# Appendix E
# Harbor-Wide Eelgrass Survey

# 2018 Monitoring of Eelgrass Resources in Newport Bay Newport Beach, California

**Prepared For:**
City of Newport Beach Public Works, Public Works
100 Civic Center Drive, Newport Beach, CA 92660
Contact: Chris Miller, Public Works Administrative Manager
CMiller@newportbeachca.gov (949) 644-3043

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**Contract: C-7487-1: 2018 Newport Harbor Shallow Water Eelgrass Survey**

**Prepared By:**

**Prepared By:**
Marine Taxonomic Services, Ltd.

**SOUTHERN CALIFORNIA OFFICE**
920 RANCHEROS DRIVE STE F-1
SAN MARCOS, CA 92069

**OREGON OFFICE**
2834 NW PINEVIEW DRIVE
ALBANY, OR 97321

**LAKE TAHOE OFFICE**
1155 GOLDEN BEAR TRAIL
SOUTH LAKE TAKOE, CA 96150

# Contents

## Appendices

## Abbreviations

| | |
|---|---|
| ac | Acre |
| Bay | Newport Bay |
| CEQA | State of California Environmental Quality Act |
| CEMP | California Eelgrass Mitigation Policy |
| City | City of Newport Beach |
| CRM | Coastal Resources Management Inc. |
| dGPS | Differential Global Positioning System |
| EFH | Essential Fish Habitat |
| EPA | Environmental Protection Agency |
| ft | Feet/Foot |
| °F | Degrees Fahrenheit |
| GPS | Global Positioning System |
| HAMP | City of Newport Beach Harbor Area Management Plan |
| HPAC | Habitat Areas of Particular Concern |
| MLLW | Mean Lower Low Water |
| m | Meter(s) |
| MTS | Marine Taxonomic Services, Ltd. |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| OTS | Ocean Technology Systems |
| RGP | Regional General Permit |
| sq | Square |
| SAV | Submerged Aquatic Vegetation |
| SWEH | Shallow Water Eelgrass Habitat |
| The Plan | Eelgrass Protection and Mitigation Plan for Shallow Waters in Lower Newport Bay: An Ecosystem Based Management Program |
| USACE | U.S. Army Corps of Engineers |

## Introduction

Marine Taxonomic Services, Ltd. (MTS) and its sub-contractor, Coastal Resources Management, Inc, (CRM) was contracted by the City of Newport Beach (City) to provide eelgrass-mapping services in Newport Bay as part of the 2018 shallow-water eelgrass assessment. The survey consisted of mapping shallow-water eelgrass habitat (SWEH) in support of the City's Eelgrass Protection and Mitigation Plan for Shallow Waters in Lower Newport Bay: An Ecosystem Based Management Program (The Plan; City of Newport Beach 2015) and the City of Newport Beach Harbor Area Management Plan (HAMP; City of Newport Beach 2010). MTS was responsible for surveying the SWEH, data analysis, and report composition. CRM was responsible for providing MTS with survey results from SWEH using sonar based methods beyond 20 feet (ft) bayward of all dock structures and in areas where it was not safe to perform diver based surveys. This was the sixth SWEH survey since the program was initiated in 2003. Previous eelgrass habitat assessments were conducted in 2003-2004 (CRM 2005), 2006-2008 (CRM 2010), 2009-2010 (CRM 2012), 2012-2014 (CRM 2015), and 2016 (CRM 2017).

## Project Purpose

The purpose of this assessment is to provide the City with detailed information on the distribution and abundance of eelgrass within Newport Harbor; including Lower and Upper Newport Bay (Bay) (Figure 1). Monitoring and maintaining a database of the Bay's eelgrass resources is essential for the City to manage these resources and understand where proposed projects might have impacts. The City has committed to monitor these resources as noted in the HAMP and The Plan. Additionally, data provided in this report will be used by the City in support of their Regional General Permit (RGP) 54 issued collectively by the U.S. Army Corps of Engineers (USACE 2015), the California Coastal Commission and the Water Board. Additionally, this database is valuable as it helps to inform the City and the public of environmental constraints regarding infrastructure improvement projects such as construction, repair, and maintenance for bulkheads, docks, and piers, as well as activities involving beach nourishment and harbor dredging.


Figure 1. Regional map of Newport Bay in Newport Beach, California.

## Background

Historical surveys of eelgrass resources have occurred since 2003. These surveys were conducted by CRM. Summaries of the previous eelgrass mapping results in Newport Bay are provided below.

2003-2004 Survey Summary

A total of 30.4 acres (ac) of eelgrass were mapped in shallow water at depths between 0-ft and -12-feet (ft) Mean Lower Low Water (MLLW). Mean station density averaged 212.8 turions per square (sq) meter (m) and ranged between 94 and 273.8 per sq m across 15 stations (CRM 2005).

2006-2008 Survey Summary

A total of 23.1 ac of eelgrass were mapped at depths less than 10 feet MLLW. Turion density averaged 130.7 turions per sq m and varied between 67.1 and 221.9 turions per sq m across 10 stations (CRM 2010).

2009-2010 Survey Summary

A total of 19.92 ac of SWEH was mapped between 2009 and 2010. Turion density averaged 123.5 and ranged between 14.3 and 629 turions per sq m (CRM 2012).

2012-2014 Survey Summary

This survey encompassed both deep and shallow water eelgrass habitats within the Bay. A total of 88.27 ac of bottom habitat was covered by eelgrass between the low tide zone and -28.5-ft MLLW. Of this a total of 42.35 ac of vegetated SWEH was mapped between 0.0-ft and -15-ft MLLW. Turion density averaged 117 turions and ranged between 39.1 and 259.3 turions per sq m (CRM 2015).

As a result of the surveys performed between 2003 and 2014, three eelgrass stability zones were identified in the Bay. The first zone is the stable eelgrass zone, where eelgrass distribution and density have been relatively constant and underwater light levels were highest. The second zone is the transitional eelgrass zone where eelgrass acreage has been highly variable and underwater light levels appeared to have had higher variation. The unvegetated eelgrass zone represents areas where eelgrass was not documented between 2003 and 2014 (CRM 2015).

2016 Survey Summary

This survey encompassed both deep and shallow water eelgrass habitats within the Bay. A total of 104.5 ac of bottom habitat was covered by eelgrass between +0.5-ft and -29.5-ft MLLW. Of this a total of 53.0 ac of vegetated SWEH was mapped between +0.5-ft and -15-ft MLLW. Eelgrass turion density averaged 163.5 turions per sq m and ranged between 86.8 and 287.7 turions per sq m (CRM 2017).

## Project Setting

Newport Bay is located within the city limits of Newport Beach, California (Figure 1). The City is bordered by three coastal cities, Huntington Beach to the northwest, Costa Mesa to the north, and Laguna Beach to the southeast. Newport Bay is generally divided into two regions, Lower Newport Bay and Upper Newport Bay. Prior to major development, Lower Newport Bay was a coastal lagoon. The lagoon 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 Newport bay. The sand spit eventually developed into present-day Balboa Peninsula (Stevenson and Emery 1958). Lower Newport Bay is a four-mile long body of water orientated in a northwest-to-southeast direction, parallel to the coastline. Currently, the Bay is a multi-user system with both recreational and commercial uses. Functioning as a major navigational harbor and anchorage for approximately 5,000 small boats and larger vessels as well as a business center for marine-related activities and tourism. The Bay is also utilized as a transitional corridor where wildlife can move between the tidally influenced channel and more protected marsh ecosystem of Upper Newport Bay or gain access to the open coastal marine environment.

Periodic dredging within the Bay is necessary to maintain a working corridor for vessel traffic, particularly in active portions of the Bay (Anchor QEA 2009). The Federal Navigation Channel (FNC) in the Bay is maintained by the USACE. While dredging for the FNC may occur at -12-ft MLLW it generally occurs at depths deeper than -15-ft MLLW. Thus, the majority of dredging activities for the FNC are largely outside of SWEH areas. On occasion, dredging for the FNC may have the ability to impact eelgrass habitat that occurs at deeper depths (not discussed in this report) (CRM 2017). There have been 50 dredging events within SWEH since the 2016 survey was conducted. It is possible that some of these dredge events had impacts to SWEH.

Lower Newport Bay supports numerous marine habitats ranging in depth, substrate composition, and tidal movements. Of these habitats, eelgrass habitat is of special importance. Growing along sea walls, in areas of open water, along and in between dock structures, eelgrass habitat is a vital resource present within many areas of Lower Newport Bay. The Newport Bay watershed (~ 154 square miles), bounded by the Newport Mesa bluffs to the west and the San Joaquin Terrace to the east, drains towards the Pacific Ocean via Upper Newport Bay. The watershed is a major contributor of suspended sediments, nutrients, and other pollutants into the Bay ecosystem (EPA 2017).

## Eelgrass Biology

Eelgrass*, Zostera,* is a marine angiosperm (Kuo et al. 2006; Hemminga and Duarte 2000). This marine plant is one of 13 genera within 5 families of seagrasses (Les et al. 1997). Seagrasses are considered productive and valuable resources. Seagrass beds absorb large quantities of the greenhouse gas, carbon dioxide, from the atmosphere and store it resulting in carbon sequestration and storage (Kuwae and Hori 2019). Economically important, eelgrass provides habitat to sustain commercially important fisheries further supporting the recreational and commercial fishing industry and associated tourism industries (Phillips 1985; Dewsbury et al. 2016). In Southern California, eelgrass grows at depths ranging from the mid-to-low intertidal extending to -30-m MLLW at some protected offshore areas of the eastern Pacific Ocean (Phillips and Mendez 1988; Phillips and Echeverria 1990; Mason 1957; Coyer et al. 2007).

*Zostera japonica*, dwarf eelgrass, is an introduced seagrass found along the west-coast, originally from Asia (Posey, 1988). *Z. japonica* has been known to inhabit the waters of the Pacific Northwest since the early 1900s (Phillips, 1985). Its presence in California has only been known for a short time (Shafer et al. 2008). Two types of eelgrass are found offshore in the Channel Islands and along the coast of Santa Barbara County, *Z. pacifica* and *Z. marina* (Coyer et al. 2007). Because eelgrass varies greatly given different environmental parameters, species of *Zostera* can be challenging to identify in situ (Olesen and Sand-Jensen 1993). *Zostera* species observed during the majority of this 2018 survey were believed to be *Z. marina*. However, *Z. pacifica* was likely observed near the entrance to the channel. Hybridization of *Z. marina* and *Z. pacifica* has been observed in other settings (Olsen et al. 2014). If hybridization is occurring within Newport Bay, identification of these two species in situ may not be possible and further genetic testing may be required.

Eelgrass is a photosynthetic organism that sustains fish and other marine life through nutrient transformation and by releasing oxygen into the marine environment (Yarbro and Carlson 2008). These plants can support a diversity of life by creating structure over otherwise featureless soft bottom habitats. Eelgrasses can form extensive beds in shallow, protected, estuarine, or other near shore environments. These grasses host a variety of marine species including microbes, algae, invertebrates (including; lobsters, crabs, worms, snail, clams, sea stars, and octopus), and fishes (Thresher et al. 1992; Valentine and Heck 1999). Some fish species are present throughout their life stages while other fishes utilize eelgrass beds during periods of juvenile development. Other vertebrates including fishes, seabirds, and sea lions utilize eelgrass beds as foraging grounds. Green sea turtles also utilize eelgrass beds, however they are rarely spotted in Newport Bay.

In addition to sustaining many forms of marine life, eelgrass reduces erosion processes and increases seafloor stability (de Boer 2007). Other marine plants, sessile organisms, and sediments are secured to the seafloor by the dense rhizome mats that penetrate these areas. Additionally, the three-dimensional blade structure of eelgrass acts as a wave dampener and softens the impacts of wave action. In some areas of extreme reduction in wave action, sediments and organic matter may begin to be deposited.

In Newport Bay, *Z. japonica* is not known to occur. *Z. marina* has historically grown in both Lower Newport Bay and Upper Newport Bay. However, the distribution and abundance of eelgrass in this area has varied greatly over time (CRM 2002, 2005, 2008, 2010, 2012, 2015, 2017). The importance of this habitat for marine life can sometimes conflict 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 temporally as noted in the The Plan.

## Eelgrass Regulatory Setting

### General Eelgrass Regulations

The federal government designated eelgrass as an Essential Fish Habitat (EFH) and a Habitat of Particular Concern (HPAC) under the Magnuson-Stevens Fishery Conservation and Management Act in 1996 (FR 62, 244, December 19, 1997; Pacific Fishery Management Council, 2008). Eelgrass habitat is considered an EFH and a HPAC as it is a key foundation to a healthy marine habitat and provides necessary ecosystem functions to sustain populations of marine organisms. The designation as an EFH requires federal agencies to consult with the National Oceanic and Atmospheric Association (NOAA) Fisheries on ways to avoid or minimize the adverse effects of their actions on eelgrass.

NOAA provides guidelines for eelgrass management under the California Eelgrass Mitigation Policy and Implementing Guidelines (CEMP) (NOAA Fisheries, West Coast Region, 2014). These guidelines provide comprehensive and consistent information to ensure the actions taken by federal agencies result in "no net loss" of eelgrass habitat or function. Under the new policy biologists will assist federal agencies to mitigate for unavoidable impacts.

Eelgrass does not have a formal listing as a state or federal endangered, rare, or sensitive species. However, the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and NOAA Fisheries understand the importance of protecting this resource. Additionally, eelgrass is protected under the Clean Water Act, 1972, as it is considered vegetated shallow water habitat.

Environmental legislation under the National Environmental Policy Act (NEPA) and State of California Environmental Quality Act (CEQA) dictates that project designs for coastal projects should;

- Make all possible attempts to avoid impacts to eelgrass.
- Minimize the degree or magnitude of impacts to eelgrass.
- Rectify or compensate for unavoidable eelgrass habitat loss by restoring soft-bottom habitat with eelgrass using transplant techniques.
- Reduce or eliminate impacts to eelgrass over time by preservation and maintaining eelgrass over the life of the project.

The 2018 Department of Fish and Wildlife Ocean Fishing Regulations include regulations on the collection of marine plants;

- There is no closed season, closed hours or minimum size limit for any species of marine aquatic plant that are allowed to be collected.
- The daily bag limit on all marine aquatic plants for which the take is authorized is 10 pounds wet weight in the aggregate.
- Marine aquatic plants may not be cut or harvested in state marine reserves.
- No eelgrass (*Zostera*), surf grass (*Phyllospadix*), or sea palm (*Postelsia*) may be cut or disturbed at any time.

The 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 states;

- 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 issues by the department.

### Newport Beach Eelgrass Regulations

Additional protection is afforded under both State and local City of Newport Beach codes and plans. The City of Newport Beach Policies state that 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-development 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 4.2.5-1). The Southern California Eelgrass Mitigation Policy was superseded by the CEMP in 2014.

The City of Newport Beach adopted a Newport Bay specific eelgrass mitigation plan in 2015. The plan was entitled "*Eelgrass Protection and Mitigation Plan for Shallow Waters in Lower Newport Bay: An Ecosystem Based Management Program*" (The Plan) (City of Newport Beach, 2015). 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 was established to set goals and best management practices (BMPs) in order to ensure a healthy eelgrass population within Lower Newport Bay. The Plan seeks to protect and promote a long-term sustainable eelgrass population while serving Lower Newport Bay's navigational and recreational beneficial uses. The goal 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.

Particular attention is placed on 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, Regional Water Quality

Control Board and the California Coastal Commission. The Plan is an integral component of the authorized RGP 54. Exceptions include; demolition, repair, and in-kind replacement of docks (including piers, gangways, floats, and piles), bulkheads, and piles with similar structures that 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. The California Eelgrass Mitigation Policy governs all other activities that affect eelgrass.

# Methods

## Project Staff

This report relies on a combination of previously collected data by CRM and results from this year's, 2018, survey efforts conducted by MTS. Integral staff for this survey included Dr. Robert Mooney (Principal Investigator), Grace Teller (Biologist, M.Sc.), and Hannah Joss (Dive Technician, B.Sc.). Dr. Mooney contributed to project oversight, client communication, and report review. Grace and Hannah acted as the primary field team biologists with additional support from MTS personnel, Melissa Hoffman, and CRM personnel, Nicholas DaSilva. Melissa assisted as topside staff and Nick assisted as a diver. Additionally, Grace was responsible for daily project management and drafting the 2018 report summary. CRM staff, Rick Ware, Nick DaSilva, and Tom Gerlinger, supported the 2018 survey through collection of sonar data, mapping support, and review of deliverables.

## Project Location

The surveys were conducted in Newport Bay, located within Newport Beach, Orange County, California. Observations and mapping occurred between July 2nd and October 3rd, 2018. Density measurements were taken across the Bay on October 3rd and 4th, 2018. The survey area included intertidal and subtidal soft bottom habitats of Newport Bay. Many of these areas paralleled rip-rap shorelines and/or headwalls. Shallow water eelgrass habitat is defined as the area extending from the intertidal zone to a depth of -15-ft MLLW. For comparison to previous surveys administered by CRM and to allow for simplified acreage accounting, the Bay was divided into 22 SWEH mapping regions (Figure 2).

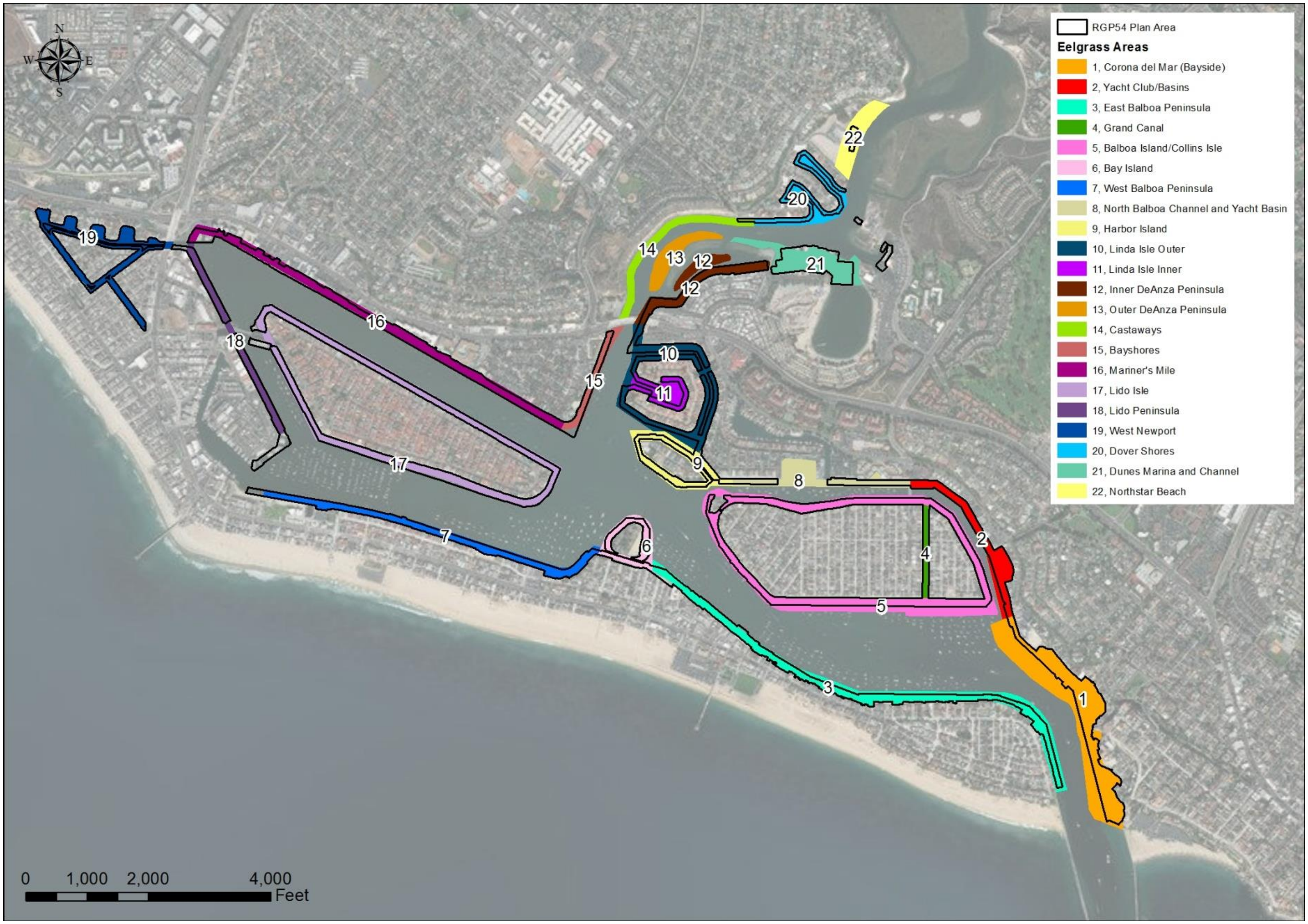


Figure 2. Map of Newport Bay showing 22 shallow water eelgrass habitat mapping regions.



MTS Marine Taxonomic Services, Ltd.

## Eelgrass Survey Methods

### SCUBA Diver Survey

The survey involved visual SCUBA diver surveys generally within all SWEH extending from the intertidal zone to 20-ft in-bay beyond the end of all channels and dock structures within Upper and Lower Newport Bay as proposed by the City. In eelgrass beds where low visibility and poor bed outlines were present the SCUBA surveys would occasionally extend beyond the 20-ft in-bay line.

The diver was outfitted with a full-face-mask compatible with an Ocean Technology Systems (OTS) surface-to-diver communication system. In addition to the OTS underwater communication system, the topside personnel was outfitted with a differential global positioning system (dGPS) and computer tablet for mapping eelgrass polygons and patches, marking waypoints, and taking notes. A Geneq SXBlue II dGPS was used for the majority of the survey and a Juniper Systems Geode dGPS was used for the last three weeks of the survey. The estimated global positioning system (GPS) error of the SXBlue II GPS and Geode GPS is less than 1 m and half-meter accuracy, respectively. The error is based on how the GPS functions in clear open skies without any interference from structures. However, on some occasions the error was higher because the survey area occurred near bulkheads, underneath piers, and between docks where open skies were not always possible. In these instances, error was estimated to be a max of 2 m and 1 m, respectively. In cases where GPS error produced obviously erroneous results, edits were made manually using landmarks. The dGPS in use was connected to the tablet via Bluetooth. Once the tablet and dGPS were connected an application, mapitGIS, was opened on the tablet and used to collect waypoints from the dGPS and map the extent of eelgrass within the survey area.

At a survey site, the diver would enter the water and be followed by the topside person on a kayak until eelgrass was found. If eelgrass was not readily observed upon entry to the survey site the topside person would then use compass navigation to direct the diver in the direction to continue searching. Once the diver, using underwater communications, signaled to the topside person that they were on the edge of an eelgrass bed, the diver would set a surface buoy and the topside person would ready the mapitGIS application to begin mapping a new polygon. GPS signals were collected every 2 seconds via the mapitGIS application as the topside kayaker followed the diver’s bubbles. Once the diver got back to the surface buoy and the entirety of the eelgrass bed was outlined, the polygon was ended. The diver then relayed details about the eelgrass bed to the topside kayaker. This information included scaled high-low density, blade height, sediment, and other marine life present. The topside kayaker would then take water depth measurements using a weighted tape measure on both the inshore and offshore edge of the polygon. If the area of eelgrass was less than 2 sq m it was marked as a single patch waypoint and the dimensions were recorded in the mapitGIS App. At the end of each survey day all polygons, patches, waypoints, and notes were exported as ESRI shapefiles (SHP) and in Google Earth (KML) file formats for validation and post processing.

Data validation consisted of importing the KML files into Google Earth Pro to review the polygon shapes. The surveyed area was segmented into close up sections and converted to PDF format for document annotation. Areas where outlier signals were detected, locations where merger of two or more polygons or cut outs of polygons were needed, and segments of polygons where they were mapped more than once were redlined on the PDF document. These revisions guided post processing eelgrass survey efforts. Post processing of data used exported SHP files and referenced the redlined PDF documents to construction of the finalized eelgrass bed using ArcMap. This combination of formats allowed the biologists who performed the survey to view and annotate data which were then processed in ArcMap by a GIS Specialist.

The survey methods described herein are consistent with the methodologies described and approved as part of The Plan.

### Sonar Survey

CRM used remote sensing techniques, (traditional sonar and down-looking sonar) to supplement the diver eelgrass survey. The traditional sonar and down-looking sonar systems were used to survey areas within -6-ft to -15-ft contours where diver survey areas were either extremely large and/or where dive conditions were considered hazardous due to currents or vessel traffic.

Sonar methods were used to augment the diver mapping surveys in the larger SWEH areas and/or in SWEH navigational areas considered a risk to divers (Regions 1, 2, 5, 8, 11, 12, 13, 21). 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-corrected GPS position. In addition, a 455/800 kHz transducer and power module with dual channels (Structure scan and down-looking) provide a 180 degree view and a down-looking 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-ft and 30-ft. 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-ft and 30-ft).

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.

Vegetation detection using down-looking sonar methods were analyzed 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).

Acoustic signals from HDS 200-kHz transducers travel through submerged aquatic vegetation (SAV) on their way to the bottom. Seafloor typically registers 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 sonar return 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 track lines at 20-ft depths, minimum plant height was 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 smoothes 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 ArcMap to illustrate the distribution of eelgrass quantified by these acoustical data collection methods.

### Eelgrass 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. To assess eelgrass habitat vegetation cover 20 quadrats were counted for eelgrass turions at 19 stations throughout the study area. The diver counted the number of live, green shoots "turions" at the sediment/shoot interface, within replicated 1/16$^{th}$ sq m quadrats, at each station. These counts were conducted along the shallow and deep edges of an eelgrass bed at each sampling site. Ten quadrats were taken along both the deep and shallow edge of the eelgrass bed. All biologists taking density measurements of eelgrass were trained previously on how to appropriately assess the number of living eelgrass turions per quadrat. The diver was instructed to randomly place the quadrat within the eelgrass bed while swimming along the edge of the bed. Additional densities were taken while swimming across the surveyed bed. Coordinates of the 19 surveyed sites are listed in Appendix A.

Field-collected density counts were entered into an Excel spreadsheet by station and by shallow or deep location, and converted into density per sq m. Summary statistics where then calculated (mean, standard deviation, and 95% confidence intervals) for each station and location. This information was summarized in tabular and graphic format.

### Environmental Parameters

Horizontal and vertical visibility observations were recorded daily. After completing a continuous section of survey area, where the visibility underwent no noticeable change, horizontal visibility observations were approximated at depth. Vertical visibility was taken at the beginning of each survey day and on occasion, at the end of the survey day. This measurement was taken by using a fiberglass measuring tape to slowly lower a Secchi disk into the water. Once the Secchi disk was no longer visible in the water column an MTS personnel would record the reading at water level.

Surface water temperature was taken at the start and end of most survey days. A digital probe style thermometer was held at the surface of the water for 30 seconds, until reaching equilibrium, and then the temperature was recorded.

# Eelgrass Habitat Mapping Survey Results

## Underwater Visibility and Temperature Measurements

### Underwater Visibility

The range of horizontal and vertical visibility was dependent on environmental conditions and distance from the mouth. In cloudy sky conditions less light penetration occurred at depth resulting in overall lower visibility conditions. Vertical visibility did not display any trend. Vertical visibility was higher away from the Bay-mouth in areas of relatively calm water and in areas of close proximity to the mouth. Vertical visibility ranged between 8.2-ft to 1.4-ft (Figure 3). Horizontal visibility was greatest near the mouth of the harbor and extended Bay-ward to the southeast corner of Balboa Island and just around the bend along Channel Road. Horizontal visibility was largely impacted by tidal conditions. Two parameters, direction of tidal flow and rate of tidal exchange, influenced horizontal visibility. The best visibility was observed during periods of rising tides with moderate to low tidal exchange. Tidal influence was reduced north of the Highway 1 bridge and in protected areas around Linda Isle. In these areas visibility was generally low and the water was somewhat stagnant. Horizontal visibility was between 15-ft and 2-ft (Figure 4). However, on occasion less than 1-ft of horizontal visibility was observed for short periods of time. Average horizontal visibility is comparable to historical averages and is about 1-ft less than the average reported in the prior 2016 survey (Figure 5).

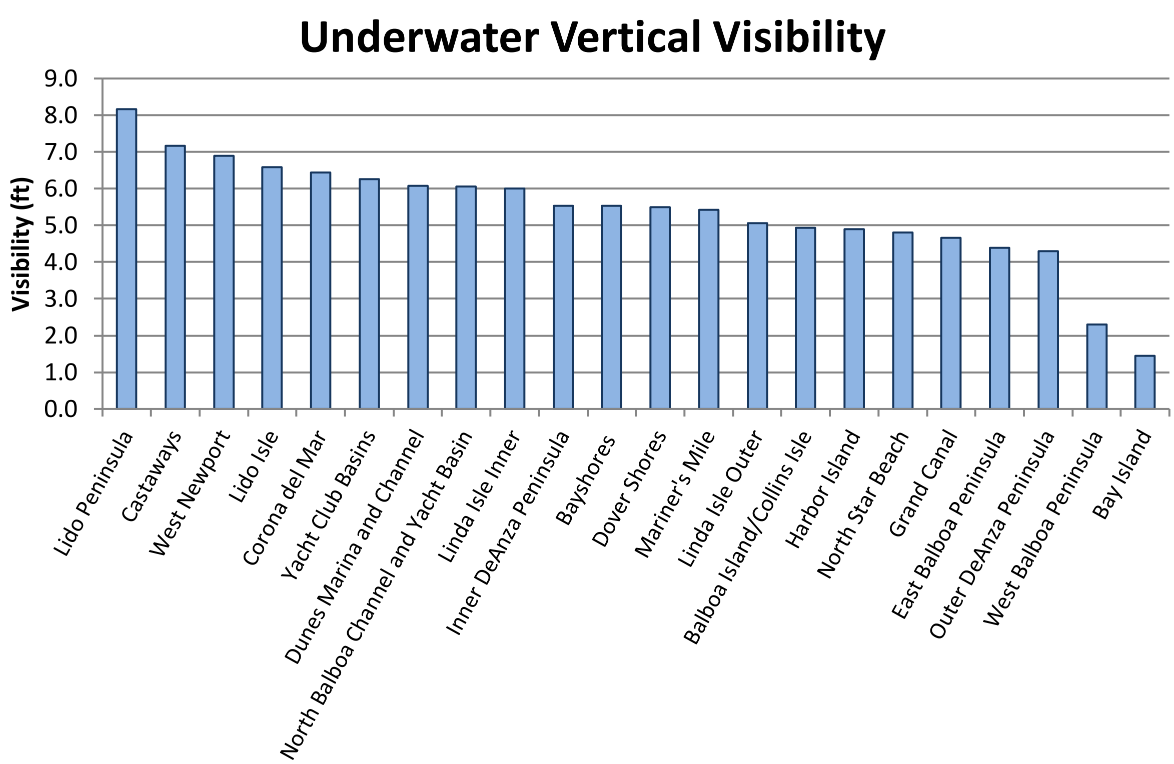


Figure 3. Underwater vertical visibility in feet at survey areas throughout Newport Bay in 2018.

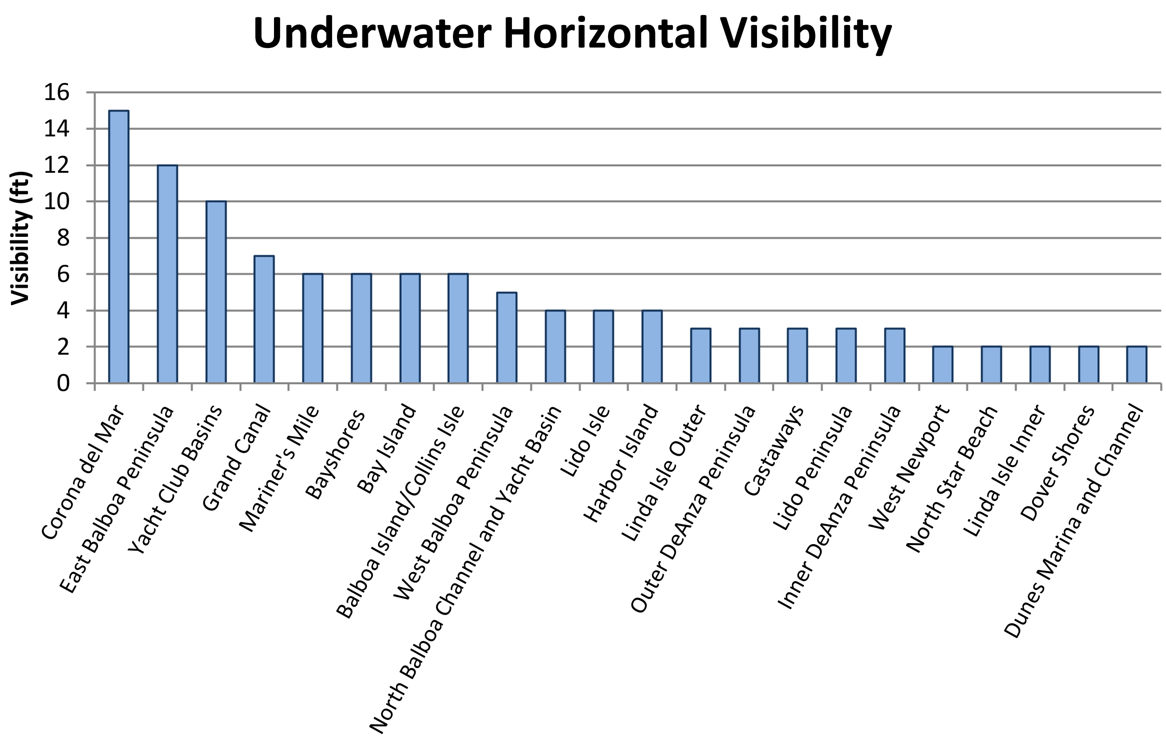


**Figure 4. Underwater horizontal visibility in feet at survey areas throughout Newport Bay in 2018.**

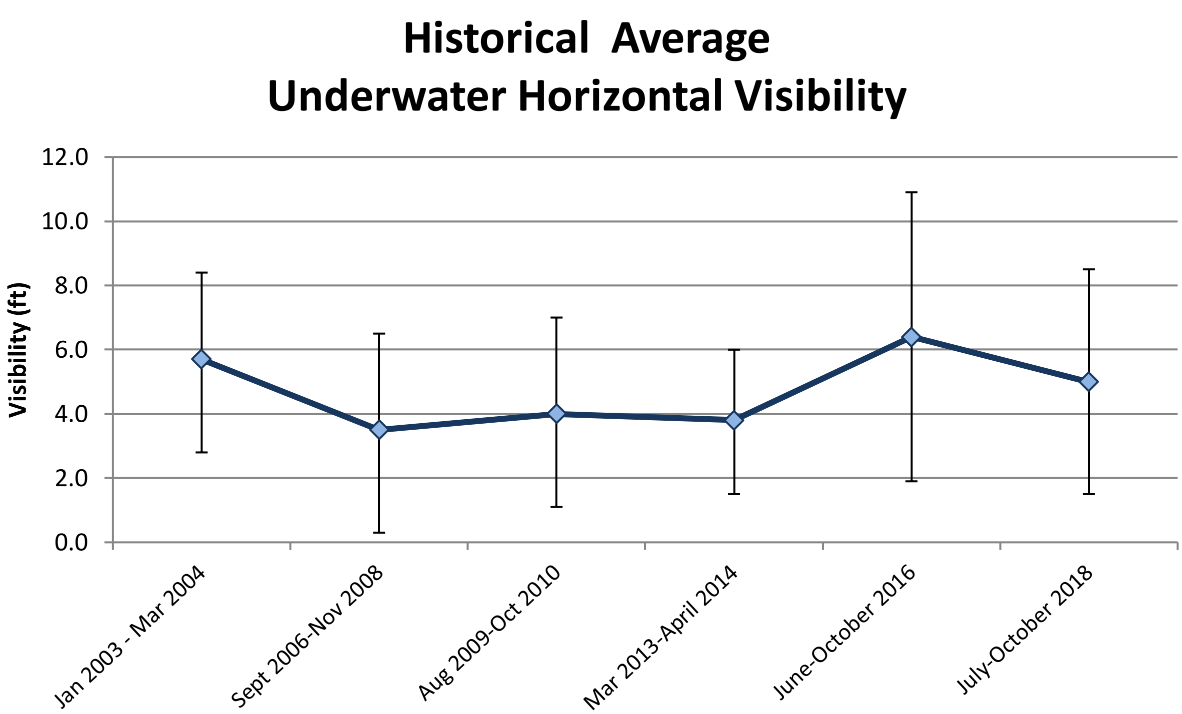


**Figure 5. Historical averages of underwater horizontal visibility from 2003 through 2018. Error bars represent one standard deviation of the mean.**

### Water Temperature

Location within the bay and time of year affect the surface temperature readings collected. Surface water temperature ranged from a low of 66.1 degrees Fahrenheit (°F) in Region 7, West Balboa Peninsula, during late September, to a high of 80.8 °F in Region 21, Dunes Marina and Channel, during late August (Figure 6). Overall, average surface water temperature was greatest in Region 21, Dunes Marina and Channel, and lowest in Region 7, West Balboa Peninsula. Surface water temperature was consistent in July and August and began to noticeably decrease in September (Figure 7).

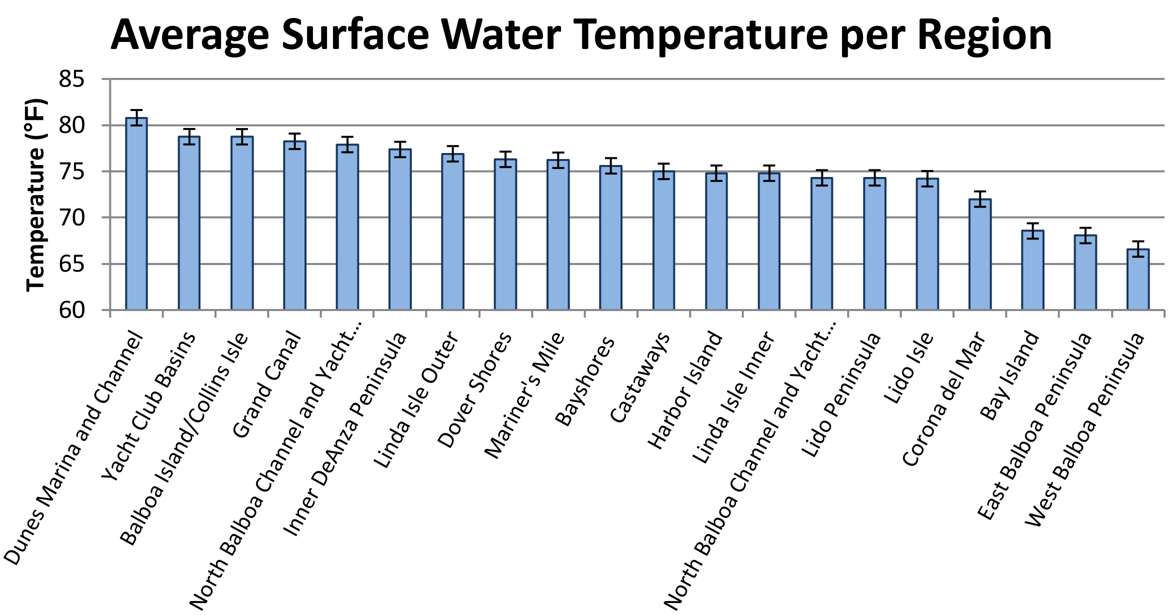


**Figure 6. Average surface water temperature by region during the 2018 eelgrass mapping survey. Error bars represent one standard error of the mean.**

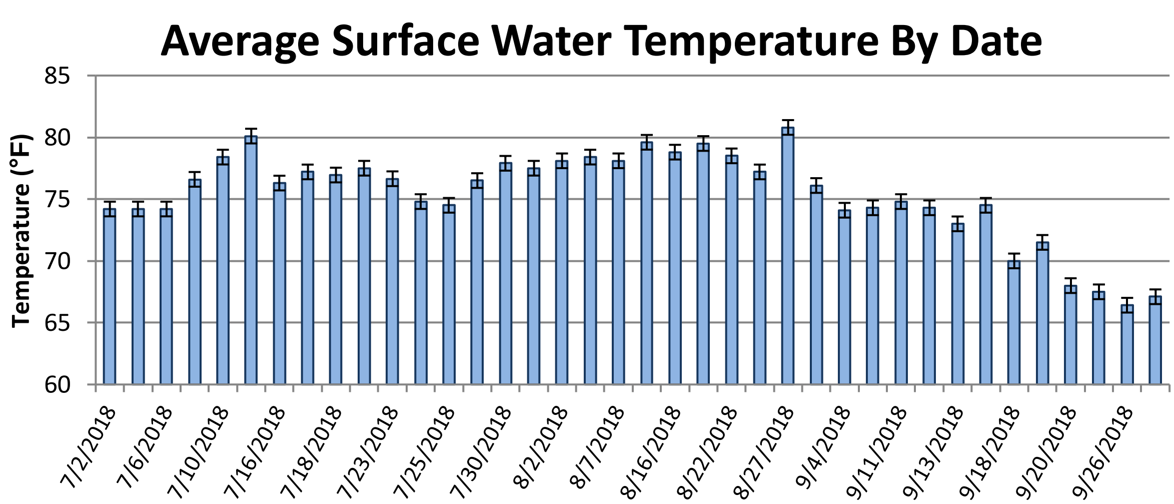


**Figure 7. Average surface water temperature by date during the 2018 eelgrass mapping survey. Error bars represent one standard error of the mean.**

## Eelgrass Distribution and Abundance

Eelgrass was mapped at depths between +0.5 and -15-feet MLLW. The -15-feet MLLW limit was a survey limit for the SWEH and not an eelgrass depth limit. To compile this information the survey team used a combination of Diver/GPS tracking methods and down looking sonar survey methods. Total acreage and percent of total reported eelgrass acreage by Region are provided in Table 1. A summary of eelgrass polygons and patches mapped within SWEH are provided in Figure 8 and Figure 9, respectively.

*Zostera marina* was the most widespread species of eelgrass within the Bay. MTS corroborates CRM 2016 findings that a second species of eelgrass was also present. *Zostera pacifica* was likely present and inhabited cooler areas in the Bay such as the entrance channel and along Corona del Mar. There was no indication that *Z. pacifica* was localized to certain depth ranges.

A total of 58.18 ac of eelgrass were mapped during the 2018 survey. Of the total mapped eelgrass, 49.89 ac of eelgrass occurred within described SWEH. The largest eelgrass coverage was in Region 1, Corona del Mar (Bayside). Here eelgrass covered 14.47 ac and covered a total of 24.88% of total reported eelgrass.

Three regions accounted for 52.45% of total eelgrass mapped;

- Corona del Mar (Bayside) (14.47 ac)
- Balboa Island/Collins Isle (8.29 ac)
- DeAnza Peninsula - Outer (7.75 ac)

**Table 1. Table summarizing eelgrass acreage and percent of total reported eelgrass within the 22 shallow water regions.**

| Region | Description | Acres | % Total |
|---|---|---|---|
| 1 | Corona del Mar (Bayside) | 14.47 | 24.88% |
| 5 | Balboa Island/Collins Isle | 8.29 | 14.25% |
| 13 | Outer DeAnza Peninsula | 7.75 | 13.33% |
| 12 | Inner DeAnza Peninsula | 6.32 | 10.86% |
| 11 | Linda Isle Inner | 3.09 | 5.31% |
| 3 | East Balboa Peninsula | 3.07 | 5.28% |
| 2 | Yacht Club/Basins | 2.67 | 4.59% |
| 10 | Dunes Marina and Channel | 2.23 | 3.83% |
| 9 | Linda Isle Outer | 2.23 | 3.83% |
| 4 | Harbor Island | 1.78 | 3.06% |
| 21 | Grand Canal | 1.13 | 1.94% |
| 16 | Mariner's Mile | 0.97 | 1.67% |
| 15 | Bayshores | 0.91 | 1.56% |
| 14 | Castaways | 0.84 | 1.44% |
| 6 | Bay Island | 0.80 | 1.38% |
| 8 | North Balboa Channel and Yacht Basin | 0.55 | 0.95% |
| 7 | Lido Isle | 0.41 | 0.70% |
| 17 | West Balboa Peninsula | 0.35 | 0.59% |
| 20 | Dover Shores | 0.32 | 0.55% |
| 18 | Lido Peninsula | 0.00 | 0.00% |
| 19 | West Newport | 0.00 | 0.00% |
| 22 | Northstar Beach | 0.00 | 0.00% |


**Figure 8. Map of eelgrass polygon coverage collected during the 2018 survey.**

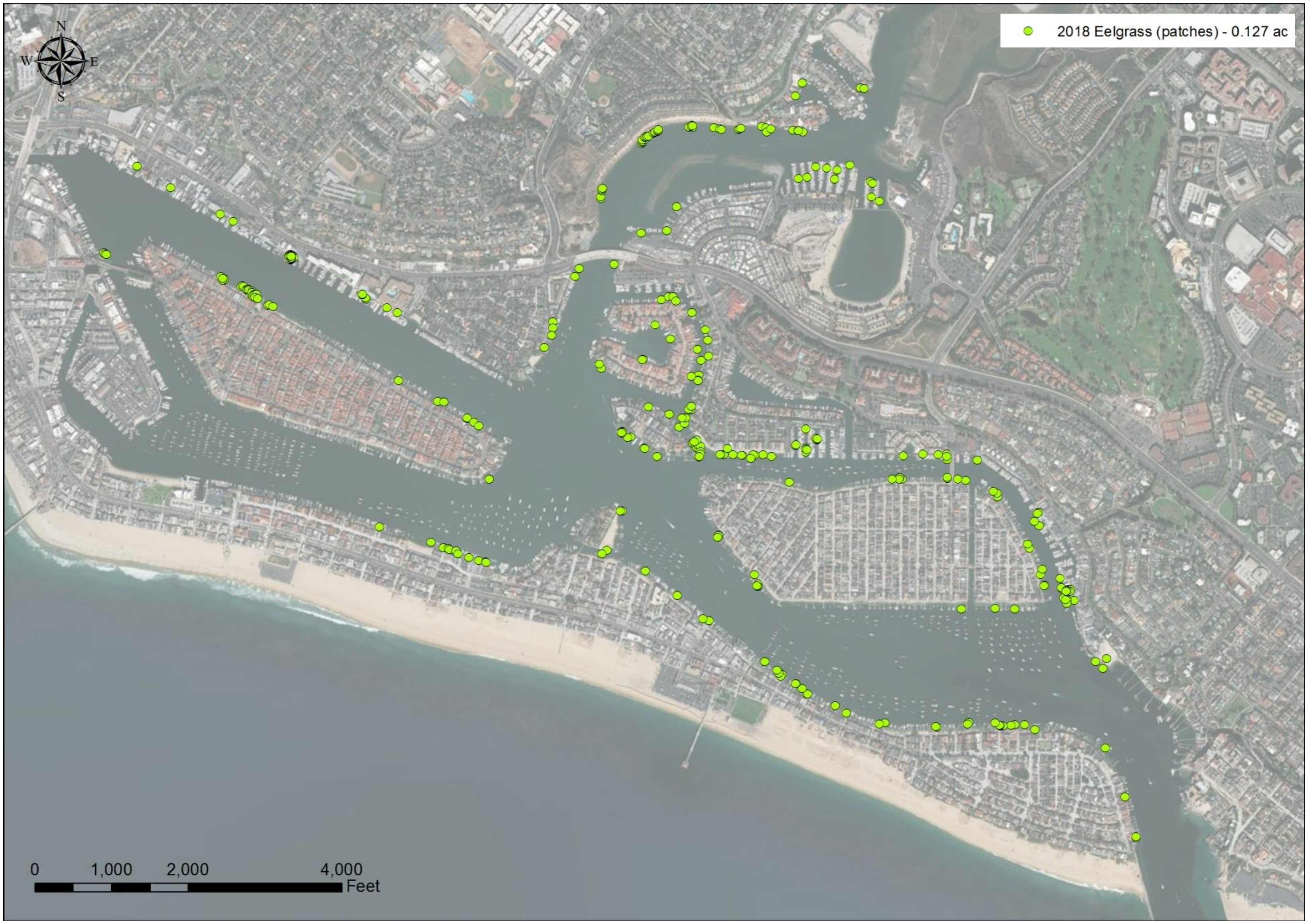


**Figure 9. Map of eelgrass patch coverage collected during the 2018 survey.**

### Region 1. Corona del Mar (14.47 ac)

The most expansive eelgrass beds were mapped in Region 1 (Figure 10).

The 2018 mapping results indicate a continued decline in eelgrass since the 2013-2014 CRM survey (CRM 2015). A total of 7.9 ac decrease over the past four years. The amount of eelgrass within Region 1 declined from 21.65 ac in 2016 to 14.47 ac in 2018. The depth range of eelgrass generally extended between the low intertidal and the -15-ft MLLW survey limit.

The majority of eelgrass decline occurred along the entirety of the bay-front side of Region 1. Many of the polygons beyond the RGP 54 Plan Area have become patchier and less of a continuous bed as noted in CRM 2017. The RGP 54 Plan Area within the harbor is defined as bulkhead to pierhead line plus 20 feet bayward, including only those exceptions for structures that extend beyond this boundary in conformance with harbor development regulations defined by Chapter 17.35 of the Newport Beach Municipal Code. Eelgrass meadows covered a large continuous area within the dockside areas of this Region. Due to the height of the dock gangways in this area, sunlight is able to penetrate areas underneath these dock features; promoting eelgrass growth and bed connectivity.

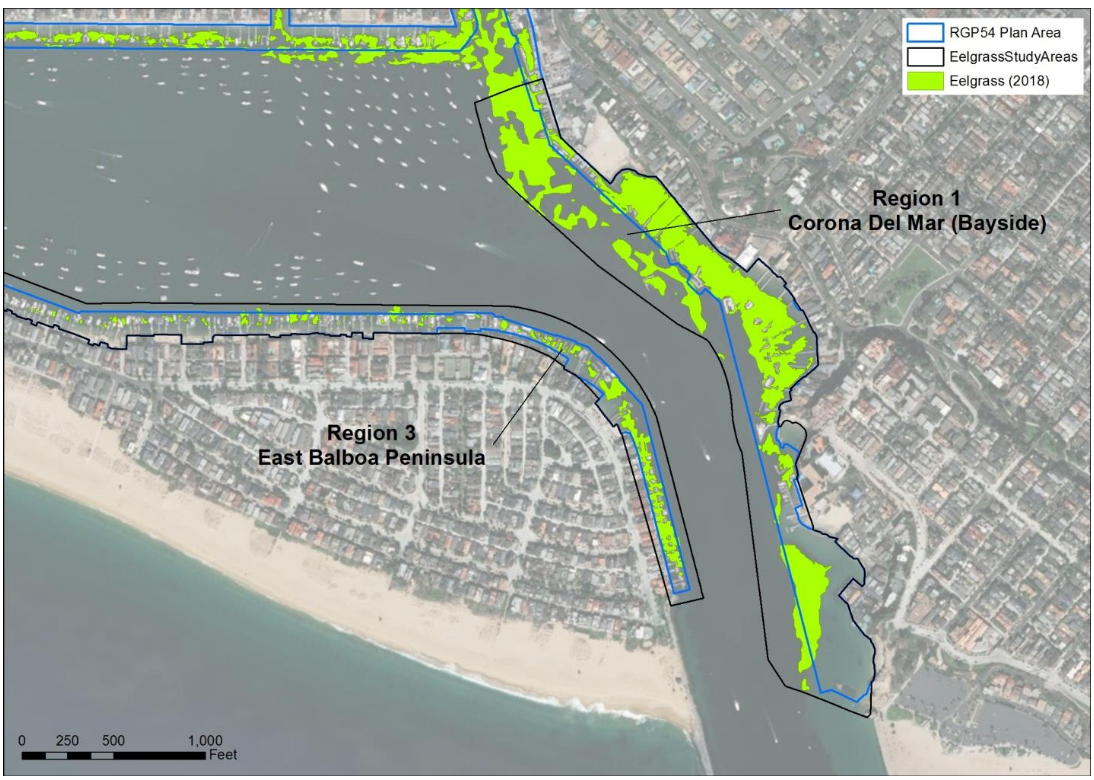


Figure 10. 2018 Eelgrass Habitat Map. Region 1 (Corona del Mar/Bayside) and Region 3 (Balboa Peninsula-East of Bay Island, Partial). See Figure 12 for remainder of Region 3. The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.

Any eelgrass mapped within SWEH and falls outside the Region boundary is included within the total acreage for the nearest associated Region.

### Region 2. Yacht Club Basins and Marinas (2.67 ac)

Region 2 supported eelgrass throughout much of the area, extending from the Balboa Yacht Club to the Balboa Island Bridge (Figure 11). Eelgrass in this area occurred at depths extending from -0.52-ft to -11.3-ft MLLW. Region 2 was ranked 7th for eelgrass acreage, containing 2.67 ac. Eelgrass in this area covers 4.59% of total eelgrass reported. Much of Region 2 eelgrass was contained within The Bahia Corinthian Yacht Club boat basin, the Balboa Yacht Club basin, and the Bayside Marina. Eelgrass in this area has continued to increase since the 2009-2010 survey (CRM 2011) and is 0.65 ac greater than reported during the previous 2016 survey (CRM2017).

### Region 3. Balboa Peninsula - East (3.07 ac)

Region 3 includes SWEH between the bulkhead and the seaward ends of docks from the Entrance Channel to Bay Island (not including Bay Island) (Figure 11 and Figure 12). Region 3 was ranked 6th for eelgrass acreage, containing 3.07 ac. Eelgrass in this region occurred at depth between 0.04-ft and -15-ft MLLW. Eelgrass here constitutes 5.28% of total reported eelgrass. Eelgrass coverage in Region 3 has decreased by 0.71 ac since the 2016 survey (CRM 2017). However, eelgrass coverage in this area is greater than all mapping efforts before 2016.

### Region 4. Grand Canal (1.13 ac)

The Grand Canal, Region 4, separating "Little Balboa" and "Balboa Island" was almost completely covered by eelgrass (Figure 11). Eelgrass beds extended between depths of 1.36-ft to -7.8-ft MLLW. Region 4 was ranked 11th for eelgrass coverage and accounted for 1.94% of total eelgrass reported. Eelgrass here has been consistent and showed little fluctuation throughout the survey years. The 1.13 ac of eelgrass mapped here represent an increase of 0.24 ac since the 2016 survey (CRM 2017). Eelgrass between Park Avenue and Balboa Avenue appears to show a more dramatic increase in coverage than the beds north or south of it.

### Region 5. Balboa Island and Collins Isle (8.29 ac)

Region 5 extends around the perimeter of Balboa Island and Collins Isle (Figure 11). Eelgrass in this area ranked 2nd, covering 8.29 acres and accounted for 14.25% of total eelgrass reported. Eelgrass beds extend between depths of 1.86-ft to -13.4-ft MLLW. Eelgrass has continued to increase since the 2009-2010 survey (CRM 2011, CRM 2015, CRM 2017). Since the 2016 survey, eelgrass has increased by 2.55 ac. Overall eelgrass coverage underwent bed expansion and growth of eelgrass patches into eelgrass beds.


Figure 11. 2018 Eelgrass Habitat Map. Regions 2 (East Balboa Channel Yacht Clubs/Basins), 4 (Grand Canal), and 5 (Balboa and Collins Islands). The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.


Figure 12. 2018 Eelgrass Habitat Map. Region 3 (Balboa Peninsula-East of Bay Island, Partial). The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.

### Region 6. Bay Island (0.80 ac)

Bay Island, Region 6, accounts for a small amount of eelgrass habitat, 0.80 ac (Figure 13). This region is ranked 15th and accounts for 1.38% of total eelgrass reported. Eelgrass beds in this area extend from 0.86-ft to -7.7-ft MLLW. Eelgrass around Bay Island has continued to increase since the 2013-2014 survey (CRM 2015). Since the 2016 survey, eelgrass has increased by 0.31 ac (CRM 2017). The new acreage emerged around the southern and northwestern extent of the island.

### Region 7. Balboa Peninsula – West (0.35 ac)

Region 7 eelgrass extended from the Bay Island Bridge to 11th street, covering 0.35 ac (Figure 13). Region 7 was ranked 18th for eelgrass coverage and accounts for 0.59% of total eelgrass reported. Eelgrass extends from 0.77-ft to -8.9-ft MLLW in the region. Eelgrass here has continued to increase since the 2013-2014 survey (CRM 2015). Since 2016 survey eelgrass coverage has increased by 0.13 ac (CRM 2017).


**Figure 13. 2018 Eelgrass Habitat Map. West Balboa Peninsula. Region 6 (Bay Island) and Region 7 (Balboa Peninsula-West, Partial). The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.**

### Region 8. North Balboa Channel and Yacht Basin (0.55 ac)

Region 8 includes eelgrass from the north side of the North Balboa Channel between the Balboa Island Bridge and Beacon Bay, covering 0.55 ac (Figure 14). Eelgrass occurred between 0.49-ft and -10.8-ft MLLW between the bulkhead and dock head walk, and fairways of the marina. Eelgrass here contributed to 0.95% of total reported eelgrass. Since the previous 2016 survey eelgrass coverage has expanded by 0.31 ac (CRM 2017). Much of the eelgrass growth appears to have occurred in the shallows of Bayside Cove, behind the Belcourt Marina, and within the marina fairways.

### Region 9. Harbor Island (1.78 ac)

Eelgrass around Harbor Island, Region 9, accounted for 1.78 ac of mapped eelgrass (Figure 14). Eelgrass extended from 0.89-ft to -8.95-ft MLLW and contributed to 3.06% of total eelgrass reported. Total eelgrass coverage here has continued to increase since the second survey in 2006-2007 (CRM 2008). Since the 2016 survey, eelgrass has increased by 0.43 ac (CRM 2017). Dramatic increases in bed coverage appear to have occurred along the northern and southern sections of Harbor Island.

### Region 10. Linda Isle - Outer (2.23 ac)

Eelgrass in Region 10, Linda Isle - Outer, covered 2.23 ac (Figure 14). Region 10 was ranked 9th and account for 3.83% of total eelgrass reported. Eelgrass in this region occurs at depths from 1.25-ft to -9.8-ft MLLW. Eelgrass coverage has fluctuated since the first survey in 2003-2004 (CRM 2005), however, coverage has continuously increased since the 2013-2014 survey (CRM 2015). Since the 2016 survey, eelgrass coverage in Region 10 has increased by 1.07 ac (CRM 2017).

### Region 11. Linda Isle - Inner (3.09 ac)

Region 11, Linda Isle - Inner, eelgrass covers 3.09 ac and accounts for 5.31% of total eelgrass reported (Figure 14). Eelgrass occurs from -2.0-ft to -5.2-ft MLLW. Since the 2016 survey, dredge activities have impacted Region 11 and likely contributed to the observed decrease in mapped eelgrass. In 2016, 5.08 ac of eelgrass were mapped in Region 11 which represents a reduction of 1.99 ac of eelgrass in this region

### Region 12. DeAnza Peninsula - Inner (6.32 ac)

Region 12, DeAnza Peninsula - Inner, eelgrass covers 6.32 ac (Figure 15). Eelgrass beds occurred from 1.07-ft to -6.15-ft MLLW and account for 10.86% of total reported eelgrass. Prior to 2016, eelgrass coverage in Region 12 was at least three times lower than coverage reported in 2016 and summarized here. Since the most recent survey in 2016, eelgrass has increased by 2.48 ac (CRM 2017).

### Region 13. DeAnza Peninsula - Outer (7.75 ac)

Ranked 3rd, Region 13, DeAnza Peninsula - Outer, has 7.75 ac of eelgrass coverage (Figure 15). Eelgrass here accounts for 13.33% of total eelgrass reported. Depth data is not available as Region 13 was a sonar only area. A dramatic increase in eelgrass coverage has occurred since the first survey in 2003-2004 (CRM 2005). Eelgrass currently covers approximately six times the area since it was first mapped. Since the 2016 survey, eelgrass coverage has increased by 3.75 ac (CRM 2017).

### Region 14. Castaways (0.84 ac)

Region 14, Castaways, contributes a small portion of acreage to total eelgrass coverage. Eelgrass here covers 0.84 ac, accounting for 1.44% of total eelgrass reported, and occurs at depths extending from 0.26-ft to -6.3-ft MLLW. The majority of previous year's survey efforts performed here resulted in less than 0.15 ac. Since the 2016 survey where 0.50 ac were mapped, eelgrass has more than doubled (CRM 2017).


**Figure 14. 2018 Eelgrass Habitat Map. Regions 8 (North Balboa Channel and Yacht Basins), 9 (Harbor Island), 10 (Linda Isle, Outer), and 11 (Linda Isle, Inner). The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.**

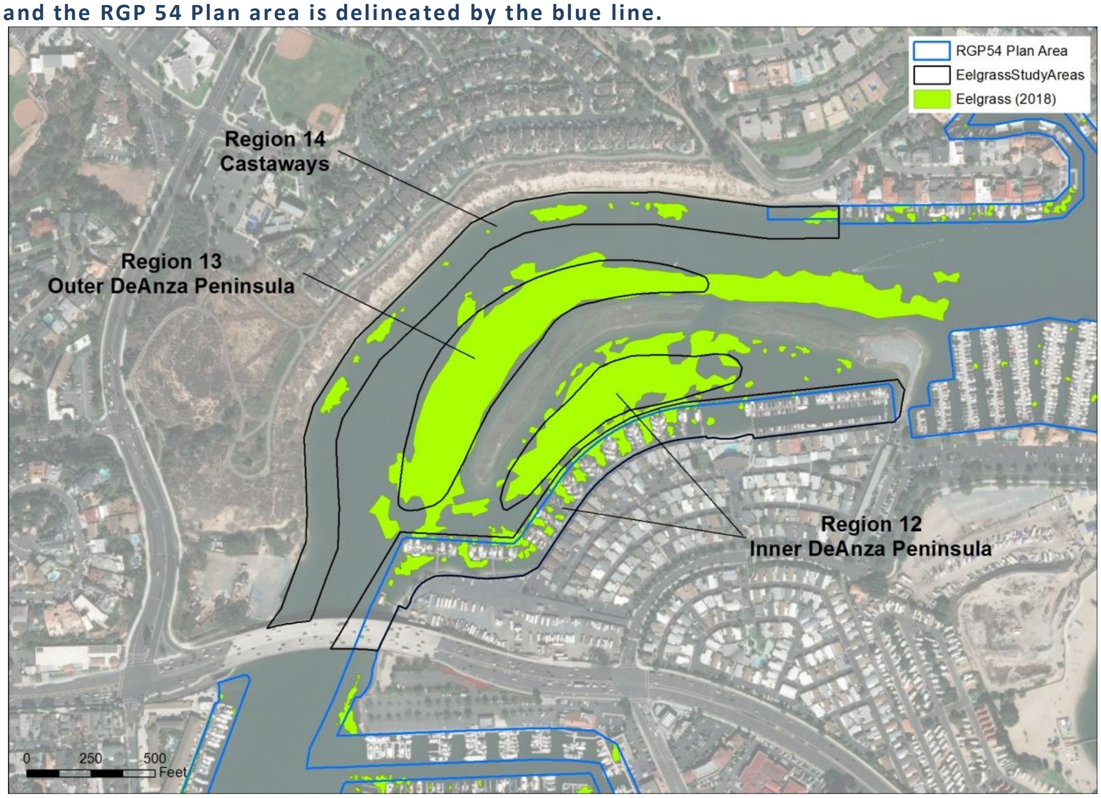


**Figure 15. 2018 Eelgrass Habitat Map. Regions 12 (DeAnza/Bayside Peninsula, East-Inner), 13 (DeAnza/Bayside Peninsula, West-Outer), and 14 (Castaways to Dover Shores). The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.**

### Region 15. Bayshores (0.91 ac)

Region 15 extends from the Coast Highway Bridge to the junction of the Lido reach (Figure 16). The eelgrass in Region 15 covered 0.91 ac and accounted for 1.56% of total eelgrass reported. Eelgrass occurs between 0.62-ft and -10.5-ft MLLW within the Bayshores area. Eelgrass in this area has generally fluctuated, but remained less than 1.00 ac, since the initial survey in 2003-2004 (CRM 2005). Since the 2016 survey, eelgrass has increased by 0.15 ac. Eelgrass within this area generally occurs as small patches between the head wall and dock structures, and in marina fairways.

### Region 16. Mariner's Mile (0.97 ac)

Along the southern portion of Bayshores and Mariner's Mile, Region 16, eelgrass covered 0.97 ac and accounted for 1.67% total eelgrass reported (Figure 16). Eelgrass here extended from 0.49-ft to -9.1-ft MLLW. In past survey efforts, eelgrass was less than 0.69 ac (CRM 2005, 2008, 2011, 2017). Since the recent 2016 survey eelgrass increased by 0.26 ac.

### Region 17. Lido Isle (0.41 ac)

Region 17, Lido Isle, eelgrass cover was most noticeable extending from the northwest to the southeast portion of the island (Figure 16). Eelgrass here covered 0.41 ac, accounted for 0.70% of total reported eelgrass, and extended from a depth of 0.63-ft to -6.4-ft MLLW. Much of the southwestern and western portion of the island was unvegetated. Eelgrass mapped during this survey represents the greatest amount of eelgrass mapped in recent surveys around Lido Isle. Since the 2016 survey, eelgrass had increased by 0.33 ac.

### Region 18. Lido Peninsula (0.0 ac)

No eelgrass has been reported in Region 18, Lido Peninsula, during any survey performed by CRM. While no eelgrass acreage was included for this region, 0.13 ac of eelgrass was discovered for the first time between Lido Peninsula and Lido Isle. Acreage for this eelgrass was included in the total eelgrass reported for Region 17, Lido Isle.

### Region 19. West Newport (0.0 ac)

Eelgrass surveys were last conducted in Region 19 in April 2014 (CRM 2017). No eelgrass was reported during that survey, nor has been reported here in this summary. Region 19 continues to be absent of eelgrass presence (Figure 17).


**Figure 16. 2018 Eelgrass Habitat Map. Regions 7 (Balboa Peninsula-West of Bay Island, Partial), 15 (Bayshores), 16 (Mariner's Mile), 17 (Lido Isle), and 18 (Lido Peninsula). The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.**


**Figure 17. 2018 Eelgrass Habitat Map. Region 19 (West Newport). Within region 9 the RGP 54 Plan area extends to the bulkhead. Due to the overlap of RGP 54 Plan area and the eelgrass study area the in-shore delineation if the RGP 54 Plan area cannot be viewed. The study area is delineated by the black line and the RGP 54 Plan area is delineated by the blue line.**

### Region 20. Dover Shores (0.32 ac)

Region 20, Dover shores, was first surveyed in 2013-2014 (Figure 18; CRM 2015). Since this survey eelgrass has continued to increase. Much of the eelgrass contributing to this acreage occurs within the western portion of this region. Eelgrass covers 0.32 ac, accounting for 0.55% of total reported eelgrass, and occurs at depth of 0.35-ft to -8.33-ft MLLW. Since the 2016 survey eelgrass has increased by 0.14 ac.

### Region 21. Dunes Marina and Channel (2.23 ac)

Dunes Marina, Region 21, was first surveyed in 2013-2014 (Figure 18; CRM 2015). Since that survey, eelgrass has continued to increase. While instances of small eelgrass beds are present within the marina's fairways, much of the total acreage for Region 21 is attributed to eelgrass extending from Region 13 into Region 21. Eelgrass here covers 2.23 ac and accounts for 3.83% of total reported eelgrass, and extends from 0.42-ft to -7.7-ft MLLW.

### Region 22. Northstar Beach (0.0 ac)

Northstar Beach, Region 22, was first surveyed in 2016 (Figure 18; CRM 2017). During the first survey 0.003 ac of eelgrass were reported. During this, 2018 survey, no eelgrass was discovered in Region 22.

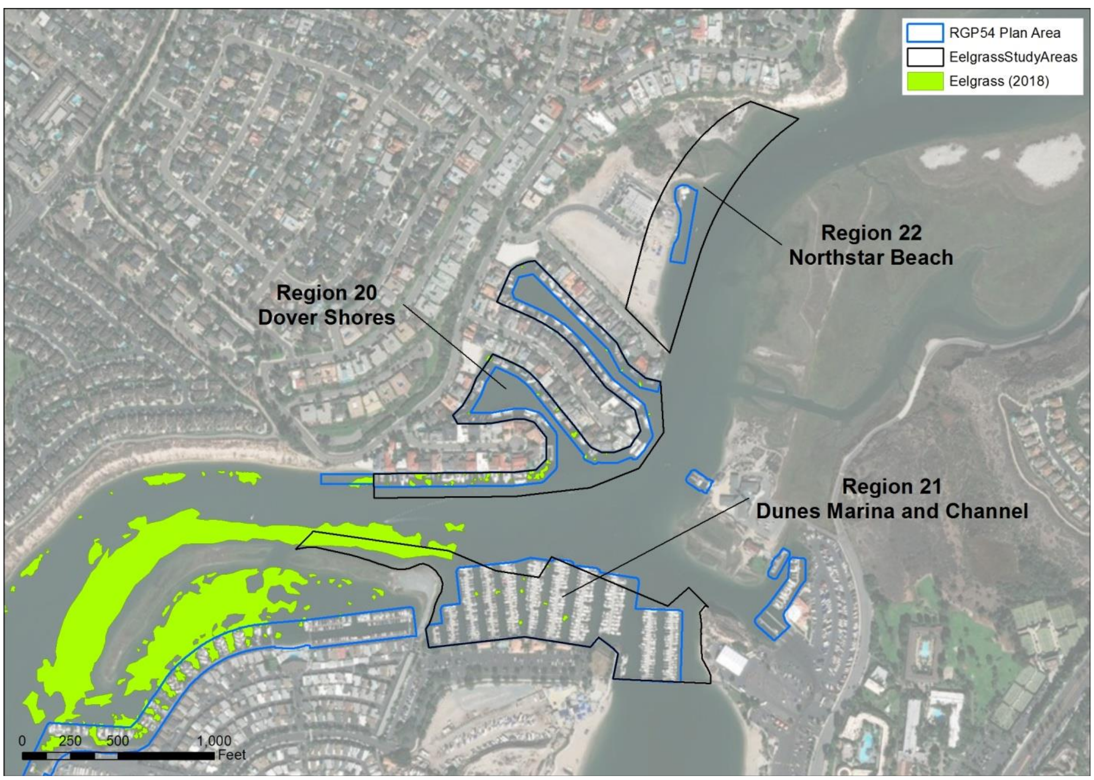


**Figure 18. 2018 Eelgrass Habitat Map. Regions 20 (Dover Shores), 21 (Dunes Marina and Channel), and 22 (Northstar Beach Area).The study area is indicated by the black outline and the RGP 54 Plan area is indicated by the blue outline. Any eelgrass that falls outside the study area boundary within SWEH is accounted for within the nearest associated Region.**

### Historical Eelgrass Coverage

In general, eelgrass in the Bay has undergone periods of decrease and increase (Figure 21). For all survey periods, Corona de Mar, Region 1, accounted for most of the eelgrass cover reported (Table 2). From 2003 to 2010 the Bay's eelgrass was declining. However, coverage in Region 1 remained consistent with little fluctuation in eelgrass cover, indicating that other areas of the Bay were undergoing eelgrass declines and contributing to the overall reduction in eelgrass coverage. Conversely, since the 2009-2010 survey, eelgrass has increased considerably. This dramatic increase can be attributed to Region 1, where large increases in eelgrass coverage were reported. Substantially higher acreages along the Corona del Mar shoreline since 2014 were in part, due to surveying an expanded area outside of the pierhead line using traditional and down-looking sonar techniques (CRM 2015). The most recent survey, summarized here, indicates that eelgrass acreage, again, has substantial acreage contributions from Region 1, however the overall increase in Newport Bay shallow water eelgrass can be attributed to eelgrass bed expansion in other areas of the bay. Eelgrass expansion is most notable in Region 5, Balboa Island and Collins Isle, and Region 13, DeAnza Peninsula-Outer. This indicates that conditions in the Bay are suitable for eelgrass growth and expansion. Future surveys will provide additional insight as to the progression and regression of eelgrass coverage within the Bay.

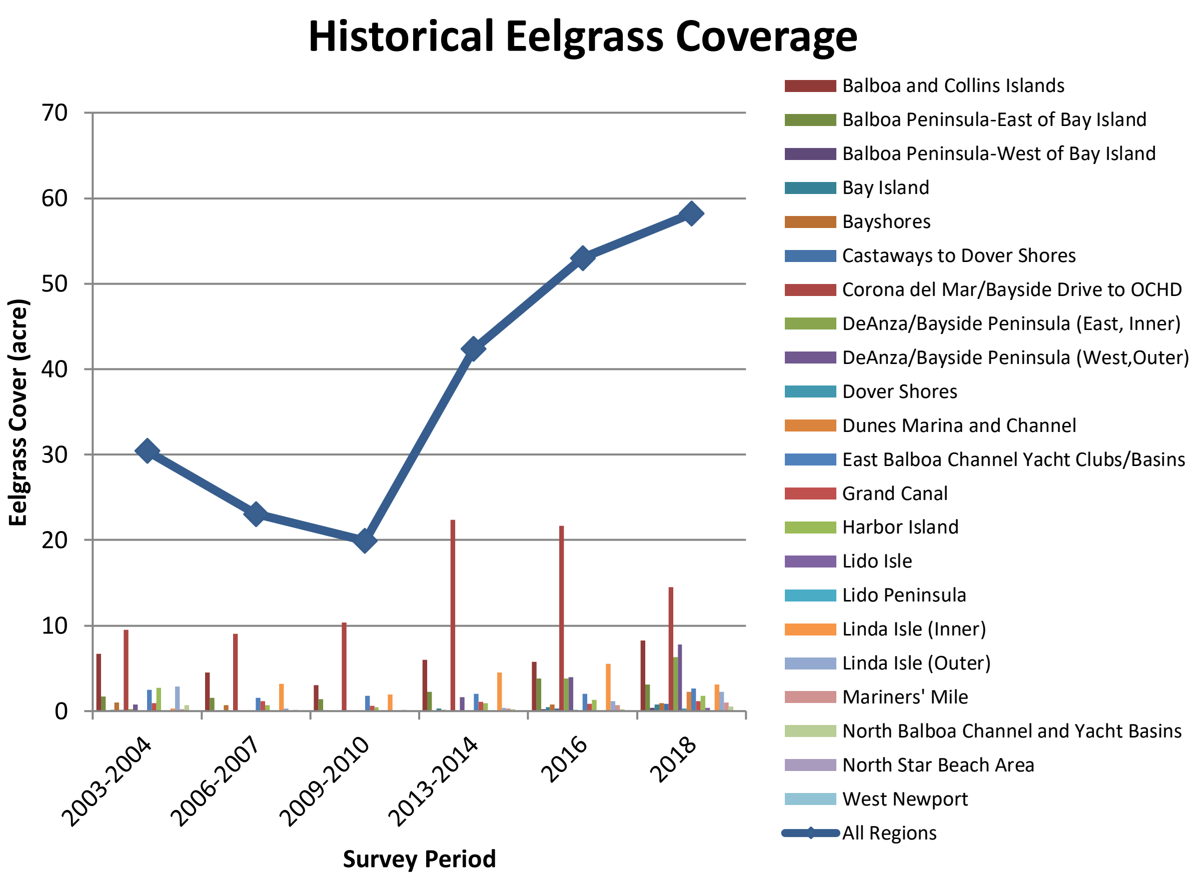


**Figure 19. Historical coverage of eelgrass by region and survey period within Newport Bay. The "All Regions" line indicates the sum of eelgrass cover in all Regions surveyed during each time period. Individual regions values and all Region totals can be found in Table 2.**

| Region | Description | Historical Eelgrass Acreage | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2003 - 2004 | 2006 - 2007 | 2009 - 2010 | 2013 - 2014 | 2016 | 2018 | Mean |
| 1 | Corona del Mar/Bayside Drive to OCHD | 9.521 | 9.075 | 10.363 | 22.372 | 21.651 | 14.474 | 14.576 |
| 5 | Balboa and Collins Islands | 6.686 | 4.554 | 3.052 | 5.978 | 5.736 | 8.298 | 5.717 |
| 11 | Linda Isle (Inner) | 0.281 | 3.218 | 1.974 | 4.495 | 5.548 | 3.091 | 3.101 |
| 3 | Balboa Peninsula-East of Bay Island | 1.672 | 1.557 | 1.391 | 2.267 | 3.782 | 3.075 | 2.291 |
| 2 | East Balboa Channel Yacht Clubs/Basins | 2.469 | 1.539 | 1.758 | 2.056 | 2.018 | 2.670 | 2.085 |
| 13 | DeAnza/Bayside Peninsula (West,Outer) | 0.792 | 0 | 0.001 | 1.596 | 4.006 | 7.754 | 2.358 |
| 9 | Harbor Island | 2.721 | 0.712 | 0.446 | 0.911 | 1.352 | 1.782 | 1.321 |
| 10 | Linda Isle (Outer) | 2.916 | 0.328 | 0.068 | 0.393 | 1.156 | 2.227 | 1.181 |
| 4 | Grand Canal | 0.898 | 1.143 | 0.623 | 1.062 | 0.889 | 1.127 | 0.957 |
| 12 | DeAnza/Bayside Peninsula (East, Inner) | 0.209 | 0.009 | 0 | 0.077 | 3.834 | 6.318 | 1.741 |
| 15 | Bayshores | 0.991 | 0.664 | 0 | 0.156 | 0.760 | 0.906 | 0.580 |
| 8 | North Balboa Channel and Yacht Basins | 0.698 | 0.115 | 0.119 | 0.242 | 0.245 | 0.554 | 0.329 |
| 16 | Mariners' Mile | 0.234 | 0.066 | 0.070 | 0.305 | 0.710 | 0.974 | 0.393 |
| 6 | Bay Island | 0.132 | 0.051 | 0.041 | 0.298 | 0.496 | 0.804 | 0.304 |
| 14 | Castaways to Dover Shores | 0.132 | 0 | 0 | 0.010 | 0.340 | 0.838 | 0.220 |
| 20 | Dover Shores | No Data | No Data | No Data | 0.009 | 0.176 | 0.318 | 0.168 |
| 7 | Balboa Peninsula-West of Bay Island | 0.034 | 0.030 | 0.014 | 0.102 | 0.212 | 0.346 | 0.123 |
| 17 | Lido Isle | 0.025 | 0.004 | 0 | 0.023 | 0.074 | 0.405 | 0.089 |
| 21 | Dunes Marina and Channel | No Data | No Data | No Data | 0.002 | 0.026 | 2.228 | 0.752 |
| 22 | North Star Beach Area | No Data | No Data | No Data | No Data | 0.003 | 0 | 0.002 |
| 18 | Lido Peninsula | No Data | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | West Newport | No Data | No Data | No Data | 0 | No Data | 0 | 0 |
| | All Regions | 30.411 | 23.065 | 19.920 | 42.353 | 53.015 | 58.181 | 37.824 |

**Table 2. Table of historical eelgrass coverage by region per survey period in Newport Bay.**

Dover shores, Dunes marina and channel, North star beach, Lido Peninsula, and West Newport are the only areas that have not been surveyed consistently since 2003.

## Eelgrass Distributional Zones In Newport Bay

Previous CRM surveys developed a second grouping for summarizing eelgrass coverage (CRM 2017). The zones were developed using an eelgrass distributional model predicated upon knowledge gathered during the 2003-2004 and 2006-2007 bay-wide eelgrass surveys (CRM 2005 & CRM 2008). This included the modeled tidal residence time periods in the bay (Everest International, 2009) and the 2008-2009 Newport Bay oceanographic survey results (CRM 2010). The model identified three distributional zones (Figure 20), which describe stable, transitional, and unvegetated sections of the Bay.

The Stable Eelgrass Zone, describes locations where eelgrass distribution appears relatively stable from year-to-year. This zone encompasses the Lower Bay, including the entrance channel, southern and eastern portions of Balboa Island and Grand Canal, Corona del Mar, and the eastern portion of the Balboa Peninsula. This zone is characterized by a tidal flushing time of less than six days. The short flushing time is thought to contribute to higher water clarity and near-bottom underwater light levels that promote eelgrass growth. Linda Isle inner is also grouped into this zone because of the long-term presence and large amount of eelgrass present between 2006 and 2016.

The Transitional Eelgrass Zone, describes areas where eelgrass is susceptible to year-to-year variation in coverage and density. This zone encompasses much of the central part of the Lower Bay including Harbor Island, Linda Isle, northern and western portions of Balboa Island, and the northern side of Lido Channel. This zone is characterized by flushing times of 7 to 14 days. Influenced by the San Diego Creek discharges during the winter months, turbidity impacts this zone by lowering water clarity and lowering near-bottom light levels. This area will expand or contract depending on environmental conditions and other influences on eelgrass growth. The change in eelgrass growth within the transitional zone is determined by evaluating changes in overall coverage and bed density.

The Unvegetated Zone, describes areas 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 greater than 14 days.

During this survey a total of 58.18 ac of eelgrass was mapped within the three eelgrass zones. In the Stable Eelgrass Zone 29.95 ac of eelgrass was mapped. The Transitional Eelgrass Zone was close in acreage to the Stable Eelgrass Zone, with 28.10 ac of eelgrass mapped. Lastly, the Unvegetated Zone had only 0.13 ac.

Since the 2016 survey, eelgrass has remained about the same in the Stable Zone, decreasing by 7.09 ac and increasing in the Transitional Zone by 12.22 ac (Figure 21). Eelgrass had not been mapped in the Unvegetated Zone during previous survey efforts. This survey mapped 0.13 ac of eelgrass and provides evidence that areas within the Unvegetated Zone may function to promote minor amounts of eelgrass habitat (Figure 21).

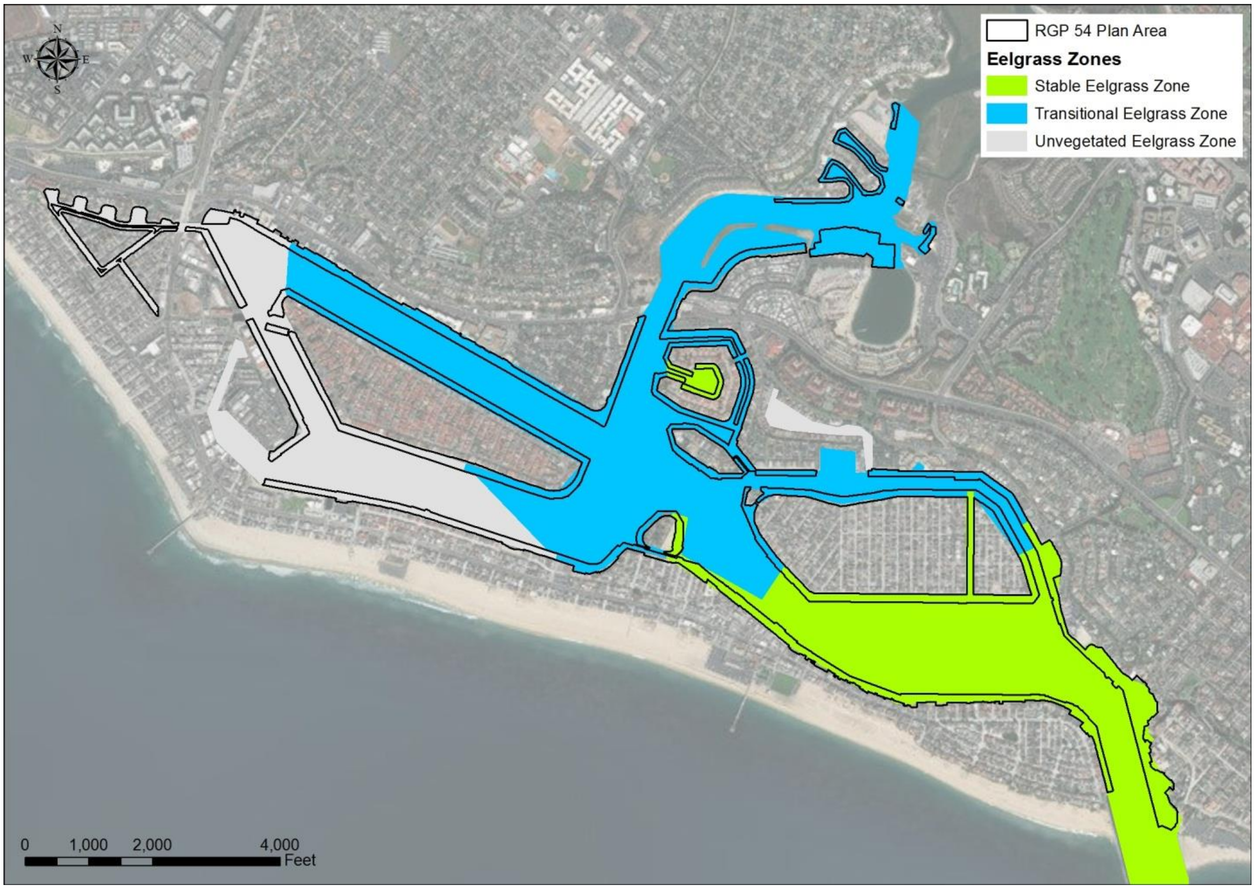


Figure 20. Map of three distributional zones within Newport Bay.

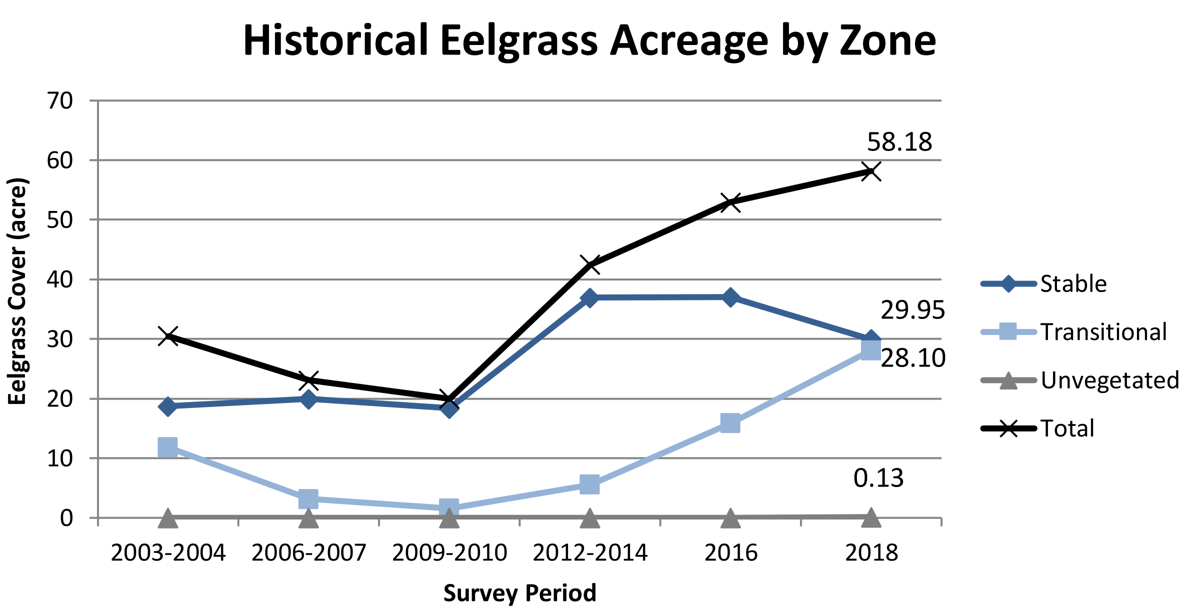


Figure 21. Historical eelgrass coverage by zone in Newport Bay.

## Density

Density measurements were taken at 19 stations throughout the Bay (**Error! Reference source not found.**, Figure 22). Eelgrass density was measured by randomly placing a 1/16 $m^2$ quadrat within the eelgrass bed at each station and counting the number of eelgrass turions within the quadrat. Station locations were selected on a premise of proximity to the mouth of the Bay, position relative to sun angle, and visibility observed during the survey.

**Table 3. Table of 19 stations where eelgrass density measurements occurred.**

| Station | Coordinates (dd.dddddd°) | |
|---|---|---|
| | Latitude | Longitude |
| 1 | 33.600914 | -117.881666 |
| 2 | 33.59912 | -117.882715 |
| 3 | 33.606123 | -117.899502 |
| 4 | 33.604443 | -117.885488 |
| 5 | 33.605803 | -117.888946 |
| 6 | 33.608659 | -117.894818 |
| 7 | 33.60798 | -117.900566 |
| 8 | 33.61106 | -117.904465 |
| 9 | 33.6114644 | -117.9028836 |
| 10 | 33.6138596 | -117.9050629 |
| 11 | 33.6175518 | -117.9022305 |
| 12 | 33.6188476 | -117.9048604 |
| 13 | 33.6213332 | -117.8983731 |
| 14 | 33.6144152 | -117.9068982 |
| 15 | 33.611964 | -117.908589 |
| 16 | 33.610543 | -117.909402 |
| 17 | 33.60871 | -117.911016 |
| 18 | 33.605942 | -117.904052 |
| 19 | 33.60955 | -117.889416 |

The average density for all 19 stations was 159.8 turions/$m^2$ and ranged between 246.1 and 73.5 turions/$m^2$. Density averages by station and region consistently agree that eelgrass density throughout the bay is higher in areas where eelgrass polygons are shallow/inshore when compared to deeper/offshore areas of eelgrass polygons.

Per station, average inshore density was 223.9 turions/$m^2$ and average offshore density was 95.7 turions/$m^2$ (Figure 23). Station 16 had the highest reported inshore density at 470.4 turions/$m^2$, followed by stations 1 and 4 where eelgrass density was 374.4 turions/ $m^2$ and 371.2 turions/ $m^2$, respectively. Offshore eelgrass density was greatest for station 4, 276.8 turions/ $m^2$ followed by stations 1 and 9, 134.4 turions/ $m^2$ and 136.0 turions/ $m^2$, respectively. Stations where eelgrass density was greater occurred within Stable and Transitional Eelgrass Zones.

The 19 density stations represent 15 Regions within the Bay (Figure 24). Of these Regions, Region 16, Mariner's Mile, had the highest reported inshore density, 470.4 turions/ $m^2$. Followed by Region 1, Corona del Mar, and Region 4, Grand Canal, 374.4 turions/ $m^2$ and 371.2 turions/ $m^2$. Offshore eelgrass density is greatest within Region 4, the Grand Canal, 276.8 turions/ $m^2$. However, due to the environmental conditions in this protected area, offshore eelgrass is not under the same environmental pressures as other offshore eelgrass locations. The next greatest offshore eelgrass density is Region 1, Corona del Mar, 134.4 turions/ $m^2$.

Over time, eelgrass density has fluctuated (Figure 25). The initial survey performed in 2004 reported the highest average density of 231.2 turions/ $m^2$. Eelgrass density displayed a dramatic decrease between the 2004 and 2008 survey periods, and continued to show signs of decay through 2014. The 2016 survey marked the first instance of eelgrass average density increase from 117.6 turions/ $m^2$ in 2013-2014 to 161.8 turions/ $m^2$ in 2016. Eelgrass density is currently stable and was reported at values very close to what was reported the previous survey, 159.8 turions/ $m^2$.


**Figure 22. Map of locations where density measurements were taken in Newport Bay during the 2018 survey.**

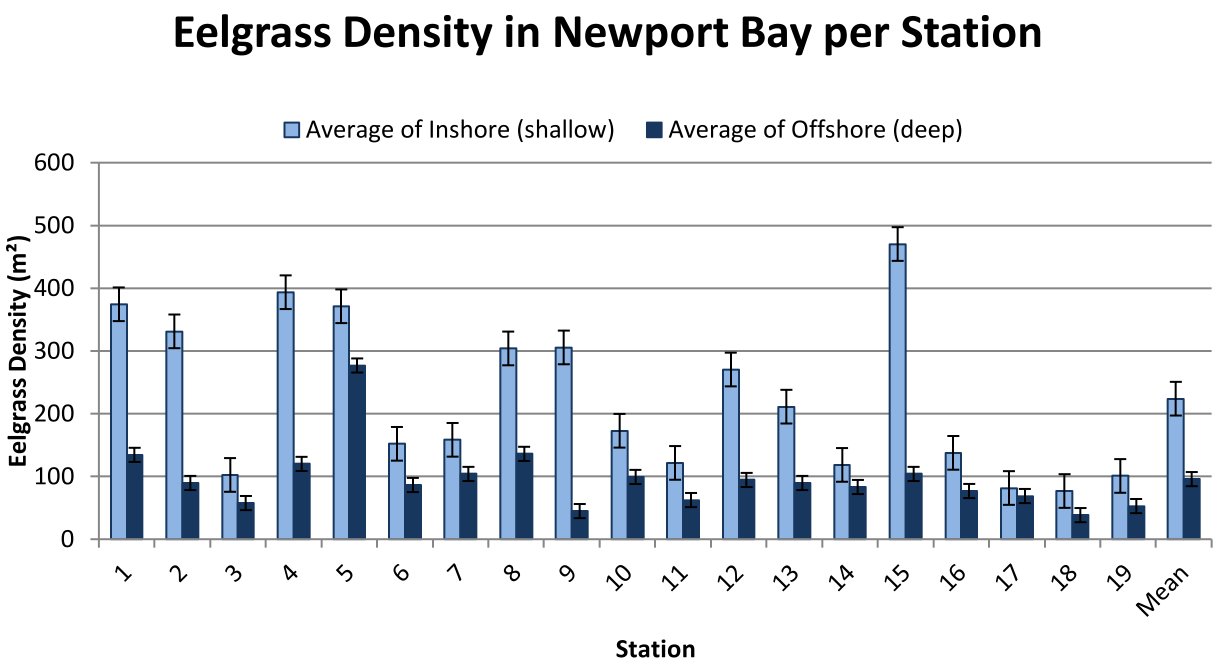


**Figure 23. Average eelgrass density per station in Newport Bay. Error bars represent one standard error of the mean.**

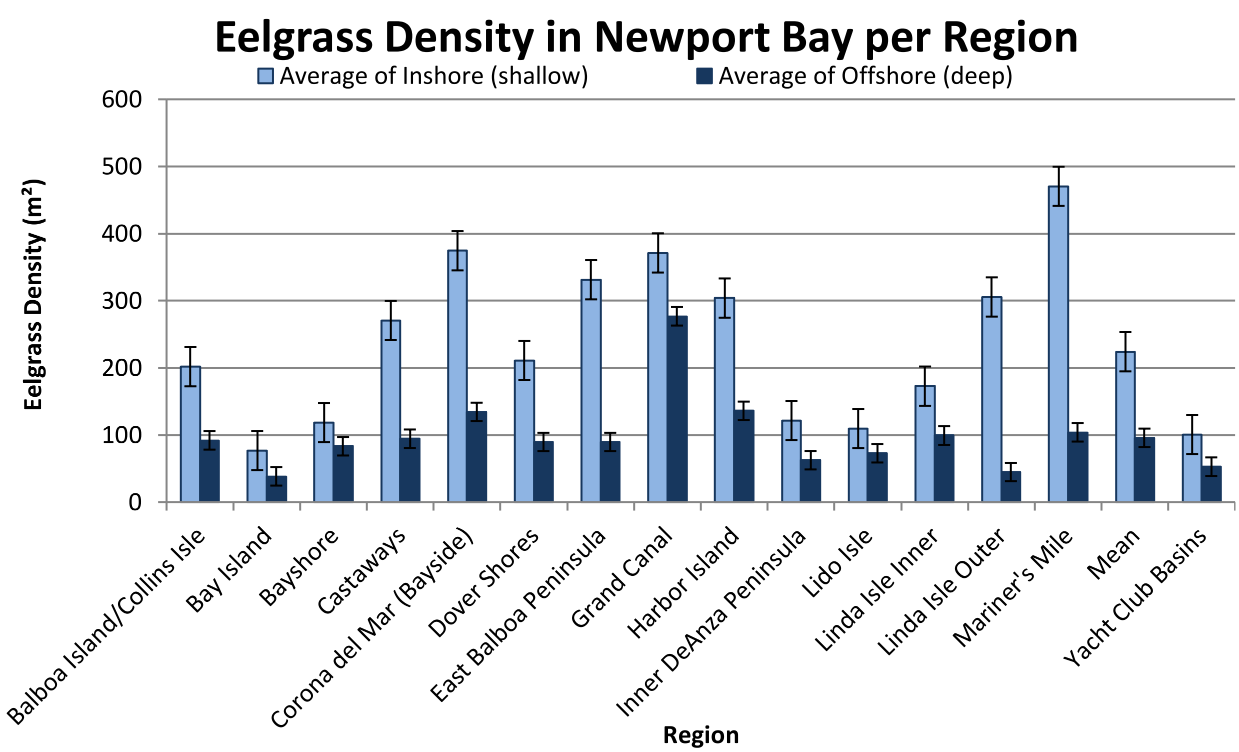


**Figure 24. Average eelgrass density per Region in Newport Bay. Error bars represent one standard error of the mean.**

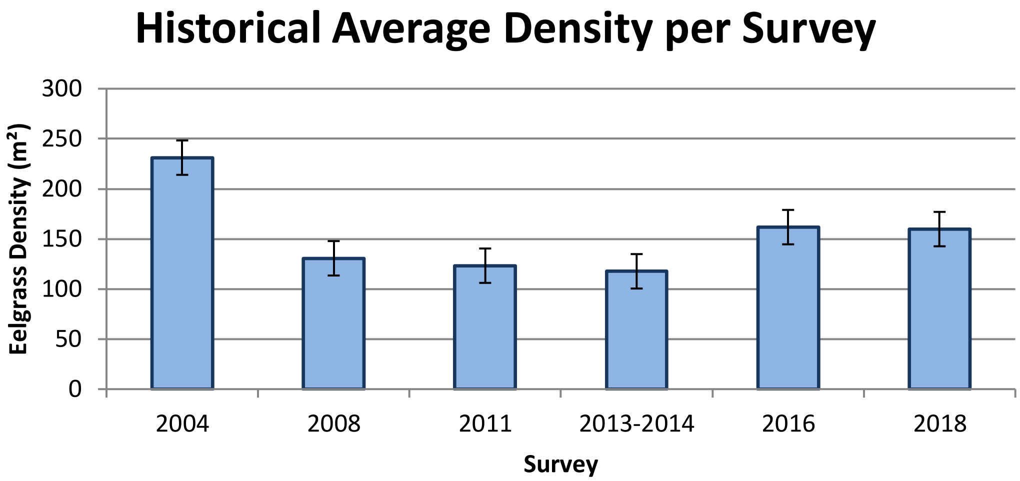


**Figure 25. Historical average eelgrass density per survey in Newport Bay. Error bars represent one standard error from the mean.**

## Other Marine Life Observed

Numerous marine species were observed during the 2018 eelgrass habitat mapping survey (Table 4). Species presence varied with distance and direction from the mouth of the Bay. However, many species were present throughout most surveyed areas in the Bay. Most species observed were associated to either hard substrate including, dock structures, seawalls, and riprap, or soft bottom habitat including both vegetated and unvegetated habitats. Images of select species captured by an underwater camera during the survey are included in Appendix A.

A few species were only observed within Zone 1 at the entrance to the Bay. These species include the California garibaldi (*Hypsypops rubicundus*), rock wrasse (*Halichoeres semicinctus*), eelgrass (*Zostera pacifica*), and the chestnut cowrie (*Cypraea spadicea*). The entrance to the Bay is the only area where two species of eelgrass (*Z. marina* and *Z. pacifica*) were observed together.

When moving farther away from the mouth of the Bay the biodiversity appeared to decrease. When moving farther away from the entrance channel fewer fish species were observed. However, some invertebrate and vertebrate species remained present when moving from Zone 2 to Zone 3. Organisms present in abundance away from the entrance channel included round rays (*Urobatis halleri*), California aglaja (*Navanax inermis*), and anemones (*Diadumene* sp. and *Pachycerianthis fimbriatus*).

Two species were only observed along bayward portions of eelgrass beds where water depth was greater than 11-ft MLLW. The sea whip (*Balticina* sp.) and the golden phoronid (*Phoronopsis californica*) were not observed in the previous years' survey effort and are considered to be a unique sighting. In rocky habitats, as found along Bayshores and western Balboa Island/Collins Isle, East Pacific red octopus (*Octopus rubenscens*) and California two spot octopus (*Octopus bimaculatus*) were common.

A California seahorse was observed on two survey days in July along the south side of inner Linda Isle. On two occasions flat worms (*Platyhelmethes*) were observed in Inner DeAnza Peninsula and along the stretch of survey area between Lido Isle and Lido Peninsula. Bat stars were observed twice, once along the southwestern portion of outer Linda Isle and once along the southeastern portion of region 16, Mariner’s Mile.

On multiple occasions California sea lion (*Zalopphus californicus*) and sea birds, surf scoter (*Melanitta perspicillata*), western grebe (*Aechmophorus occidentalis*), California brown pelican (*Pelecanus occidentalis californicus*), Brant's cormorant (*Phalacrocorax penicillatus*), double crested cormorant (*Phalacrocorax auritus*), California gull (*Larus californicus*), Heermann's gull (*Larus heermanni*), Western gull (*Larus occidentalis*), glaucous-winged gull (*Larus glaucescens*), great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), and black crowned night heron (*Nycticorax nycticorax*) were observed.

One observation of concern was the presence of sand stars throughout the bay. This species was clearly in distress as many individuals observed were showing signs of withering. Only individuals observed within the entrance channel appeared to be healthy.

*Caulerpa taxifolia* is a noxious species of marine algae. This species was eradicated from nearby Huntington Harbor (Anderson et al. 2005). This species of marine algae was not observed at any time within the bounds of the area surveyed in Newport Bay. In accordance with the Caulerpa Survey Protocol, reporting forms have been submitted to the NMFS and CDFW.

**Table 4. Table of species observed during the 2018 Newport bay shallow water eelgrass survey. (table continued on next page)**

| Phyla | Genera | Species | All Zones (hard substrate) | All Zones (soft substrate) | Zone 1 | Zone 2 | Zone 3 |
|---|---|---|---|---|---|---|---|
| **Bacteria** | | | | | | | |
| | red/rust bacteria, unID | rust bacteria, unID | | | | X | X |
| | white sulfur bacteria, unID | sulfur bacteria, unID | | | | X | X |
| **Brown Algae-Phaeophyta** | | | | | | | |
| | brown algae | *Codium fragile spp. tomentosoides* | X | | | | |
| | brown algae | *Colpomenia sinuosa* | X | | | | |
| | brown algae | *Cystoseira osmundacea* | X | | | | |
| | brown algae | *Dictyopteris undulata* | X | | | | |
| | brown algae | *Dictyota flabellata* | X | | | | |
| | sargassum weed | *Sargassum muticum* | X | | | | |
| **Crustacean-Arthropoda** | | | | | | | |
| | Aorid amphipod | *Grandidierella japonica* | X | | | | |
| | barnacle | *Balanus glandula* | X | | | | |
| | buckshot barnacle | *Chthamalus fissus/dalli* | X | | | | |
| | California spiny lobster | *Panulirus interruptus* | | | X | X | |
| | cancer crab | *Cancer* sp. | X | | | | |
| | lined shore crab | *Pachygrapsus crassipes* | X | | | | |
| | Mysid shrimp | Mysidacea unID | X | | | | |
| **Fish-Pisces** | | | | | | | |
| | barred sand bass | *Paralabrax nebulifer* | | X | | | |
| | barred surfperch | *Amphistichus argenteus* | | | X | X | |
| | black croaker | *Cheilotrema saturnum* | | | X | X | |
| | black surfperch | *Embiotoca jacksoni* | | | X | X | |
| | blacksmith | *Chromis punctipinnis* | | | X | X | |
| | blenny | *Parablennius* spp. | X | | | | |
| | California garibaldi | *Hypsypops rubicundus* | | | X | | |
| | California halibut | *Paralichthys californicus* | | | X | X | |
| | California lizardfish | Synodus lucioceps | | | X | X | |
| | California salema | Xenistius californiensis | | | X | X | |
| | California sargo | *Anisotremus davidsonii* | | | X | X | |
| | kelp bass | *Paralabrax clathratus* | | | X | X | |
| | kelp surfperch | *Brachyistius frenatus* | | | X | X | |
| | mullet | *Mugil cephalus* | | X | | | |
| | Opaleye | *Girella nigricans* | X | | | | |
| | Pacific sea horse | *Hippocampus ingens* | | | X | X | |
| | pile surfperch | *Domalichthys vacca* | | | X | X | |
| | rock wrasse | *Halichoeres semicinctus* | | | X | | |
| | Rockfish, unID | *Scorpaenidaw,* unID | X | | | | |
| | round stingray | *Urobatis halleri* | | X | | | |
| | rubberlip surfperch | *Rhacochilus toxotes* | | | X | X | |
| | senorita | *Oxyjulis californica* | | | X | X | |
| | speckled sanddab | *Citharichthys stigmaeus* | | X | | | |
| | spotted sand bass | *Paralabrax maculatofasciatus* | | | X | X | |
| | topsmelt | *Atherinops affinis* | | | X | X | |
| | Diamond turbot | *Hypsopsetta guttalata* | | X | | | |
| | yellowfin croaker | *Umbrina roncador* | | | X | X | |
| **Flatworms-Platyhelminthes** | | | | | | | |
| | Polyclad worm | *Prostheceraeus bellostriatus* | | | | X | X |
| | Polyclad worm, unID | Platyhelminthes, unID | | | | X | X |
| **Gorgonians-Cnidaria** | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| brown gorgonian | *Muricea fruticosa* | X | | | | |
| California golden gorgonian | *Muricea californica* | X | | | | |
| **Green Algae-Chlorophyta** | | | | | | |
| green algae | *Ulva intestinalis* | X | | | | |
| green algae | *Ulva lactuca* | X | | | | |
| green algae | *Bryopsis corticulans* | X | | | | |
| green algae | *Chaetomorpha aerea* | | | | X | X |
| **Jellyfish and Anemones-Cnidaria** | | | | | | |
| anemone | *Diadumene* sp. | X | | | | |
| burrowing anemone | *Pachycerianthis fimbriatus* | | X | | | |
| fairy palm hydroid | *Corymorpha palma* | | | X | X | |
| hydroid | *Aglaophenia dispar* | X | | | | |
| sea pen | *Styalatula elongata* (> 11ft MLLW only) | | | X | X | |
| sea whip | *Balticina* sp. (>11ft MLLW only) | | | X | | |
| **Marine Worms-Phoronid** | | | | | | |
| golden phoronid | *Phoronopsis californica* (>11ft MLLW only) | | | | X | X |
| **Moss Animals-Bryozoa/Ectoprocta** | | | | | | |
| bryozoan | *Thalamoporella californica* | X | | | | |
| red"= "chip" bryozoan | *Watersipora subtorquata* | X | | | | |
| stoloniferan bryozoan and arborescent bryozoans | *Zoobotryon verticillatum, Bulgula neritina, Bulgula californica* | X | | | | |
| stoloniferan bryozoan and arborescent bryozoans | *Zoobotryon verticillatum, Bulgula neritina, Bulgula californica* | | X | | | |
| **Red Algae-Rhodophyta** | | | | | | |
| red algae | *Gelidium* sp. | X | | X | X | |
| red algae | *Grateloupia* sp. | X | | | | |
| red algae | *Microcladia* sp. | X | | X | X | |
| red algae | *Polysiphonia* sp. | X | | X | X | |
| red algae | *Gracilariopsis sjoestedtii* | | | X | X | |
| red algae | *Gracilaria* sp. | | | X | X | |
| red coralline algae | *Corallina* sp. | X | | X | X | |
| **Seagrasses-Zosteracea** | | | | | | |
| ditchgrass | *Ruppia maritima* | | X | | | |
| eelgrass | *Zostera pacifica* | | | X | | |
| eelgrass | *Zostera marina* | | X | | | |
| surf grass | *Phyllospadix torreyi* | | X | | | |
| **Sea stars, urchins, and cucumbers** | | | | | | |
| bat star | Asterina miniata | | | X | X | |
| giant California sea cucumber | *Apostichopus californicus* | | | | | |
| sand star | *Astropecten armatus* | | | X | X | |
| urchin (juv.) | *Stringylocentrotus* sp. | | | | | |
| **Snails and Octopus-Mollusca** | | | | | | |
| Asian date mussel | *Musculista senhousia* | X | | | | |
| bay mussel | *Mytilus galloprovincialis* | X | | | | |
| calcarious tube snail | *Serpulorbis squamigerus* | | | X | X | |
| California horn snail | *Cerithidea californica* | | X | | | |
| California two-spot octopus | *Octopus bimaculatus* | | | X | X | |
| carinate gastropod | *Alia carinata* | | X | | | |
| chestnut cowrie | *Cypraea spadicea* | | | X | | |
| dorid nudibranch | *Doriopsilla albopunctata* | | X | | | |
| East Pacific red octopus | *Octopus rubescens* | | | X | X | |
| giant keyhole limpet | *Megathura crenulata* | | | X | | |
| giant Pacific oyster | *Crassostrea gigas* | X | | | | |
| giant rock scallop | *Crassadoma gigantea* | X | | | | |
| Gould's bubble snail | *Bulla gouldiana* | | X | | | |
| hermit crab | *Pagurus* sp. | | X | | | |
| Kellet's whelk | *Kelletia kelletii* | | | X | X | |
| kelp scallop | *Leptopecten latiatauratus* | | X | | | |
| Lewis' moon snail | *Polinices lewisii* | | | X | X | |
| mossy chiton | *Mopalia muscosa* | | X | | | |
| native oyster | *Ostrea lurida* | X | | | | |
| predatory sea slug | *navanax inermis* | | X | | | |
| rock jingle | *Chama* sp. | X | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | rough limpet | *Lottia limatula* | | X | | | |
| | speckled scallop | *Argopecten ventricosa* | | X | | | |
| | wavy chione | *Chione undatella* | X | | | | |
| | wavy top snail | *Lithopoma undosa* | | | X | X | |
| **Sponges-Porifera** | | | | | | | |
| | Porifera, unID | Sponge, unID | X | | X | X | X |
| | yellow sponge | *Cliona* sp. | X | | X | X | X |
| | yellow sponge | *Haliclona* sp. | X | | X | X | X |
| **Tunicates-Urochordata** | | | | | | | |
| | colonial sea squirt, unID | colonial Ascidiacea, unID | X | | | | |
| | colonial tunicate | *Botryllus/Botrylloides* complex | X | | | | |
| | sea squirt, unID | Ascidiacea unID | X | | | | |
| | solitary tunicate | *Styela montereyensis* | X | | | | |
| | solitary tunicate | *Styela plicata* | X | X | | | |

## Conclusions

Eelgrass plays an important role for many organisms and environmental processes in bays and near shore estuaries. Some of the most important roles of eelgrass are;

- providing habitat for marine fish and invertebrate species
- providing protective cover and refuge for its inhabitants
- provides spawning areas for many species, including commercially important California halibut and barred sand bass
- provides foraging center for sea birds, sea turtles, and marine mammals
- contributes to decaying organic material as part of marine/estuary food web
- filters pollutants from the water, sequesters carbon dioxide gas
- protects shorelines from erosion by dampening wave energy

Shallow water eelgrass surveys were conducted in Newport bay in support of the City of Newport Beach Harbor Area management Plan between July and October 2018. This was the sixth survey conducted in a series of surveys conducted since 2003.

The bay was divided into three zones enveloping 22 shallow water-mapping regions. The results of this survey indicate that eelgrass is present in many parts of Newport Bay and covers 58.18 ac within the SWEH regions. Eelgrass was found to extend from intertidal areas to -15-ft MLLW, however, eelgrass was occasionally present at deeper depths occurring outside the designated survey area. Eelgrass occupied sediment ranging from fine-silt to coarse sand and shell hash.

SWEH eelgrass was abundant in Zone 1 near the entrance channel between Corona del Mar and Balboa Island extending to Bay Island at depths between low intertidal to -15-ft MLLW. Significant amounts of eelgrass were also reported in Linda Isle-Inner and DeAnza Peninsula-Inner and Outer. Of the majority of eelgrass reported, 52.45%, was found in Corona del Mar (Region 1), Balboa Island/Collins Isle (Region 5), and DeAnza Peninsula (Regions 12 & 13).

Reductions in eelgrass cover were reported for Regions 1, 3, 11, and 22. All other Regions reported eelgrass coverage greater than values reported in the previous 2016 CRM survey. Many of the Regions where eelgrass increased occurred within Zone 2, whereas noticeable losses to eelgrass cover occurred in Zone 1, largely within Region 1, Corona del Mar. For the first time, since the 2003 CRM survey, eelgrass was reported in Zone 3, the unvegetated zone.

Eelgrass density collected at 19 stations indicates that density has remained relatively constant when compared to the previous 2016 survey (CRM 2017). Generally, density was greatest along the shallower portions of mapped eelgrass polygons. While density was greatest in these shallow areas, no single Region displayed density values far above the other Regions.

Many species were observed throughout the survey effort. Species diversity generally decreased moving away from the entrance channel. Uncommon species observed included the

Pacific sea horse (*Hippocampus californicus*) and the golden phoronid (*Phoronopsis californica*). Noxious algae (*Caulerpa taxifolia*) was not found in Newport Bay.

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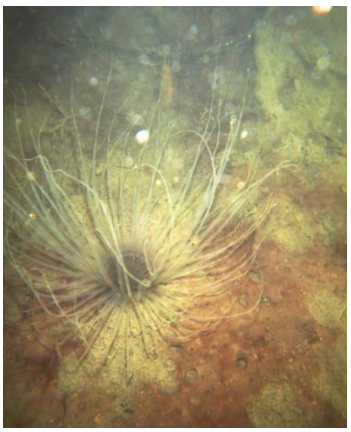
Appendix A

Colonial Anemone surrounding Eelgrass
(*Diadumene* sp.) (*Zostera marina)*

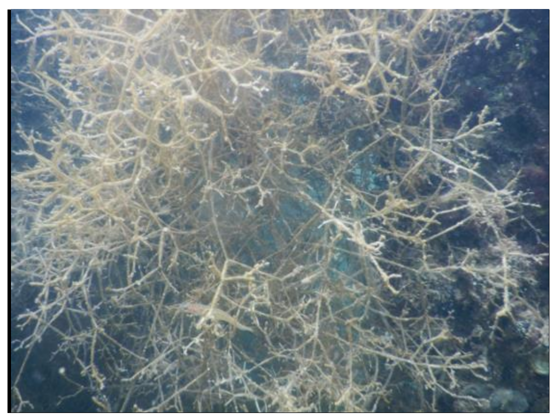
Predatory Sea Slug
(Navanax inermis)



Burrowing Anemone
(*Pachycerianthis fimbriatus*)

Gould's Bubble Snail
(*Bulla gouldiana*)

Bat Star
(*Asterina miniata*)



Bryozoan
(*Zoobotryon verticillatum*)

Mossy Chiton and Red Coralline Algae
(*Mopalia muscosa*) and (*Corralina* sp.)

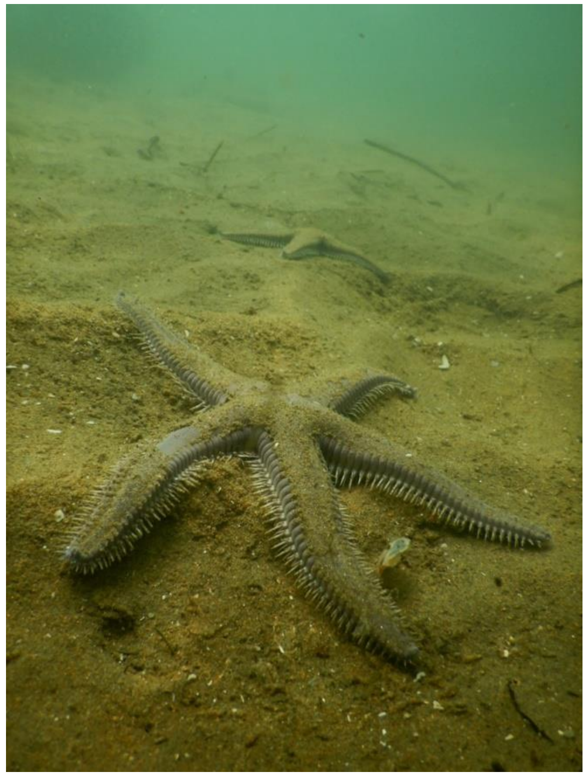
Sea Whip
(*Balticina* sp.)

Hermit Crab
(*Pagurus* sp.)

Golden Phoronid
(*Phoronopsis californica*)

Solitary Tunicate
(*Styela plicata*)

Giant Keyhole Limpet
(*Megathura crenulata*)



Dead and Decaying Sand Stars - present beyond zone 1 (left)

Healthy and Living Sand Stars - present in eelgrass beds near entrance to bay (right)

(*Astropecten armatus*)

Round Stingray
(*Urobatis Halleri*)

Juvenile Urchin Living on Eelgrass
(*Stringylocentrotus* sp.) (*Zostera marina*)

Dorid Nudibranch - White-Spotted Sea
Goddess (*Doriopsilla albopunctata*)

East Pacific Red Octopus
(*Octopus rubescens*)

Polyclad Worm, unID
(Platyhelmenthes)

California Two-Spot Octopus
(*Octopus bimaculatus*)

Polyclad Worm
(*Prostheceraeus bellostriatus*)

California Golden Gorgonian
(*Muricea californica*)

Giant California Sea Cucumber
(*Apostichopus californicus*)

California Spiny Lobster
(*Panulirus interruptus*)

California Sargo and Opaleye
(*Anisotremus davidsonii*) (*Girella nigricans*)

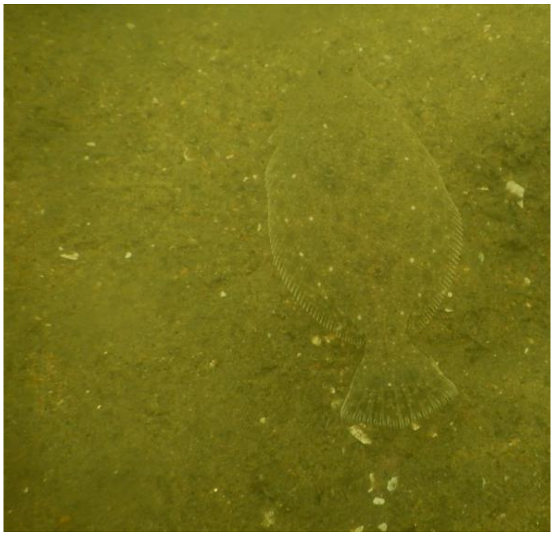
Juvenile California Sargo
(*Anisotremus davidsonii*)

Pacific Seahorse
(*Hippocampus ingens*)

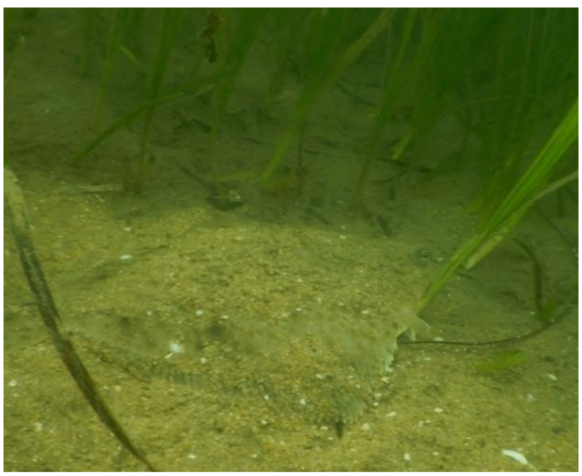
Kelp Bass in Eelgrass
(*Paralabrax clathratus*) (*Zostera Marina*)

Barred Surfperch in Eelgrass
(*Amphistichus argenteus*) (*Zostera marina*)

Multiple Species of Blenny
(*Parablennius* spp.)



California Halibut
(*Paralichthys californicus*)



Diamond Turbot
(*Hypsopsetta guttata*)

California Garibaldi and Kelp Bass
(*Hypsypops rubicundus*) (*Paralax clathratus*)

Barred Sand Bass in Eelgrass
(*Paralabrax nebulifer*) (*Zostera marina*)

Black Surfperch and Sargassum Weed
(*Embiotoca jacksoni*) (*Sargassum muticum*)