04	26.20	9.86

TRANSITIONAL	2003-2004	2006-2007	2009-2010	2012-2014	2014-2016	MEAN (acres)	STANDARD DEVIATION
Balboa Island/Collins Isle	2.10	1.00	0.58	1.19	2.06	1.39	0.67
Bay Island	0.01	0.00	0.00	0.02	0.08	0.02	0.03
Bayshores	0.99	0.66	0.00	0.15	0.75	0.51	0.42
Castaways	0.13	0.00	0.00	0.01	0.34	0.10	0.15
Dover Shores	0.00	0.00	0.00	0.02	0.18	0.04	0.08
Dunes Marina	0.00	0.00	0.00	0.00	0.02	0.00	0.01
Harbor Island	2.94	0.72	0.44	0.91	1.35	1.27	0.99
Lido Isle	0.02	0.00	0.00	0.02	0.07	0.02	0.03
Inner DeAnza Peninsula	0.21	0.01	0.00	0.08	3.83	0.83	1.68
Linda Isle Inner	0.13	0.12	0.03	0.20	0.62	0.22	0.23
Linda Isle Outer	2.90	0.27	0.07	0.42	1.15	0.96	1.16
Mariner's Mile	0.23	0.07	0.07	0.31	0.71	0.28	0.26
North Balboa Channel and Yacht	0.76	0.15	0.21	0.26	0.24	0.32	0.25
West Balboa Peninsula	0.03	0.03	0.01	0.10	0.18	0.07	0.07
Outer DeAnza Peninsula	0.77	0.00	0.00	1.60	4.01	1.27	1.66
Yacht Club/Basins	0.60	0.11	0.16	0.24	0.29	0.28	0.19
North Star Beach	0.00	0.00	0.00	0.00	0.00	0.0000	0.00
Transitional Eelgrass Zone	11.82	3.14	1.57	5.54	15.88	7.59	6.06
Stable+Transitional Total	30.52	23.09	19.97	42.47	52.92	33.79	13.76

APPENDIX 5. EELGRASS TURION DENSITY DATA-2004, 2008, 2011, 2014, 2016

2004 Survey	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 Survey	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 Suvey	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 Survey	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

2016 Survey	**Mean**	**Std Dev**	N	**95% CI**
East Entrance Channel	189.2	71.9	29.0	26.2
China Cove	173.4	62.0	29.0	22.6
Carnation Cove	233.5	92.4	29.0	33.6
Public Fishing Dock	236.4	65.2	31.0	23.0
East Balboa Channel	123.6	57.2	29.0	20.8
South East Balboa	104.3	69.9	30.0	25.0
Outer Grand Canal	138.4	68.5	29.0	24.9
South Grand Canal	287.7	107.1	29.0	39.0
C Street	184.2	106.1	28.0	39.3
Bay Island	173.5	100.0	27.0	37.7
Newport Harbor Yacht Club	184.2	92.1	29.0	33.5
Lido Island	118.9	52.3	25.0	20.5
West Harbor Island	86.8	41.4	27.0	15.6
Bayshore Beach	212.1	83.6	32.0	29.0
OCC	103.3	41.2	30.0	14.7
Inner Linda Isle	127.6	81.7	28.0	30.3
Balboa Channel	115.8	53.8	29.0	19.6
PCH Bridge	176.2	87.1	30.0	31.2
DeAnza East	143.3	50.3	29.0	18.3
DeAnza West	157.6	70.2	30.0	25.1

APPENDIX 6
LIST OF SPECIES OBSERVED DURING THE EELGRASS SURVEY
JUNE 2016-OCTOBER 2016

Common Name	Scientific Name
Bacteria	
white sulfur bacteria	Unid sulfur bacteria
red / rust bacteria	Unid rust bacteria
Green Algae-Chlorophyta	
green algae	*Bryopsis corticulans*
green algae	*Chaetomorpha aerea*
green algae	*Ulva intestinalis*
green algae	*Ulva lactuca*
Brown Algae-Phaeophyta	
brown algae	*Codium fragile spp. tomentosoides*
brown algae	*Colpomenia sinuosa*
brown seaweed	*Cystoseira osmundacea*
brown seaweed	*Dictyopteris undulata*
brown seaweed	*Dictyota flabellata*
feather boa kelp	*Egregia menziesii*
giant kelp	*Macrocystis pyrifera*
sargassum weed	*Sargassum muticum*
Red Algae-Rhodophyta	
red coralline algae	*Corralina* sp.
red algae	*Gelidium* sp.
red algae	*Gracilariopsis sjoestedtii*
red algae	*Gracilaria* sp.
red algae	*Grateloupia* sp.
red algae	*Microcladia* sp.
red algae	*Polysiphonia* sp.
Seagrasses-Zosteracea	
ditchgrass	*Ruppia maritima*
surfgrass	*Phyllospadix torreyi*
eelgrass	*Zostera pacifica*
eelgrass	*Zostera marina*
Sponges-Porifera	
yellow sponge	*Cliona* sp.
Porifera, unid	unid. Sponge
yellow sponge	*Haliclona* sp.
Jellyfish and Anemones-Cnidaria	
hydroid	*Aglaophenia dispar*

solitary anemone	*Anthopleura sola*
anemone	*Bundeopsis* sp.
fairy palm hydroid	*Corymorpha palma*
anemone	*Diadumene* sp.
anemone	*Epiactis prolifera*
burrowing anemone	*Pachycerianthus fimbriatus*
sea pen	*Stylatula elongata*
Gorgonians-Cnidaria	
California golden gorgonian	*Muricea californica*
Brown gorgonian	*Muricea fruticosa*
Flatforms-Platyhelminthes	
Polyclad Worm	*Eurylepta californica*
Polyclad Worm	*Prostheceraeus bellostriatus*
Marine Worms-Annelida	
ornate tube worm	*Diopatra ornata*
sand castle tube worm	*Phragmatopoma californica*
Snails and Octopus-Mollusca	
carinate gastropod	*Alia carinata*
sea hare	*Aplysia californica*
Gould's bubble snail	*Bulla gouldiana*
California horn snail	*Cerithidea californica*
Giant Rock Scallop	*Crassadoma gigantea*
ringed dorid nudibranch	*Diaulula sandiegensis*
dorid nudibranch	*Doriopsilla albopunctata*
Kellet's whelk	*Kelletia kelletii*
wavy top snail	*Lithopoma undosa*
rough limpet	*Lottia limatula*
mossy chiton	*Mopalia muscosa*
predatory sea slug	*Navanax inermis*
octopus	*Octopus bimaculatus*
Lewis' moon snail	*Polinices lewisii*
calcareous tube snail	*Serpulorbis squamigerus*
Bivalves-Mollusca	
speckled scallop	*Argopecten aequisulcatus*
rock jingle	*Chama* sp.
wavy chione	*Chione undatella*
Giant Pacific oyster	*Crassostrea gigas*
Asian date mussel	*Musculista senhousia*
bay mussel	*Mytilus galloprovincialis*
Native oyster	*Ostrea lurida*

Crustaceans-Arthropoda	
barnacle	*Balanus glandula*
cancer crab	*Cancer* sp.
buckshot barnacle	*Chthamalus fissus/dalli*
Aorid amphipod	*Grandidierella japonica*
mysid shrimp	Mysidacea, unid.
lined shore crab	*Pachygrapsus crassipes*
California lobster	*Panulirus interruptus*
swimming crab	*Callinectes* sp.
southern kelp crab	*Pugettia producta*
Hermit crab	*Pagurus* sp.
Sea stars, urchins, and cucumbers-Echinodermata	
bat star	*Asterina miniata*
sand star	*Astropecten armatus*
sea cucumber	*Parastichopus parvimensis*
red sea urchin	*Mesocentrotus franciscanus*
Moss Animals-Bryozoa/Ectoprocta	
bryozoan	*Thalamoporella californica*
stoloniferan bryozoan	*Zoobotryon verticillatum*
arborescent bryozoan	*Bugula neritina, Bugula californica*
Red "chip" bryozoan	*Watersipora subtorquata*
Tunicates-Urochordata	
colonial tunicate	*Botryllus/Botrylloides* complex
solitary tunicate	*Styela plicata*
solitary tunicate	*Styela montereyensis*
Unidentified sea squirt	Unid. Ascidiacea
Unidentified colonial ascidian	Urochordate, unid.
Fish-Pisces	
Horn Shark	*Heterodontus francisci*
Pacific Angel Shark	*Squatina californica*
Round Stingray	*Urobatis halleri*
Bat Ray	*Myliobatis californica*
California Lizardfish	*Synodus lucioceps*
Topsmelt	*Atherinops affinis*
Pacific Sea Horse	*Hippocampus ingens*
Bay Pipefish	*Syngnathus leptorhynchus*
Rockfish (juv)	*Scorpaenidae, unid.*
Kelp Bass	*Paralabrax clathratus*
Spotted Sand Bass	*Paralabrax maculatofasciatus*
Barred Sand Bass	*Paralabrax nebulifer*
California Sargo	*Anisotremus davidsonii*

California Salema	*Xenistius californiensis*
Black Croaker (juv)	*Cheilotrema saturnum*
Yellowfin Croaker	*Umbrina roncador*
Opaleye	*Girella nigricans*
Halfmoon	*Medialuna californiensis*
Barred surfperch	*Amphistichus argenteus*
Kelp Surfperch	*Brachyistius frenatus*
Pile Surfperch	*Damalichthys vacca*
Black Surfperch	*Embiotoca jacksoni*
Rubberlip Surfperch	*Rhacochilus toxotes*
Blacksmith	*Chromis punctipinnis*
California Garibaldi	*Hypsypops rubicundus*
Mullet	*Mugil cephalus*
Rock Wrasse	*Halichoeres semicinctus*
Senorita	*Oxyjulis californica*
Giant Kelpfish	*Heterostichus rostratus*
Arrow Goby	*Clevelandia ios*
Goby, unid.	Gobiidae, unid.
Bay Goby	*Lepidogobius lepidus*
Speckled Sanddab	*Citharichthys stigmaeus*
California Halibut	*Paralichthys californicus*
Horny Head Turbot	*Pleuronichthys verticalis*
Turbot, unid.	Pleuronichthys, unid
Bullseye Puffer	*Sphoeroides annulatus*

Sea Lions and Dolphins-Mammalia

California Sea Lion	*Zalophus californicus*
Bottlenose Dolphin	*Tursiops truncatus*

On-Water Birds (Aves)

Surf Scoter	*Melanitta perspicillata*
Western Grebe	*Aechmophorus occidentalis*
California Brown Pelican	*Pelecanus occidentalis californicus*
Brandt's Cormorant	*Phalacrocorax penicillatus*
California Gull	*Larus californicus*
Great Blue Heron	*Ardea herodias*
Snowy Egret	*Egretta thula*