Upper Newport Bay Ecosystem Restoration Project Post-Restoration Bathymetric Monitoring

Year 5 - 2015

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INTRODUCTION

This report summarizes the results of the 2015 (Year 5) bathymetric monitoring for Upper Newport Bay located in Newport Beach, California (Figure 1). Bathymetric monitoring is critical to ensuring that the Upper Newport Bay ecosystem is maintained in a manner that protects beneficial uses associated with wetlands and wildlife. The United States Army Corps of Engineers (ACOE) developed a monitoring program for the restoration project following completion of construction in 2010 (ACOE 2010). The monitoring program specified that post-restoration bathymetric monitoring be performed in monitoring years 1, 2, 3, 5, and 8. The Year 8 monitoring was subsequently changed to Year 10 as part of the adaptive management process. The monitoring for years 1-3 occurred in January 2011, 2012, and 2013. The current bathymetric monitoring event represents the Year 5 monitoring.

METHODS

Data Collection

The 2015 bathymetric data were collected by Marine Taxonomic Services, Ltd. staff (MTS) between June 24 and June 28, 2015. The survey team used a Teledyne Odom MB1 multibeam echosounder to collect depth data along a 120 degree swath beneath the survey vessel. The depth data were adjusted for speed of sound through water and ship motion. Speed of sound was used to adjust depth data in real time with a Teledyne Odom Digibar V. Speed of sound data were also collected in the field with a Teledyne Odom Digibar S to develop water column speed of sound profiles that were applied during post-processing to improve data quality. The effects of ship motion (roll, pitch, and heave) were corrected in real time with an integrated SMC IMU-108. Survey positioning was provided by an integrated Hemisphere GPS VS101. Patch testing was performed prior to the start of the survey so that minor adjustments could be made to offsets applied to the relative positions of sensors.

Tidal adjustments were provided by establishing two tidal monitoring stations. The stations were located at the Back Bay Science Center and in Unit II Basin. A Solinst Levelogger was used to record the amount of water above the sensor at each station. The sensor elevations and therefore overall project elevation benchmarks were determined relative to U.S. Army Corps of Engineers (ACOE) Survey Markers designated "Shellmaker 2" and "Loren". Shellmaker 2 is on the Back Bay Science Center property; Loren is adjacent to Back Bay Drive near Unit II Basin. The Back Bay Science Center tidal monitoring station was used to provide tidal offsets for all survey data south of 33° 37' 48" N. The Unit II Basin tidal station provided tidal offsets for data collected to the north.

Survey data were collected using a combination of the MB1 image software and HYPACK HYSWEEP multibeam data collection software.

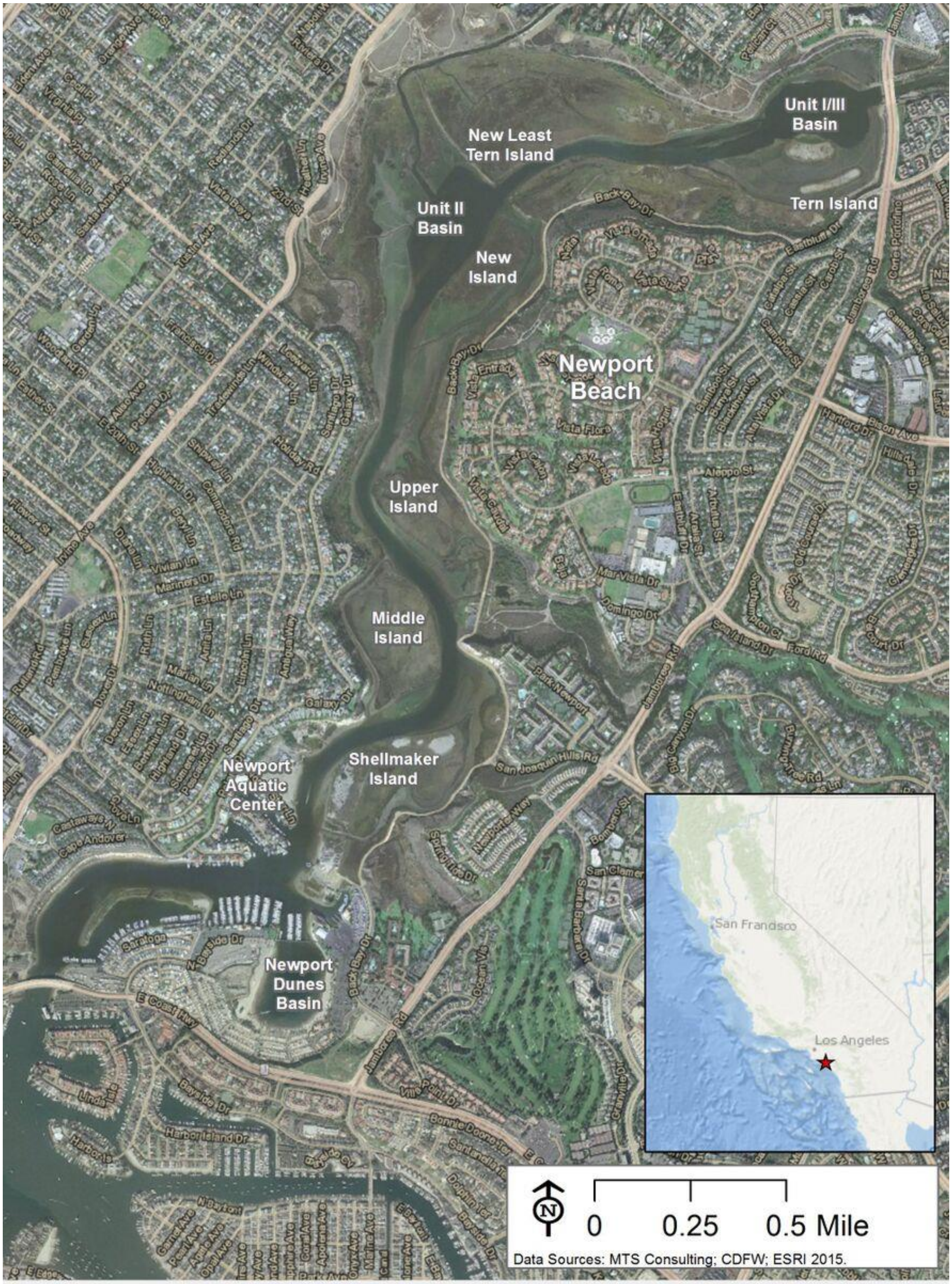

Figure 1. The above figure shows the location of Newport Beach, California (inset) and an aerial view of Upper Newport Bay.

Post Processing

The bathymetric swath data were post-processed using HYPACK HYSWEEP software. Each survey file was corrected for adjustments to sensor offsets as determined from patch test data and loaded into the software for inspection. The survey files were then inspected for errors. Common errors in the data included noise in the water column, such as bubbles from passing vessels and noise at the limits of the MB1 sensor range. Artifacts such as bubbles in the water column were removed by cutting out the bad data using tools in the processing software. Noise at the extents of a given swath was either manually cut from the data using the same techniques applied to the water column or they were filtered using filtering procedures within the software.

Once the data were processed, the files were combined to produce a single XYZ dataset for the survey area. The XYZ data set was created using the Universal Transverse Mercator (UTM) grid system – Zone 11 in meters for the horizontal data with 1-meter grid spacing. The depth values were expressed in meters relative to Mean Lower Low Water (MLLW). The depth values were the mean of the points within each 1-meter grid. The extents of the survey area were then digitized in ESRI ArcMap software.

The XYZ data were processed in the triangulated irregular network (TIN) model generator in HYPACK. The triangulated irregular network (TIN) model allowed for minor survey gaps to be filled by using an algorithm that connects the most suitable points into a series of non-overlapping triangles. The connections between points were used to fill survey gaps when there were gaps that exceeded the 1-meter grid spacing.

Following the generation of the TIN model, the model was exported as an XYZ dataset. An unintended consequence of the TIN model generator is that some areas beyond the survey extents become connected. For instance, small islands and other areas inaccessible to the survey vessel become connected by the TIN triangles and depth values are generated outside the survey extents. This was corrected by clipping the exported XYZ dataset by the digitized survey extent in ArcMap.

Map Products

The XYZ data from the 2015 survey were used to generate a surface of the seafloor as well as 1-foot and 2-foot contours relative to MLLW. The contours were created by converting the XYZ depth data from meters to feet and bringing the data back into the TIN model generator in HYPACK and then exporting the data as contours. The contour files were exported as DXF files and were provided electronically to the County of Orange. The XYZ data were imported to ArcMap and used to create a surface that uses colors to represent depth.

Comparisons of the Year 3 (2013) data with the current survey (Year 5) were performed by subtracting the 2015 XYZ grid from the 2013 XYZ grid. The 2013 XYZ data were collected by the ACOE. The results of that survey were processed and compared to prior surveys by another contractor (M&A 2014). The County of Orange provided the 2013 survey data to MTS for comparison to the current survey. The received data were XYZ data where the horizontal data were on a 3-foot grid in State Plane (Zone 6, feet). Vertical data were feet relative to MLLW. Prior to performing the analysis, the ACOE data were converted from State Plane to UTM and depth units were converted to meters.

The two data layers were subtracted in the HYPACK TIN model generator. The software uses the minimum extent of the two surveys. In other words, it only performs the analysis where the two surveys overlap. Generally, the current survey had greater coverage than the 2013 survey such that the extents for performing the analysis were the same as the 2013 survey extents. The results of the analysis were exported as a XYZ file where negative values represented grid cells where erosion occurred and positive values represented areas where accretion had occurred between the two surveys. The amount of erosion or accretion was then calculated by HYPACK in cubic meters and converted to cubic yards. All figures were generated by overlaying the data on an aerial view of Upper Newport Bay in ArcMap. All data and presentations were provided in feet and cubic yards to be consistent with prior work.

RESULTS

The Year 5 survey covered approximately 310 acres within Upper Newport Bay. This exceeded the 226 acres covered by the Year 3 survey and meant that coverage was enough to provide a complete comparison of Year 5 relative to Year 3. The Year 5 surveyed depths ranged from intertidal to -22.02-feet MLLW.

The Year 3 and Year 5 survey results look similar in terms of depth when plotted at the same scale (Figure 2). The only notable difference between the two surveys when placed side by side at the same scale is the greater coverage of the Year 5 survey. The Year 5 survey intentionally sought to collect data in shallower water than prior surveys so that the data could better support vegetation and habitat monitoring by providing depths that included as much mudflat habitat as possible. The additional areas surveyed consisted primarily of shallow channels surrounding some of the islands (e.g., Shellmaker Island and Middle Island) and the main channel banks.

Comparison of the Year 3 and Year 5 datasets shows where material was eroded and accreted (Figure 3). The southern portion of the survey area between the Pacific Coast Highway Bridge and the Newport Dunes resort shows a mixture of accretion and erosion since 2013. The navigation channel as well as cove and marina areas showed minor amounts of accretion while the areas between the shore and navigation channel showed minor amounts of erosion. Moving northward, the channel running through the marsh toward the Unit II Basin showed minor amounts of accretion to the south and a mixture of accretion and erosion before reaching the Unit II Basin. The unit II basin, the Unit I/III Basin and the channel connecting the two basins generally show accretion and are the areas with the most significant accretion.

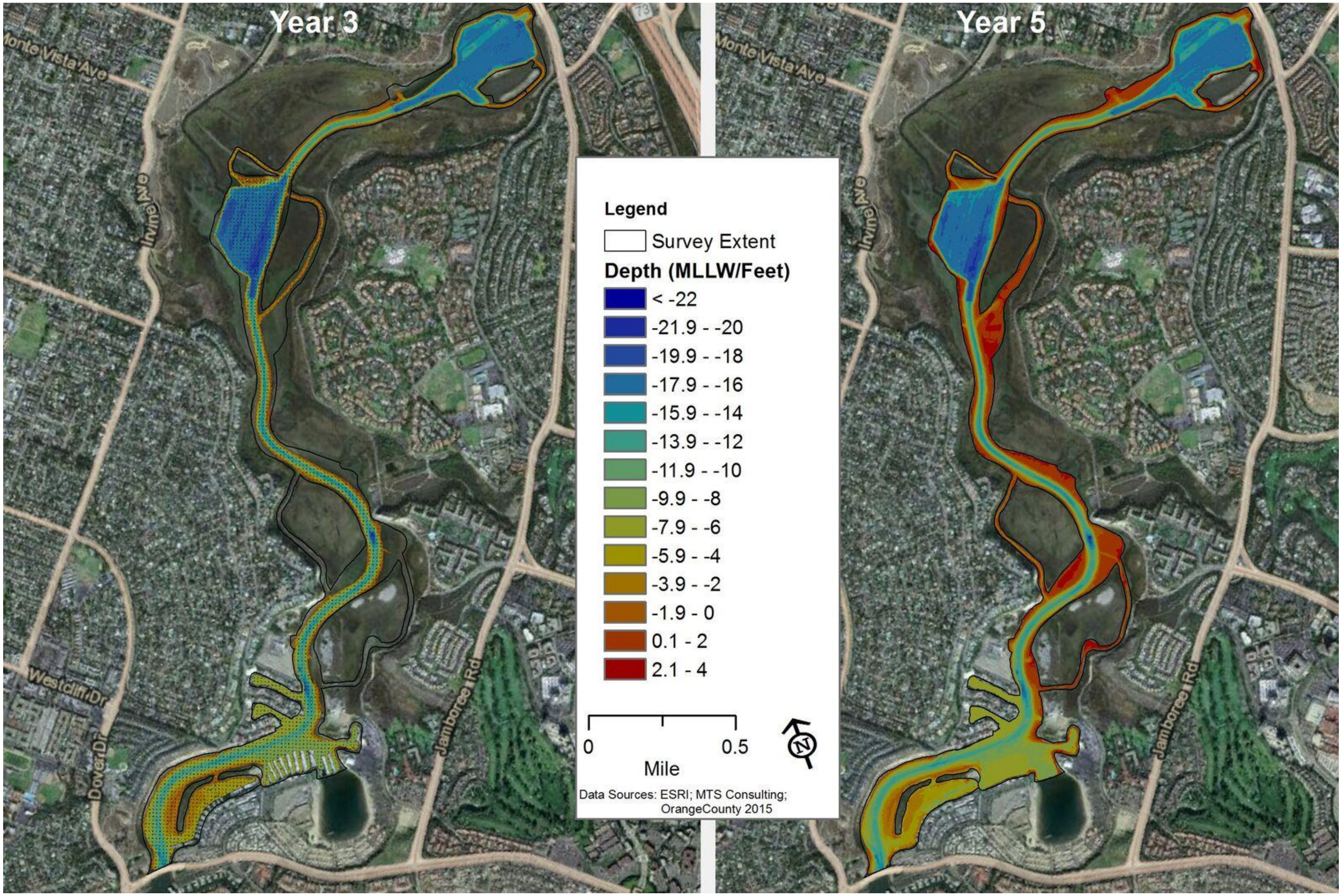

Figure 2. The above figure shows the results of the Year 3 survey (left) and the current Year 5 survey (right). The surveys are plotted using the same color scale relative to feet Mean Lower Low Water. (MLLW).

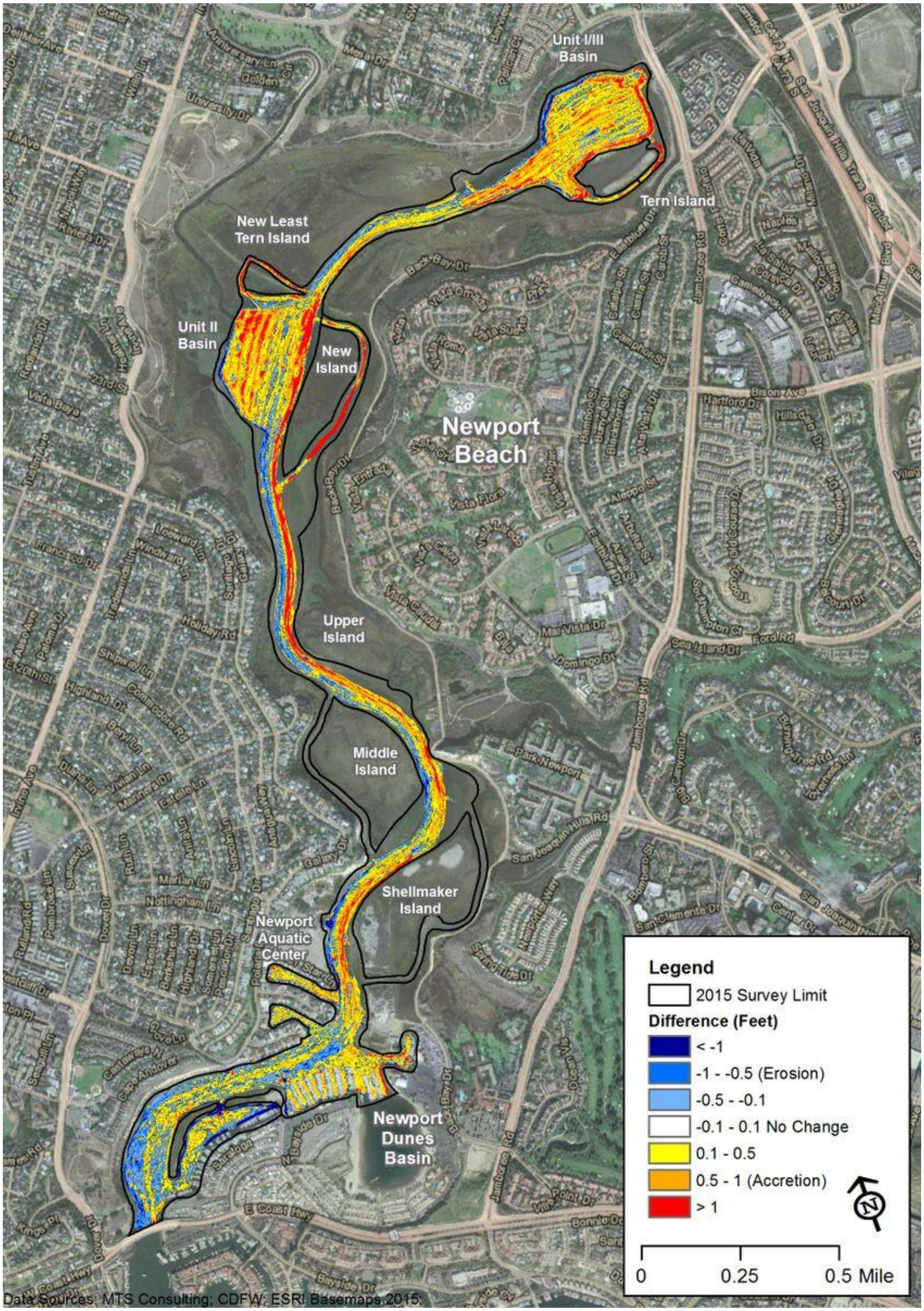

Figure 3. The above figure shows the areas where erosion (blue scale) and accretion (yellow-red scale) have occurred since the Year 3 survey.

The subtraction of the Year 3 sediment surface from the Year 5 surface provided the means to calculate the volumetric change between the two surveys where they overlap (Table 1). Over the entirety of the overlapping survey areas there was a total accretion of 147,419 cubic yards of sediment. The areas where erosion occurred lost 49,358 cubic yards. The net change between the Year 3 and Year 5 surveys was a gain of 98,061 cubic yards of sediment.

Table 1. The below table provides the amount of accretion, erosion, and the net accretion for the entire area where the Year 3 and Year 5 surveys overlap (Upper Newport), the Unit II Basin, and the Unit I/III Basin. Values are in cubic yards.

	Upper Newport	Unit II Basin	Unit I/III Basin
Accretion	147,419	31,243	27,091
Erosion	-49,358	-2,546	-1,653
Net Difference	98,061	28,697	25,438

The Unit I and Unit I/III basins were designed to act as sediment traps for material entering Upper Newport Bay from San Diego Creek. Because of this design feature, sediment accretion and erosion was calculated for the Year 3 and Year 5 surveys for the sediment basins themselves (Table 1). The areas used to perform the calculations are shown in Figure 4 and were drawn to be similar to the areas compared during previous surveys as opposed to covering the total area that could be compared.

The Unit II Basin survey results showed areas with accretion totaled 31,243 cubic yards of sediment. Erosion in Unit II basin totaled 2,546 cubic yards. The net difference in the Unit II basin was an accretion of 28,697 cubic yards. In the Unit I/III Basin areas with accretion totaled 27,091 cubic yards and areas with erosion lost 1,653 cubic yards of sediment. The net change in Unit I/III was the accretion of 25,438 cubic yards of sediment.

The average survey results within the Unit II and Unit I/III basins are consistent with the observation of net accretion of sediment within both basins. The average depth within the Unit II basin was -15.88-feet MLLW during the Year 3 survey and was elevated to -15.06 in the Year 5 survey (Table 2). This represents an average increase of 0.82 feet. In the Unit I/III basin the average depth increased from -15.44 to -14.40-feet MLLW; an average increase of 1.04 feet. The same area was used to calculate the basin statistics in Table 2 as was used to calculate the volumetric changes and is shown in Figure 4.

Table 2. The below table compares the minimum elevation, the maximum elevation, and the mean elevation for the Unit II and Unit I/III basins for the Year 3 and Year 5 surveys. Units are in feet relative to Mean Lower Low Water.

	Unit II Basin			Unit I/III Basin		
Event	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Year 3 (2013)	-21.72	0.68	-15.88	-19.06	0.72	-15.44
Year 5 (2015)	-22.02	1.82	-15.06	-18.78	3.83	-14.40

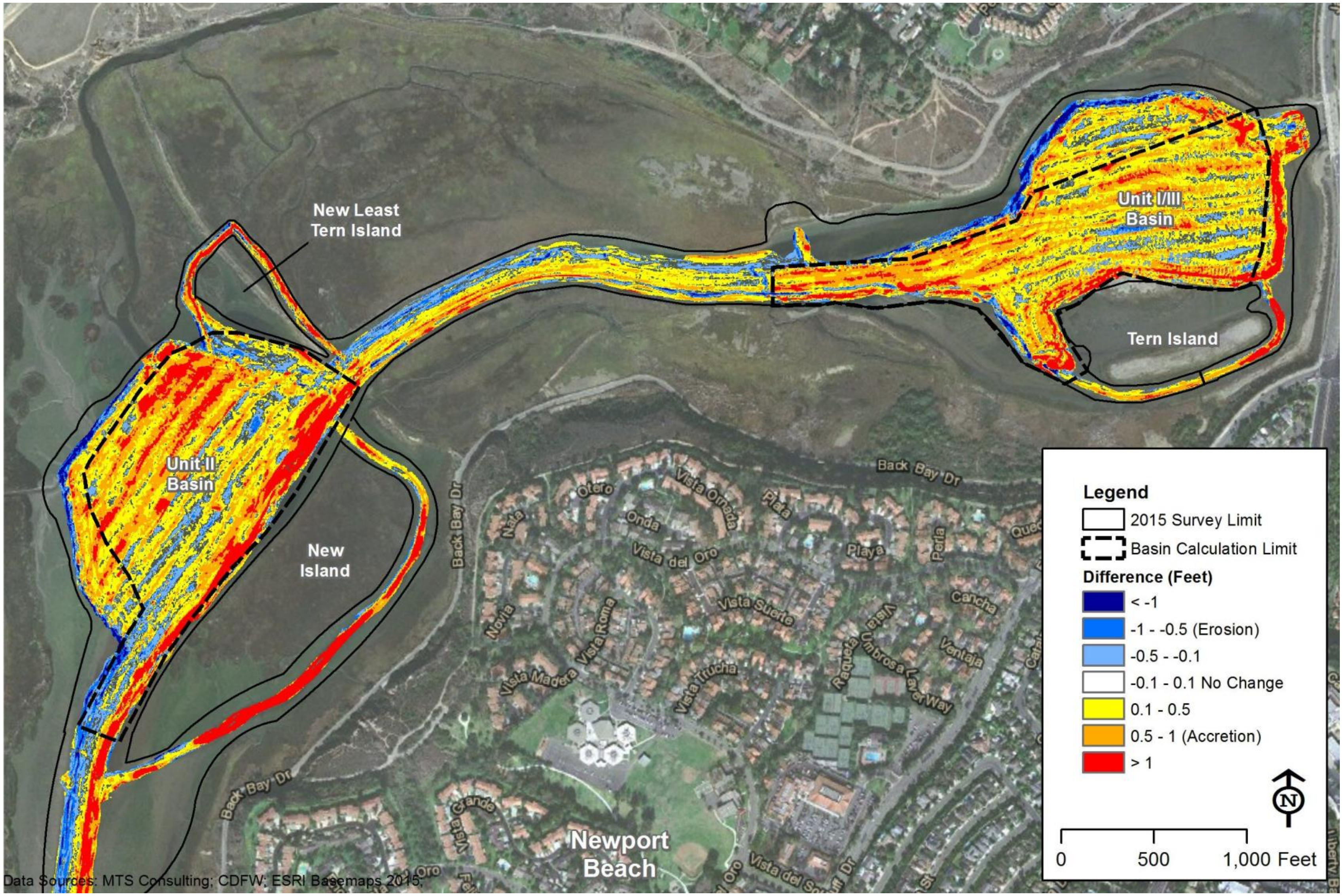

Figure 4. The above figure shows the accretion and erosion detail for the Unit II and Unit I/III basins in Upper Newport Bay.

DISCUSSION

The Upper Newport Bay ecosystem is physically and biologically diverse. The diversity of the system presents some challenges that limit survey results in some areas. For example, the presence of eelgrass on the shoal just north of the Pacific Coast Highway and near the western shore along the navigation channel, presents a challenge for the multibeam sonar used in the Year 5 survey. The sonar returns appear to have mapped eelgrass as seafloor in some cases. During post-processing, some of the eelgrass was cleaned from the record so that the bottom could be more accurately mapped. However, it was not possible to completely remove the eelgrass. For comparative purposes, it is also not known to what extent the Year 3 data may have similar issues. Overall, this is a minor concern in a limited portion of the survey area and has little overall impact on the comparisons of surfaces across surveys.

The physical nature of the channels and banks within Upper Newport Bay provide additional challenges to accurate mapping near shorelines and comparisons of those areas across surveys. The shallow depths of side channels means survey time is limited in those regions by tidal constraints. The shallow depths also limit the amount of data collection per unit time since the swath width of the sonar is narrower in shallow water. This meant a limited amount of data was collected in side channels. One instance where this limitation resulted in data that appear to have a greater amount of error than other areas is the southern portion of the side channel around "New Island". In that area, low survey density in the center of the channel appears to have resulted in the channel appearing shallower than it actually is. This also means portions of the channel appear to have accreted more material than they actually did.

In other areas of Upper Newport Bay, the configuration of channel banks and survey limitations in shallow water result in what often appears to be significant differences near shorelines when comparing the Year 3 and Year 5 surveys. In many cases, the differences may be attributable to survey density and how gaps were filled across the two surveys. For instance, the ACOE data from Year 3 used a combination of singlebeam and multibeam sonar data. If singlebeam was used in the shallow areas, the coverage would be very limited. Any gaps at the top of a channel bank would be interpolated to align with data collected by multibeam in the channels themselves. This would act to cut off the top of the channel bank. Thus, minor differences in data density and how data were interpolated across survey gaps between the two surveys could result in differences across surveys that don't exist. Overall, such differences are confined to the edges of the surveyed areas and have no real implications for assessing the function of the basins to capture sediment.

As mentioned in the Year 3 monitoring report (M&A 2014), simple observation of volumetric change is not adequate to assess the long-term ability of the Unit II and Unit I/III basins to capture sediment. This is because much of the material that enters the basins from San Diego Creek form a soft light mud with large amounts of porewater. As the sediments settle and consolidate, the volume can change even without additional sediment input.

Although there are limitations in assessing the rate of infill, it is obvious from the Year 5 survey results when compared to previous surveys that Upper Newport Bay continues to get shallower as anticipated.

The Unit II Basin received an average of 14,348 cubic yards of sediment per year since the Year 3 survey and became shallower by 0.41 feet per year. The Unit I/III basin had an average accretion of 13,046 cubic yards per year and shallowed by 0.52 feet per year. These changes are slightly higher than what may have been anticipated because the survey was intentionally delayed so that the 2014-15 rain season could be captured in the survey record. Thus, sediment that has entered the system since the last survey (February 2013) includes material generated from the end of the 2012-13 rain season, all of the 2013-14 rain season, and all of the 2014-15 rain season.

Estimating the life span of the basin in terms of their ability to capture sediment is complicated by the fact that rain years vary and therefore the amount of material that enters the system will vary based on the amount of rainfall and the severity of individual rainfall events. However, given the observations of the Year 5 survey and observations of prior surveys, it is reasonable to expect that the basins will meet their 20 year service goal. The fact that the last two years have been relatively dry rain years means little material has entered the system. This means there is capacity in the system to absorb material than may result from more significant rain years in the future.

The Year 3 monitoring report identified a total accretion of 138,010 cubic yards of sediment in Upper Newport Bay between 2011 and 2013. The results of the current survey were similar at 147,419 cubic yards between 2013 and 2015. The small amount of additional material observed during this reporting period may be due to the fact that Year 5 monitoring included more rain months than the prior period (monitoring in June rather than January). Given that restoration design modelling used an average input of 164,000 cubic yards per year (ACOE 2011), it is reasonable to expect that the design goals are currently being met and the system is capable of functioning for 20 or more years per the design projections. Moreover, the elevation changes within the basins are consistent with this assessment. If the basins are getting shallower by approximately 0.5 feet per year, and the material compresses over time, it is reasonable to expect based on current data that the basins will be at or even deeper than -10-feet MLLW after 20 years of service.

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