

# 2017 San Diego Bay Eelgrass Inventory

Prepared for:



*U.S. Navy Region Southwest  
Naval Facilities Engineering Command*

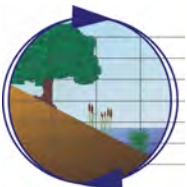


and



*San Diego Unified Port District*

Prepared by:



*Merkel & Associates, Inc.*

March 2018

**2017 SAN DIEGO BAY  
EELGRASS INVENTORY UPDATE**

*Merkel & Associates, Inc.*

March 2018

**BACKGROUND**

**Eelgrass**

Eelgrass is a native marine plant indigenous to the soft-bottom bays and estuaries of the northern hemisphere. The species is found from middle Baja California and the Sea of Cortez to northern Alaska along the west coast of North America and is common in healthy-shallow bays and estuaries. In southern California, eelgrass is generally limited along the shoreward margin by desiccation stress at low tides and is limited along its deeper fringe by low light levels.



Eelgrass plays many roles within coastal bays and estuary ecosystems. It clarifies water through sediment trapping and stabilization and provides benefits through nutrient transformation and water oxygenation. Eelgrass serves as a primary producer in detrital based food webs and is directly fed upon by invertebrates, fish, and birds. It provides physical community structure and supports epiphytic plants and animals, which in turn are grazed upon by larval and juvenile fish, invertebrates, and birds. Eelgrass is a nursery area for commercially and recreationally important finfish and shellfish species, including fishes restricted to bays and estuaries as well as oceanic species, which enter the coastal areas to breed or spawn.

In addition to the high intrinsic values of eelgrass as a habitat, it also provides significant value as a tool for examining long-term trends in water quality improvement or deterioration. It has ideal characteristics for use in monitoring system change. Eelgrass is found at the end of the watershed within coastal bays and estuaries; and as such, monitoring the status of eelgrass resources helps to assess overall watershed management effectiveness. Eelgrass responds to persistent water quality stresses rather than short duration fluctuations. It is adapted to a wide range of tolerances and is capable of "averaging" exposure conditions including temperature, turbidity, seasonal light levels, sedimentation rates, etc., to result in either positive growth or a gradual decline. As a result, short-term variability such as can be seen with water quality testing is of relatively little consequence to eelgrass. A more biologically meaningful measure of long-term trends in ecosystem health can be seen in the response of eelgrass to chronic exposure to the ambient environment.

The eelgrass resources of San Diego Bay are significant not only on a local scale, but also regionally. San Diego Bay is the largest open water bay in southern California and one of only a handful of bays in California that supports sizeable eelgrass meadows. San Diego Bay ranks third behind Humboldt Bay and San Francisco Bay in total eelgrass habitat, supporting approximately 15 percent of all eelgrass habitat within the State of California. San Diego Bay supports approximately 50 percent of the total amount of eelgrass resources in southern California.

**San Diego Bay**

San Diego Bay is a 10,994-acre bay located between the City of San Diego to the north and east, the cities of National City, Chula Vista, and Imperial Beach to the east and south, and the City of Coronado to the south and west. The Bay represents the largest estuary in southern California. It is approximately 15.5 miles in length and contains 54 miles of shoreline. Portions of the Bay north of the Coronado Bay Bridge are narrow and deep, while most of the southern portions of the Bay are wide and shallow. Much of the northern and central Bay shoreline has been developed.

Eelgrass is predominantly a subtidal resource and as a result it is difficult to monitor and track changes in its distribution. Moreover, comparisons between various eelgrass surveys are burdened by advancements in technology and orders of magnitude advancements in precision and accuracy of mapping capabilities. Prior to the 1990's, eelgrass surveys in San Diego Bay were performed by a variety of techniques including trawl and grab sampling, diver transects, and true color and infrared aerial imagery (Lockheed 1979a, Lockheed 1979b, SDUPD 1979, SDUPD 1990). Mapping was aided by estimation of locations based on various landmarks and, on rare occasion, some controlled survey points from which relative locations were visually approximated. Small-scale eelgrass mapping was conducted primarily through the use of grabs and divers, whereas the large-scale efforts tended to rely on aerial imagery. However, aerial imagery was not consistently capable of detecting eelgrass at depth. As a result, shallow eelgrass beds were generally well mapped, but deeper eelgrass beds were often under-reported or missed entirely.

In 1988, sidescan sonar was first used to map eelgrass within the 2000-acre Mission Bay. The boat trackline was plotted using microwave navigation, and eelgrass density was determined from sonographic charts while diver transects were used to ground-truth the work effort (Merkel 1988). This approach was subsequently updated to make use of real-time differential GPS data to plot the centerline boat position as well as a CAD-based mapping effort (Merkel 1992). In 1993, the U.S. Navy applied this technology to San Diego Bay and provided the first comprehensive survey of eelgrass resources within the Bay (U.S. Navy 1994). The Navy and the San Diego Unified Port (Port) District followed this effort with another baywide survey in 1999 using single-beam sonar methods (U.S. Navy 2000). In 2004 and 2008, Merkel & Associates carried out both eelgrass surveys and bathymetric mapping updates that included the entire San Diego Bay (Merkel 2005, 2009). In 2011, advancements in mapping technology were made with the application of interferometric sidescan sonar to conduct the updated eelgrass mapping (Merkel 2011). The use of interferometric sidescan sonar technology substantially improved the spatial accuracy of acoustic backscatter mapping.

The present 2017 survey is a continuation of the prior eelgrass survey efforts and provides insight into long-term trends in eelgrass habitat and environmental change within the Bay. Again making use of interferometric sidescan sonar, the present survey also benefitted from improvements in vessel positioning and heading correction through the use of real time kinematic (RTK) GPS. Eelgrass survey results are presented on a baywide-scale in separate maps. Depths are presented in feet using mean lower low water (MLLW) as derived from composite bathymetric charts prepared as a product of 2008 surveys (Merkel & Associates 2009).

Baywide eelgrass surveys have been jointly performed by the Navy and Port as a tool for tracking the ecological and water quality conditions, detecting trends or patterns derived from anthropogenic influences or climatic changes, and for natural resource and development planning. Per the San Diego Bay Integrated Natural Resource Management Plan, continuation of baywide eelgrass surveys every 5 years has been identified as a monitoring priority (US Navy and Port 2013).

## **SURVEY AND ANALYSIS METHODS**

### **Sonar Data**

Survey equipment used for data collection included a digital interferometric sidescan sonar system with motion sensor integration, and a dual antenna differential global positioning system (dGPS) was used for navigation. Data were collected over the course of 22 survey days by Merkel & Associates to result in full baywide coverage. Survey density was higher within shallow environments than was employed in more open deepwater environments where eelgrass would not be expected and existing high-resolution bathymetry existed. Surveys in these areas were performed to confirm existing data sets.

### ***Sidescan Sonar***

A hull mounted 468 kHz digital interferometric sidescan sonar system included SEA SWATHplus-H sonar, integrated with a Valeport miniSVP sound velocity sensor, and an SMC IMU-108 motion sensor to correct for speed of sound in water and roll, pitch, and heave of the survey vessel. The sidescan sonar data were collected with across-track swath widths of 31 m on both the port and starboard transducers. The acoustic wave phase difference at different sensors allows for triangulation of the position of the acoustically reflective surface.

### ***Navigation***

The navigation system used during the surveys employed an on-board dual antenna RTK GPS. The positional accuracy horizontal positioning of the survey vessel was maintained with a Hemisphere VS111 providing positional accuracy within 2 centimeters, 95 percent of the time. The secondary antenna provided heading and yaw correction. During the survey, the vessel was operated on parallel tracks with slightly overlapping sonagraphic records. The first trackline within each area was located 15 to 20 meters from the shoreline allowing full coverage of the Bay floor up to the middle intertidal zone or above. Once the initial trackline had been completed, the vessel moved offshore in approximately 25-meter increments and paralleled the primary trackline. Maintaining a line parallel to the primary trackline was accomplished by the use of a real-time position and digital trackline map. Once sufficient shoreline buffer had been developed, straight-line swaths were employed to minimize data loss occurring in turns. High wave environments and areas with significant vessel traffic were surveyed at night to maximize the quality of acoustic record collected.

Surveys were conducted in waters shallow enough to support eelgrass and surveys were extended into water depths beyond the limits of any mapped eelgrass. Tracklines were overlapped to provide for 100 percent seafloor coverage within the survey area. In total, approximately 526 miles of survey tracks were navigated during the 2017 eelgrass survey (Figure 1).

### **Eelgrass Mapping**

Following the completion of the sonagraphic survey, the stored sidescan data were post-processed into a series of geo-rectified mosaic images covering all surveyed areas of San Diego Bay. The images were imported into geographic information systems (GIS) software to delineate eelgrass beds through on screen digitization of the acoustic signatures of eelgrass observed in the sonagraphic record.

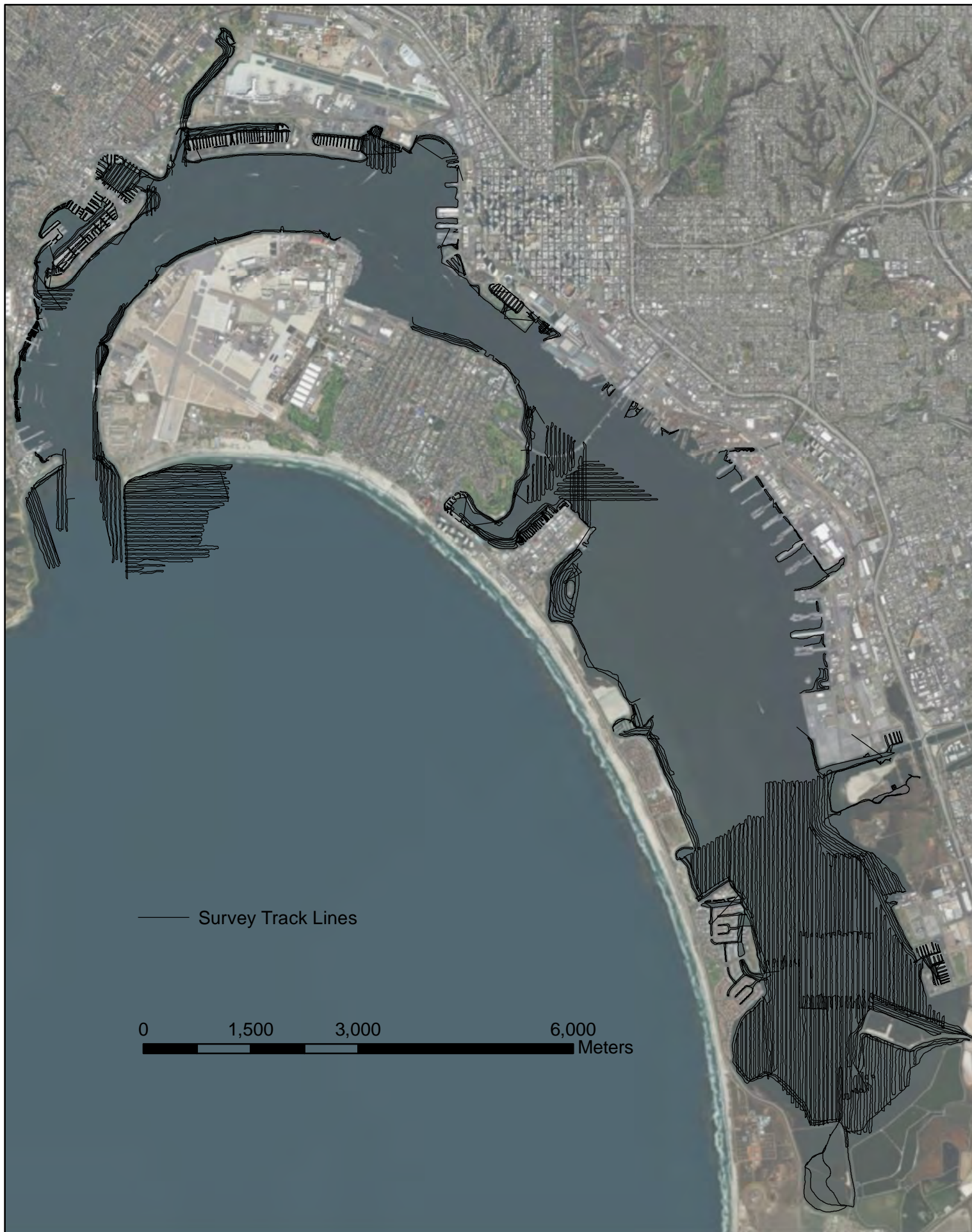


Figure 1. 2017 eelgrass survey track lines

### Ground-Truthing

Remotely operated vehicle (ROV) and drop video camera spot checks, as well as low-tide surface inspections, were used to ground-truth maps prepared using sonographic data. The distribution of ground-truthing sites was non-random and primarily focused on sites identified as having substantial discrepancies existing between the prior surveys and the present survey. Additionally, ground-truthing focused on southern portions of the Bay where warm water conditions favor the abundance of the subtropical upright bryozoan, *Zoobotryon verticillatum*. This large bryozoan returns a similar but substantially less acoustically reflective signal as eelgrass; and thus, sonographic interpretation was expected to be most questionable in these areas. The south bay region also supported limited occurrences of widgeon grass (*Ruppia maritima*), a short, densely growing, seagrass found in areas around the Chula Vista Wildlife Reserve which requires some initial signature verification based on the growth state of both eelgrass and widgeon grass at the time of mapping.

Other ground-truthing efforts were focused in areas of mixed rubble and soft bottom where *Sargassum muticum* can generate similar, but distinguishable acoustic signatures to those of eelgrass. Finally, ground-truthing efforts occurred around marinas, docks, and other areas where sonographic surveys were encumbered by limited open water access and where eelgrass distribution patterns are complex or demarcated by dramatic changes in bed density over short distances. Although ground-truthing efforts were focused in some regions of the Bay, all portions of the Bay were ground-truthed to the level of detail required to confirm the accuracy of the sonographic data analysis.

## RESULTS

Information presented in this report has been prepared for use in digital format and large-scale presentation format for the Navy and Port District. Reduced versions of graphics are incorporated in this document for completeness of interpretation. Eelgrass distribution relative to bathymetry has been based on a 2008 composite bathymetric chart that was based on a number of primary and secondary sources as an element of the 2008 survey effort (Figure 2). This bathymetric chart utilizes both original data collection and composite data from other sources (Merkel & Associates 2009). No additional bathymetric chart updates have been incorporated into this effort. Each prior baywide survey has been compared against this same bathymetric chart for development of depth distribution analyses.

### Eelgrass

The 2017 eelgrass distribution within San Diego Bay extended over a total bottom area of 1,692.8 acres (Figure 3). The distribution of eelgrass follows the general patterns of distribution noted in prior surveys. The greatest extent of eelgrass is found within the shallow southern ecoregion of the Bay with more extensive eelgrass also being found on the shallower fringes of the western Bay shorelines where more gradual soft shorelines are more prominent (Figure 2). Other smaller beds are scattered throughout the more developed regions of the Bay where shallows allow for adequate light levels to support eelgrass habitat. Eelgrass beds also exist at the mouth of San Diego Bay within the shallows outside of Ballast Point and along Zuniga Jetty on North Island.

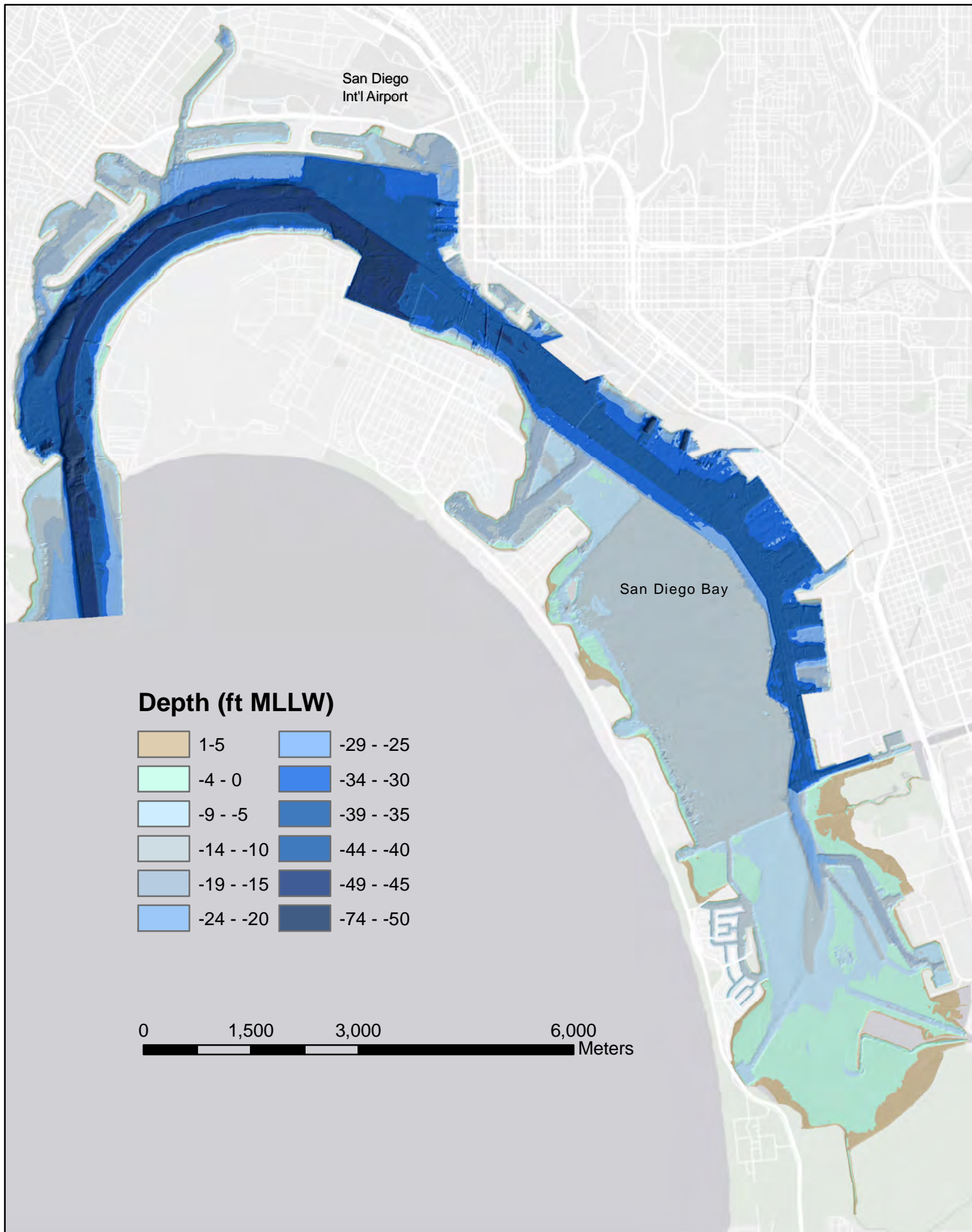


Figure 2. Composite 2008 bathymetry update of San Diego Bay



Figure 3. Eelgrass spatial distribution for San Diego Bay 2017 baywide survey

## DISCUSSION

### Eelgrass

San Diego Bay is a naturally shallow water embayment that has been dredged to accommodate various navigational uses including both intermediate depth recreational boating as well as deep commercial and military harbor needs (Figure 2). The resulting bathymetric distribution within San Diego Bay exhibits a broad depth distribution curve, with natural bay depths occurring over much of the area less than -6 feet MLLW and deeper dredged harbor extending to much deeper depths (Figure 4). Eelgrass is most expansive within the southern portions of the Bay where extensive shallow flats are located. In the northern portions of the Bay, eelgrass tends to occur within fringing beds where the upper and lower limits of eelgrass growth occur close to the shoreline due to rapidly sloping bottom as developed shorelines give way to dredged/navigable waters. Notable exceptions to this trend are the eelgrass beds occurring in shallow waters north of the western terminus of the Coronado Bridge, adjacent to the Naval Amphibious Base, and on shoals near the mouth of the Bay.

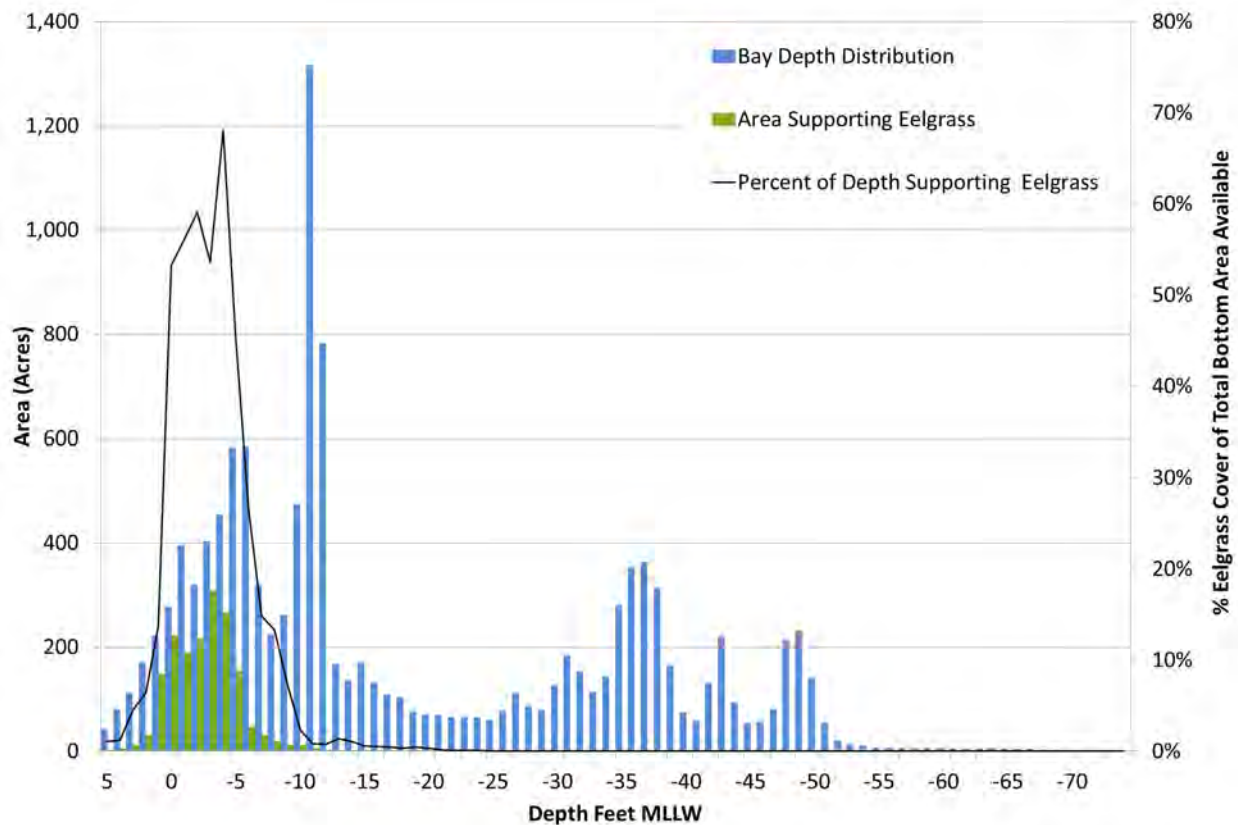


Figure 4. San Diego Bay depth distribution by percentage of total area.

Throughout the Bay, eelgrass was observed to be restricted to the shallower portions of the baywide depth range (Figure 4). Eelgrass grows most extensively in waters ranging from approximately +1 to -8 feet MLLW, with the greatest percentage of available substrate being occupied between -2 and -4 feet MLLW (Figure 4). Some notable deviations from this typical range are seen in areas on higher mudflats and at the toe of riprap slopes, where wave scour, boat propeller scars, and activities of rays have created small perched pools that can support eelgrass habitat above the +1 foot MLLW elevation that typically defines the upper elevation of eelgrass in San Diego Bay. In addition, deepwater eelgrass beds are found near the mouth of the Bay where clear water supports the broad-leaved Pacific eelgrass (*Zostera pacifica*) between Point Loma and Zuniga Jetty. At the mouth of San Diego Bay, these beds rarely extend to depths in excess of -21 feet MLLW but are generally restricted to depths in excess of -12 feet MLLW. A very small amount of eelgrass also occurs in deeper waters within the eastern portion of the central bay where clear water often occurs around the commercial piers that are exposed to flows from the deep navigation channel.

When comparing the eelgrass depth distribution observed in 2017 with that observed during the 2014 eelgrass survey, a notable decrease in eelgrass can be seen to have occurred within shallow portions of the eelgrass depth distribution range (Figure 5). The substantial loss of eelgrass between 2004 and 2008 appeared to be a biologically mediated decline given the pattern of losses occurring in expansive high-density beds rather than in isolated less dense beds and the pattern of subsequent recovery. Similar anomalous declines in the region's eelgrass beds were also observed in other systems such as Mission Bay as well (Merkel & Associates 2008a).

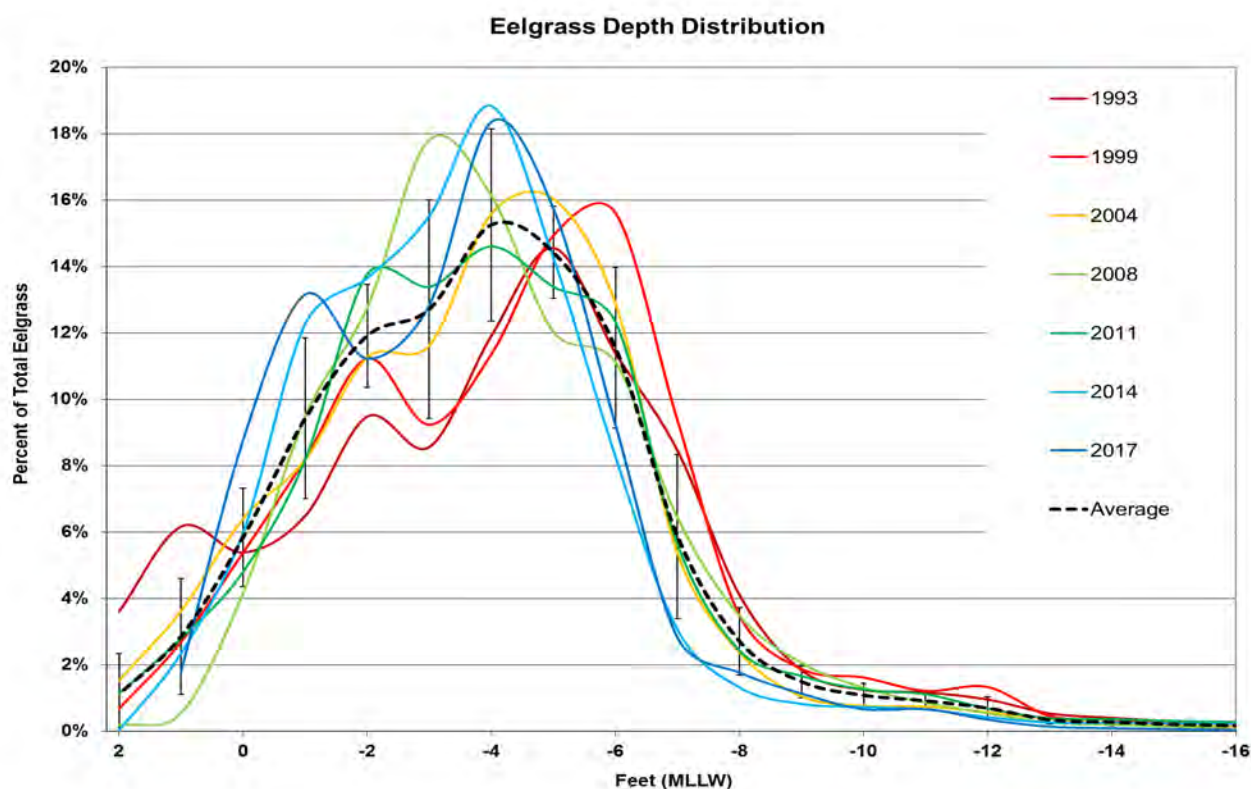


Figure 5. Eelgrass distribution by depth and year. Average  $\pm$  1 SD (1993, 1999, 2004, 2008, 2011, 2014, and 2017 survey years).

The 2011 regional survey suggested that prior declines observed in the 2008 survey were reversing with expansion of eelgrass being observed during the survey. The 2014 survey provided evidence of continued recovery. However, the 2017 survey revealed a subsequent decline in eelgrass with the majority of the decline occurring in shallower portions of the bay. The decline was a notable reduction in upper margins of eelgrass beds.

The current survey found 1,692.8 acres of eelgrass in the Bay. A comparison of eelgrass distribution patterns between the 1993, 1999, 2004, 2008, 2011, 2014, and the present 2017 surveys indicates an eelgrass expansion of 542 acres (50%) between 1993 and 1999, from 1,091.4 acres in 1993 to 1,633.7 acres in 1999. The expansion between 1999 and 2004 was 450.0 acres, a 27% expansion. From 2004 to 2008, eelgrass suffered a 37% decline losing 769 acres of eelgrass dropping from 2,083.7 acres to 1,315.1 acres. From 2008 to 2011, eelgrass experienced a 39% expansion from 1,315.1 acres to 1,830.4 acres. From 2011 to 2014, eelgrass experienced an expansion of almost 7% from 1,830.4 acres to 1,955.7 acres. From 2014 to 2017, eelgrass suffered a decline of just over 13% dropping from 1,955.7 to 1,692.8 acres. The predominant changes in eelgrass coverage occurred within beds outside Ballast Point and within the southern ecoregion where eelgrass declined substantially from the prior survey periods. Within other portions of the Bay where eelgrass is typically restricted to fringing beds along deeper waters, eelgrass showed little change in extent from the prior 2014 condition (Figure 6).

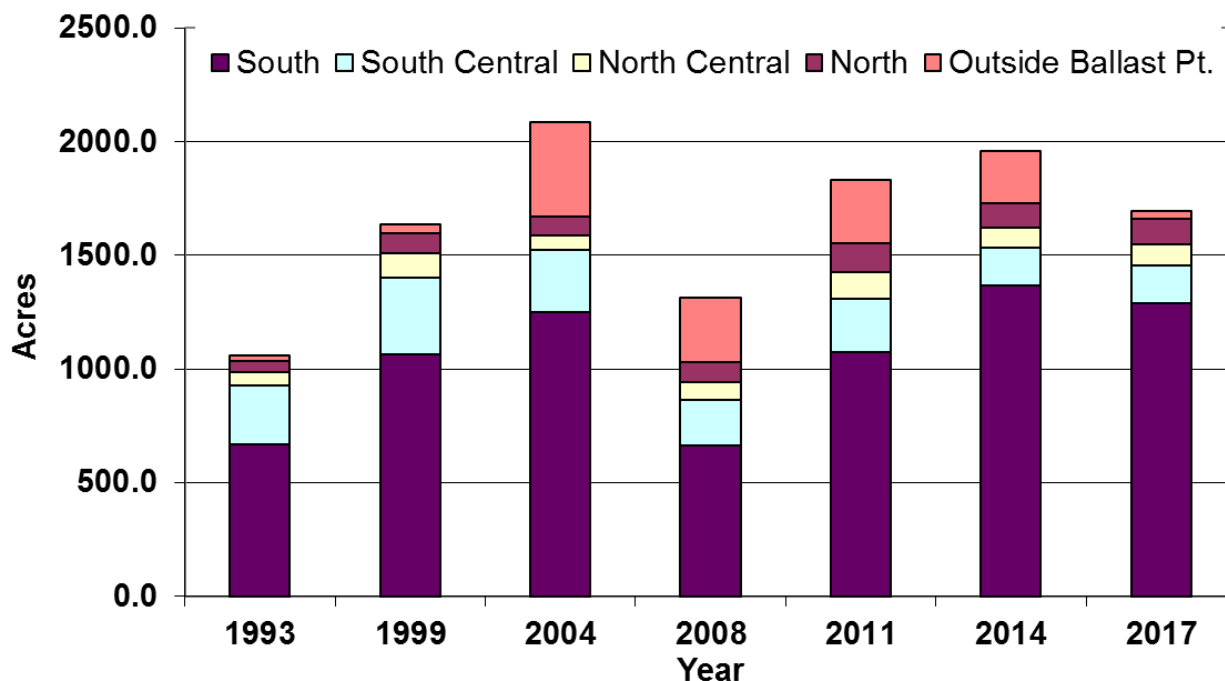


Figure 6. Eelgrass distribution by ecoregion and year.

Change in eelgrass extent within San Diego Bay are generally believed to be transitory responses to prevailing environmental conditions prior to the surveys and potentially extending through the survey period. However, over longer periods of repeated survey intervals, a robust picture of the system norm dilutes inter-survey variability. To begin to illuminate the robust and less stable patterns of eelgrass distribution, a frequency distribution map has been prepared (Figure 7). This map presents eelgrass persistence patterns as a frequency value derived by dividing the number of times eelgrass was present at a particular location by the total number of surveys conducted. As the number of surveys increases, the stability and variance in the map can be quantified. In the future, running averages over multiple survey years will allow separation of trends from variability.

Eelgrass is considered to be a habitat forming species that creates unique biological environments. As submerged aquatic beds, eelgrass is given special status 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 special status has led to numerous mitigation efforts implemented under the Southern California Eelgrass Mitigation Policy (NMFS 1991) (SCEMP) and more recently the California Eelgrass Mitigation Policy (NOAA 2014) (CEMP). Many of these efforts have successfully established eelgrass beds within the Bay. Because of the environmental importance of eelgrass and its accompanying heightened regulatory protection status, it is important to develop a good understanding of the dynamics of eelgrass distribution on a temporal scale. While recent baywide surveys would suggest a long-term gradual increasing trend in eelgrass area within San Diego Bay (Figure 6), this is not truly the case. A closer review of the data on an ecoregion basis reveals that the overall increases in eelgrass are driven by variable net gains and losses within differing regions of the Bay. This is most clearly seen with high variability in the extent of eelgrass outside of Ballast Point (Figure 6). Eelgrass habitat is marked by seasonal and inter-annual variability such that on a fine scale, gains and losses of eelgrass habitat occur throughout the Bay, and it is appropriate to consider the distribution of eelgrass in a more probabilistic sense (Merkel & Associates 2000). Thus, various portions of the Bay have a higher or lower probability of supporting eelgrass habitat at any given time. When evaluating the eelgrass frequency results (Figure 7), it is evident that some areas within the Bay had highly consistent presence of eelgrass, while other areas supported eelgrass only during one or two of the survey years.

From a resource management standpoint, it is appropriate to consider that areas that lack eelgrass during a particular survey period may support eelgrass at other times. Further, it is also reasonable to also acknowledge that not all eelgrass beds provide the same consistency in habitat values through time. As such, planning efforts should consider both spatial and temporal characteristics of the resource when evaluating benefits or detriments that may occur as a result of land-use and habitat management decisions. Substantially more complicated is the need to consider effects of actions taken away from eelgrass beds on parameters that influence eelgrass habitat development or sustainability. These may include alterations to circulation patterns from such actions as new channel configurations or expansion or construction of large breakwaters and marinas that may change circulation conditions. Other factors such as nutrient and sediment loading of the Bay from watershed inputs may also have widespread and varying influences on eelgrass.

The ability of eelgrass to weather short-term stressful environmental conditions has been demonstrated on a number of occasions through natural and experimental restriction of resource availability. However, prolonged stresses such as consistent light limitation will result in a decline in eelgrass habitat. Within most sub-tropical and temperate environments, desiccation stresses limit

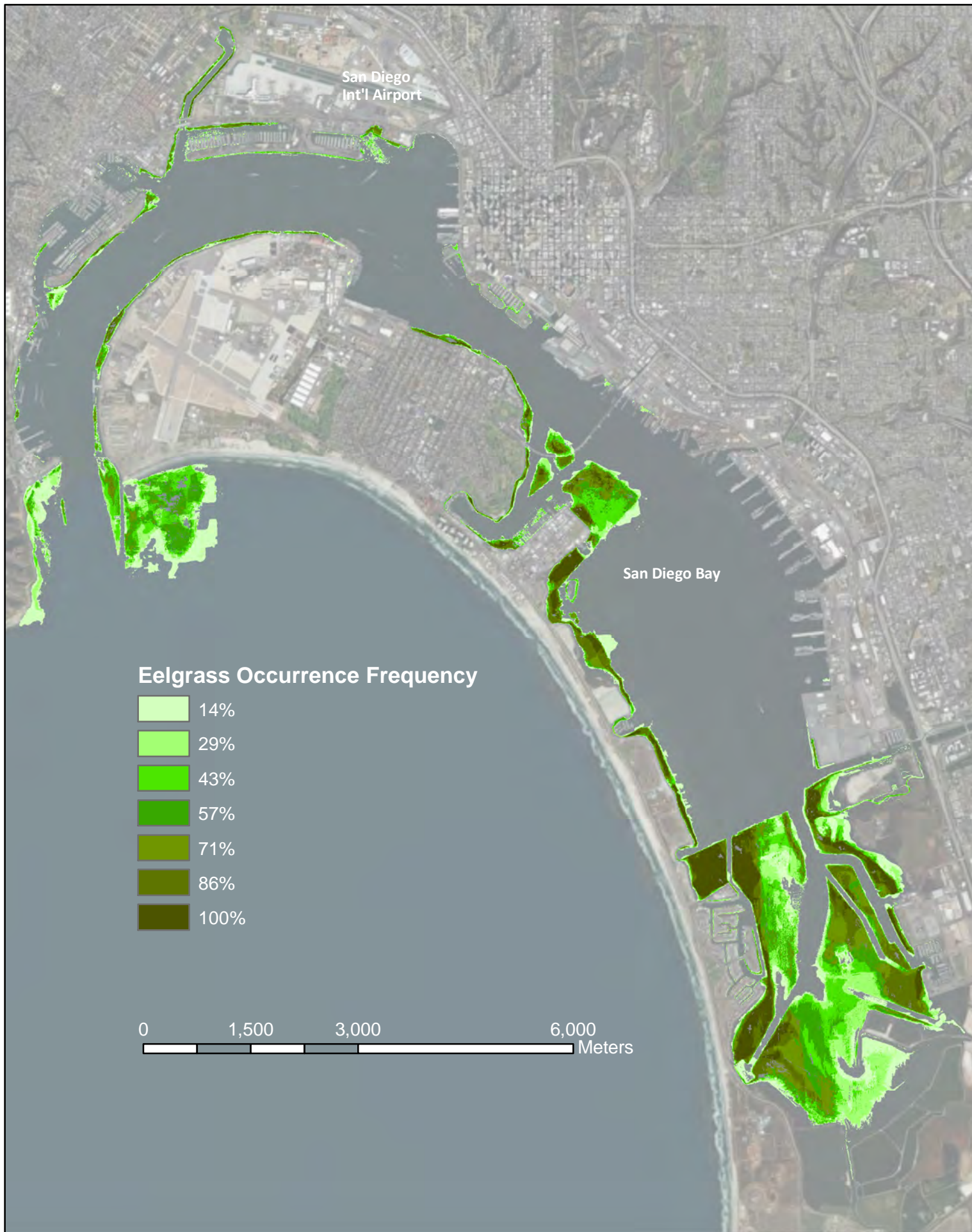


Figure 7. Eelgrass occurrence frequency for the baywide eelgrass survey years 1993, 1999, 2004, 2008, 2011, 2014, and 2017

the upper edge of eelgrass growth, and light requirements needed to balance respiration and fuel metabolism (photo-compensation depth) set the lower limits of eelgrass growth in soft-bottom bays. This trend holds true in San Diego Bay; and as a result, a distinct topographic, but seasonably variable boundary typically defines the upper limit for eelgrass between 0.0 and +1.0 feet MLLW. A less distinct lower limit is defined by differences in depth and light penetration. The recent addition of potential biologically limiting factors on bed distributions creates a new complication to the standard model for eelgrass distribution patterns in San Diego Bay.

The differing survey methods used prior to 1993 prevent in-depth comparisons of longer-term trends in San Diego Bay eelgrass abundance. However, on a decadal scale, eelgrass does appear to have historically expanded in its range in the Bay when compared to the best estimates that can be made from prior historic surveys and ancillary historic photographs and data. Eelgrass expansion within the Bay is likely the result of improved water quality and restoration efforts. Raw-sewage and industrial-waste discharges into the Bay have been significantly reduced since the 1970s (SDUPD 1990, USFWS 1998). The improved water quality has resulted in lower total particulate matter that would otherwise decrease light availability for eelgrass. Additionally, stresses related to nutrient enrichment leading to plankton and macroalgal blooms have declined with reductions in waste discharges.

The long-term monitoring program for eelgrass in San Diego Bay has begun to provide a view of eelgrass not as snapshots in time, but rather as a persistent, however, dynamic resource. To make full use of this monitoring program as a tool in assessing environmental trends, it is critical that it be continued into the future. In addition to the full bay surveys that are conducted on an approximately 3-5 year cycle, the Navy and Port also complete more frequent semiannual surveys of indicator transects. These higher frequency surveys provide beneficial estimators of depth distribution and extent of bottom cover within various regions of the bay.

In order to optimize the value of these surveys as a supplement to the less frequent full-bay surveys, the transect monitoring and methodology should be coupled with defined bay segments that can be used to estimate eelgrass changes during intervening years. Ideally, the transect surveys would integrate a spatial survey methodology (i.e., sidescan sonar) that would allow development of estimators of overall eelgrass presence and eelgrass extent by bay segment during intervening years between comprehensive baywide surveys. Such a program has been modeled after a similar effort that has been developed and tested for two years in San Francisco Bay and which has now been applied for management purposes in the past several years (Merkel & Associates 2008b, 2011b, 2013, 2018).

A similar regional monitoring developed for the Southern California Bight using the same methodology would provide an ideal structure for such a monitoring program (Bernstein et al 2011). In these programs, swath survey transects are distributed to provide a highly accurate estimate of baywide eelgrass changes using discrete repeated sampling of established transects. The results of the transect sampling are then scaled to benchmark years so that the discrete spatial distribution of eelgrass as well as the overall coverage may be analyzed through time. Given the knowledge of eelgrass distribution in San Diego Bay, implementation of such a monitoring program would be relatively straight forward and of high benefit in understanding interannual bed dynamics.

A pilot investigation of this type of monitoring was undertaken in San Diego Bay, among several other systems in southern California, in 2016 by NOAA NMFS in support of the development of a

southern California eelgrass monitoring program (Merkel & Associates 2017). The 2016 monitoring conducted by NMFS in San Diego Bay estimated 1,847.74 acres of eelgrass existed in 2016, while the present 2017 survey revealed 9 percent less eelgrass presence. In reviewing the data from the two surveys, it is believed this decline observed between years was real and not an artifact of the subsampling methodologies. Declines in eelgrass that have been most dramatic between 2016 and 2017 occurred in the far south bay with large portions of the shallow flats south and west of the Chula Vista Wildlife Reserve declining in eelgrass extent.

Recent warming patterns that increased bay water temperatures in 2015 and 2016 have subsided. While the present 2017 survey reveals a reduction in eelgrass from the prior surveys, it is believed that eelgrass was already in a state of rebound during the most recent survey. However, the lowest dip in eelgrass was likely missed by survey intervals. The center core of the south bay has always been an area of great variability with respect to eelgrass occurrence. This area is also the area where greatest expansion or contraction of eelgrass can occur within San Diego Bay. During the 2017 season, eelgrass expansion opportunity within this area was seen as high, given the substantial bare bottom and the widely scattered first year eelgrass plants spread across a broad depth range. This pattern is typical of early stages of eelgrass expansion by seedling recruitment. For this reason, it is expected that eelgrass will again expand substantially in San Diego Bay, barring any substantial climatic anomalies in ocean elevation, temperature, or major wet weather patterns.

#### **USE OF THESE EELGRASS MAPS**

To facilitate easy reference of the present survey data as well as prior survey information and frequency data, multiple large format maps have been prepared and provided digitally to the Navy and Port. Reduced versions of these maps have been included in Appendix A-1 to A-3 to this report. In addition, digital data from the 2017 eelgrass survey has also been delivered in an ESRI ArcGIS shapefile format.

Because of the level of error inherent in regional mapping, these data should only be used as a general measure of the health of the system over time and as a planning tool. Eelgrass data reflect a particular period in time and are anticipated to be seasonally and stochastically dynamic. Information cannot be extrapolated for impact assessment purposes or site specific uses. While maps are generally accurate with respect to location of eelgrass, it is clear that eelgrass within San Diego Bay is dynamic. For this reason, it is essential that these maps not be over applied to situations for which they are not suited.

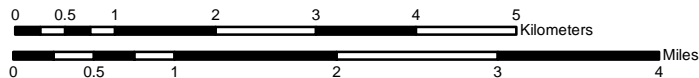
Eelgrass maps and bathymetric data are for planning and resource management purposes only and are not to be used for project specific analyses or navigation purposes. The authors make no representation regarding the accuracy of these maps for navigation applications.

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**APPENDIX A-1. EELGRASS DISTRUCTION 2017**

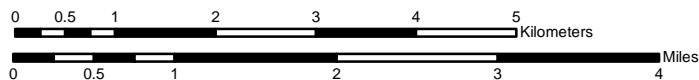
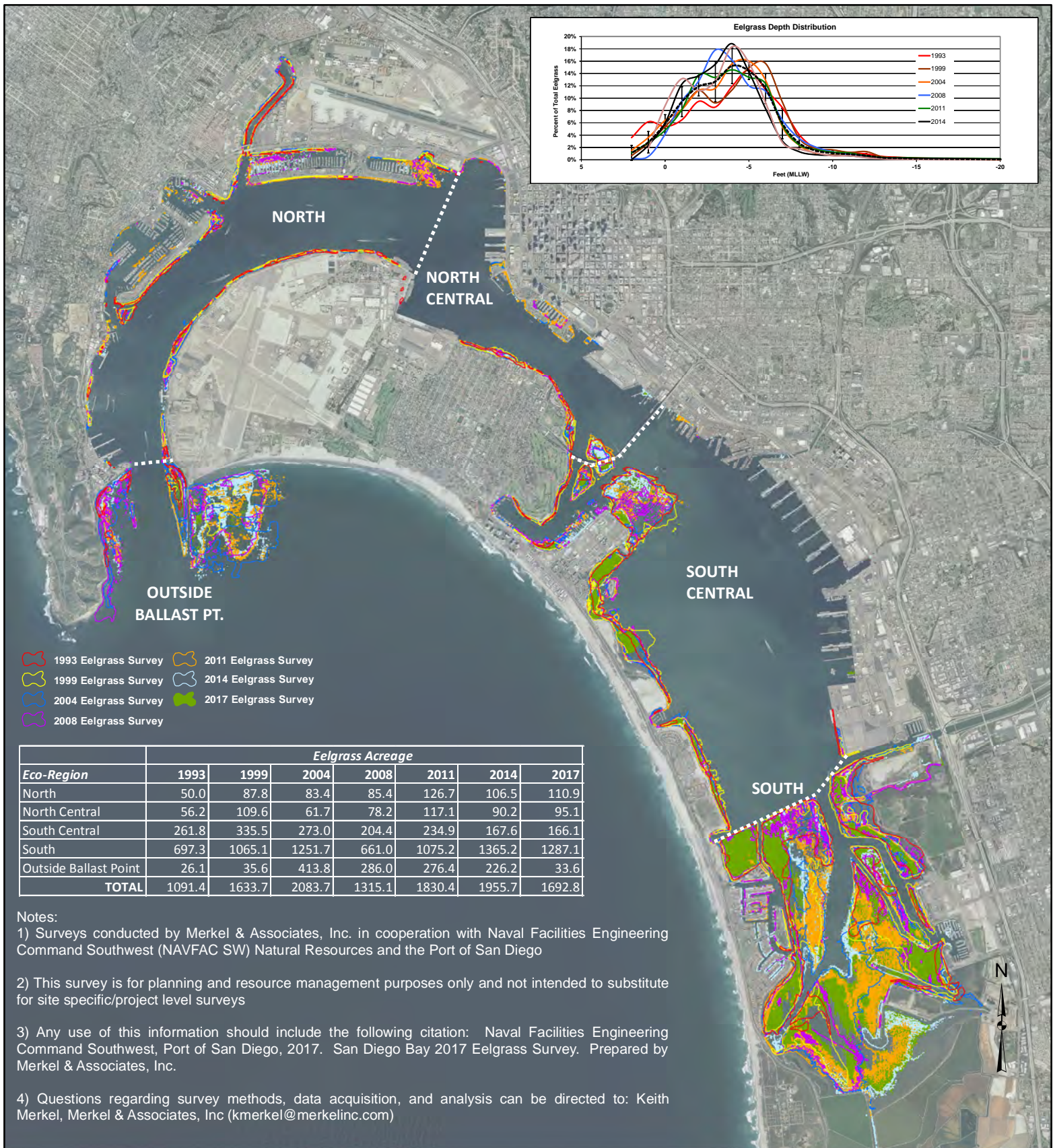


# SAN DIEGO BAY

2017 EELGRASS SURVEY



**APPENDIX A-2. EELGRASS DISTRIBUTION 1993-2017**

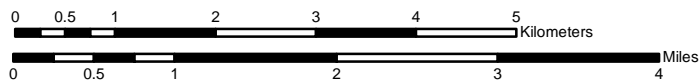
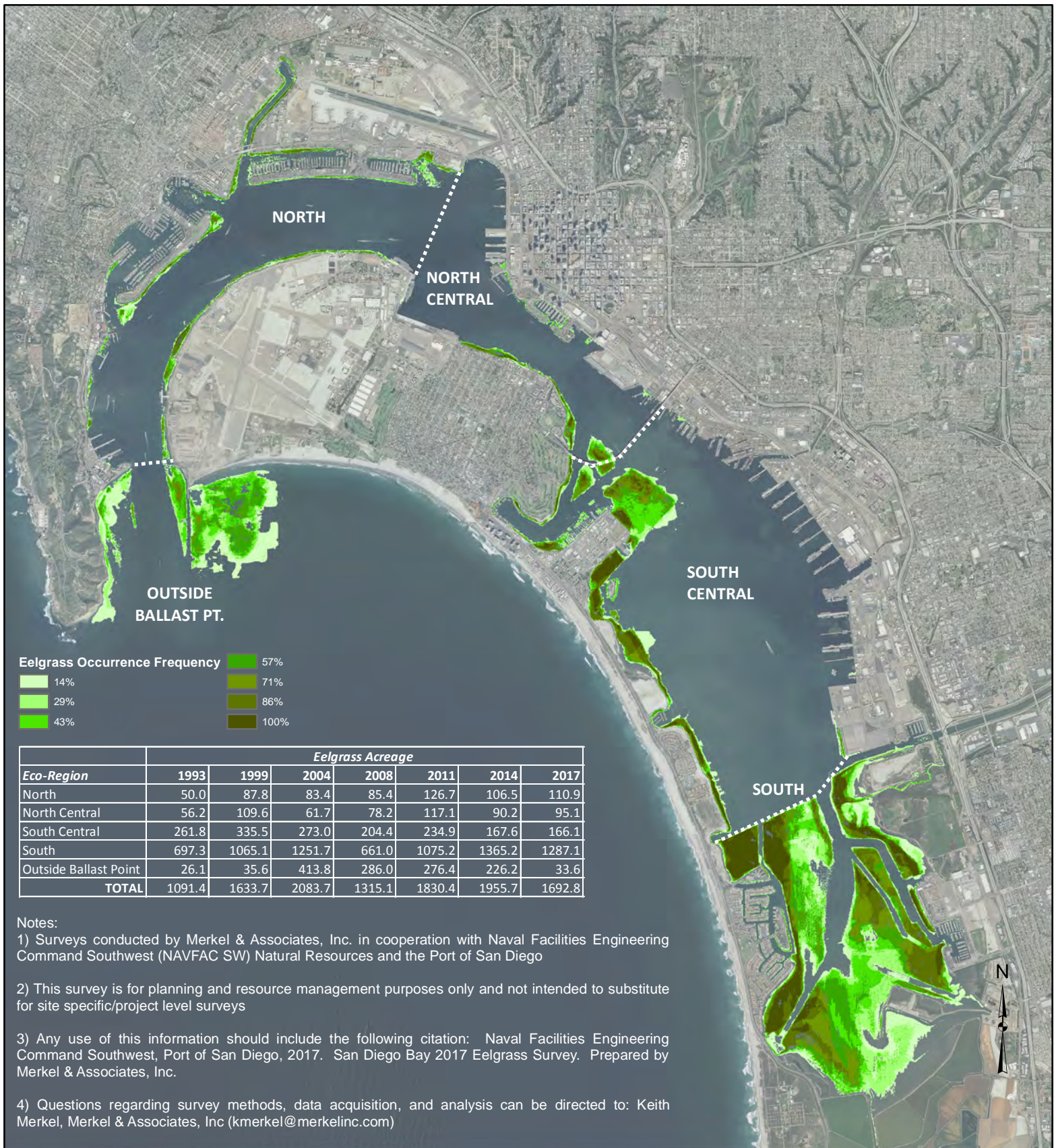


# SAN DIEGO BAY

## 2017 EELGRASS SURVEY



**APPENDIX A-3. EELGRASS FREQUENCY 1993-2017**



# SAN DIEGO BAY

2017 EELGRASS SURVEY

