South San Diego Bay
Coastal Wetland Restoration
and Enhancement Project

Year 2 Postconstruction Monitoring Report

Prepared for:

Southwest Wetlands Interpretive Association
700 Seacoast Drive, Suite 108
Imperial Beach, CA 91932

Prepared by:

Nordby Biological Consulting
5173 Waring Road # 171
San Diego, CA 92120

and

Tijuana River National Estuarine Research Reserve
301 Caspian Way
Imperial Beach, CA 91932

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EXECUTIVE SUMMARY

Western Salt Ponds

The second year of the five-year monitoring program for the South San Diego Bay Restoration Project ("Project") has been completed. The western salt ponds site has met the Project goals and objectives for most physical and biological monitoring parameters, as demonstrated below.

Tidal amplitude within the western salt ponds mirrors that in south San Diego Bay. Similarly, water quality (specific conductivity, salinity, dissolved oxygen, temperature, turbidity, pH, and chlorophyll) within the restored ponds reflects the water quality parameters of south San Diego Bay.

The topography and bathymetry of the site continues to evolve with changes to both the excavated channels and marsh plain. These changes are the result of sediment movement within the western salt ponds associated with restored tidal influence. However, the targeted habitat distributions are expected to develop as anticipated with substantial areas of salt marsh, intertidal mudflat, and intertidal and subtidal habitat. The marsh plain in Pond 10 has consolidated over the last two years and many areas can support the weight of researchers conducting monitoring tasks. Consolidation of sediment deposited in Pond 11 is expected to continue and elevations there are expected to change with time.

Despite initial low survival of planted salt marsh vascular plants, cordgrass continues to expand vegetatively in Pond 10. Based on other low marsh restoration projects in southern California, the surviving plantings are expected to expand exponentially in upcoming growing seasons. In addition, natural recruitment of Pacific pickleweed and Bigelow's pickleweed has occurred in the western salt ponds and is expected to continue in the future.

Year 2 fish monitoring was refined based on the results of the Year 1 surveys. The 1 m beam trawl was discontinued due to low numbers of fish captured in Year 1. Otter trawls conducted at nine stations within Ponds 10 and 11 yielded 13,135 individuals representing 11 species. Slough anchovy (72.5%) and deepbody anchovy (23.7%) accounted for 96.2% of the catch. Round stingray accounted for 3% of the total fishes collected and 72.5% of the total biomass. Minnow traps deployed at 11 sampling sites yielded a total of 262 individual fish representing four species. This was down significantly from last year's total of 642 individuals. The dominant species collected was again longjaw mudsucker with 172 individuals representing 61% of the catch (55% last year). The fish assemblage continues to evolve as the channels and marsh plain in the ponds change in relation to sediment movement and consolidation. The occurrence of round stingray, bat ray and gray smoothhound shark in the restored ponds, as well as the numerically dominant slough and deepbody anchovy, demonstrates a trend toward a fish assemblage that is similar to that in south San Diego Bay. In research studies of the fishes of south San Diego Bay, collections were dominated by slough anchovy, round stingray and shiner perch (Pondella et al. 2009) and slough anchovy and topsmelt (Allen 2006). The number of species and abundance of fish is expected to increase as the sediment in the ponds consolidates and is colonized by invertebrates.

Macrobenthic invertebrate assemblages continue to develop and provide food for migratory shorebirds and fish. Results from small cores (4.8 cm in diameter expressed 2 cm into the sediment) sieved through a 300 micron mesh during preconstruction, 2012 and 2013 demonstrated shifts in the benthic community to one primarily dominated by polychaetes, although there was seasonal and annual variability. Larger cores (10 cm in diameter and 50 cm deep) were dominated by California jackknife clam (43%) and California horn snail (31%).

Avian use of the salt ponds in 2013 was down somewhat relative to 2012 with a high of 35 species compared to a high of 44 species in 2012; however, numbers of individuals were similar. Western sandpiper once again was the numerically dominant species.

Chula Vista Wildlife Reserve

The Chula Vista Wildlife Reserve has met some of the Project goals and objectives, but has fallen short in terms of expectations of tidal amplitude. As in 2012, monitoring of tidal amplitude in 2013 was plagued by equipment failure as pressure sensors were water-logged; however, sufficient data was collected to chart spring and neap tides at three stations within the reserve. These data indicate that moderate to fairly severe truncation of the low tides continued in Year 2, depending on sampling station.

Year 2 monitoring of the Chula Vista Wildlife Reserve revealed water quality that was within expected parameters based on a one-time sampling event. The increase in tidal influence provided by channel excavation is expected to continue to improve water quality relative to south San Diego Bay.

Cover by vascular plants planted from salvaged and nursery grown stock increased in Year 2 and is expected to further increase in Year 3. Vegetation was dominated by Bigelow’s pickleweed which recruited naturally to the site. California horn snail (76%) and California jackknife clam (13%) dominated the benthic invertebrates sampled using large cores (50 cm long, 10 cm diameter core sieved through a 3 mm mesh). Fish collected using minnow traps were dominated by California killifish (94%). Fish collected using enclosure traps were dominated by arrow goby (59%) and fish collected by seine were dominated by California killifish, topsmelt and arrow goby. Fish and invertebrate assemblages are similar to other southern California bays and lagoons and provide food for foraging shorebirds and ground-nesting birds.

1.0 INTRODUCTION

The U.S. Fish and Wildlife Service (USFWS) San Diego National Wildlife Refuge (NWR) Complex and the Port of San Diego (Port) completed construction of the South San Diego Bay Coastal Wetland Restoration and Enhancement Project ("Project") in December 2011. Funding support was provided by the California Coastal Conservancy (Conservancy) and National Oceanic and Atmospheric Administration (NOAA)/National Marine Fisheries Service (NMFS) through the American Recovery and Reinvestment Act of 2009; the USFWS Wildlife and Sport Fish Restoration Program and Coastal Program and National Coastal Wetland Conservation (NCWC) Program; and the U.S. Environmental Protection Agency (EPA). The Project included the restoration and enhancement of approximately 261 acres of coastal wetland habitat within the south end of San Diego Bay, San Diego County, California. The project consisted of restoration activities at two locations: 1) restoration of 230 acres (including 12 acres of upland) of solar salt evaporation ponds 10, 10A and 11 (western salt ponds) located at the southwestern edge of San Diego Bay within the South San Diego Bay Unit of the San Diego Bay NWR; and 2) the 43-acre Chula Vista Wildlife Reserve (CVWR) located to the west of the South Bay Power Plant (Figure 1).

Approximately one year prior to construction of the Project, monitoring of physical and biological parameters was conducted to compile baseline conditions for comparison with those parameters following construction. Postconstruction monitoring was based on a detailed Postconstruction Monitoring Plan. Postconstruction site conditions, e.g., unconsolidated muddy substrate, required modification of some of the proposed monitoring methods. These modifications are described by parameter. This report serves as the second annual postconstruction monitoring report of the Project covering the period of January to December 2013.

1.1 Western Salt Ponds Restoration

The western salt ponds component of the Project restored approximately 218 acres of wetlands by converting former solar salt evaporation ponds into subtidal and intertidal habitats. The conceptual restoration plan, including the proposed distribution of habitats, is presented in Figure 2. Restoration activities included dredging shallow subtidal channels (-2 ft NAVD88) in Ponds 10 and 11 and slurrying the dredged material to Pond 11 to raise its elevation from primarily subtidal to intertidal elevations. The dredged material was deposited into Pond 11 instead of Pond 10 because the pre-project elevation of Pond 10 was within the range of intertidal salt marsh at approximately +4 ft NAVD88. Overall, a total of approximately 140,000 cubic yards of material was dredged with about 120,000 cubic yards excavated in Pond 10 and an additional 20,000 cubic yards in Pond 11. Approximately 102 acres of low marsh was restored in Ponds 10 and 11 within the elevation range suitable for supporting California cordgrass (*Spartina foliosa*). Approximately 39 acres of subtidal habitat were dredged in Ponds 10 and 11. Dredging created major tidal creeks with the intention that second and third-order creeks would develop naturally through tidal action.

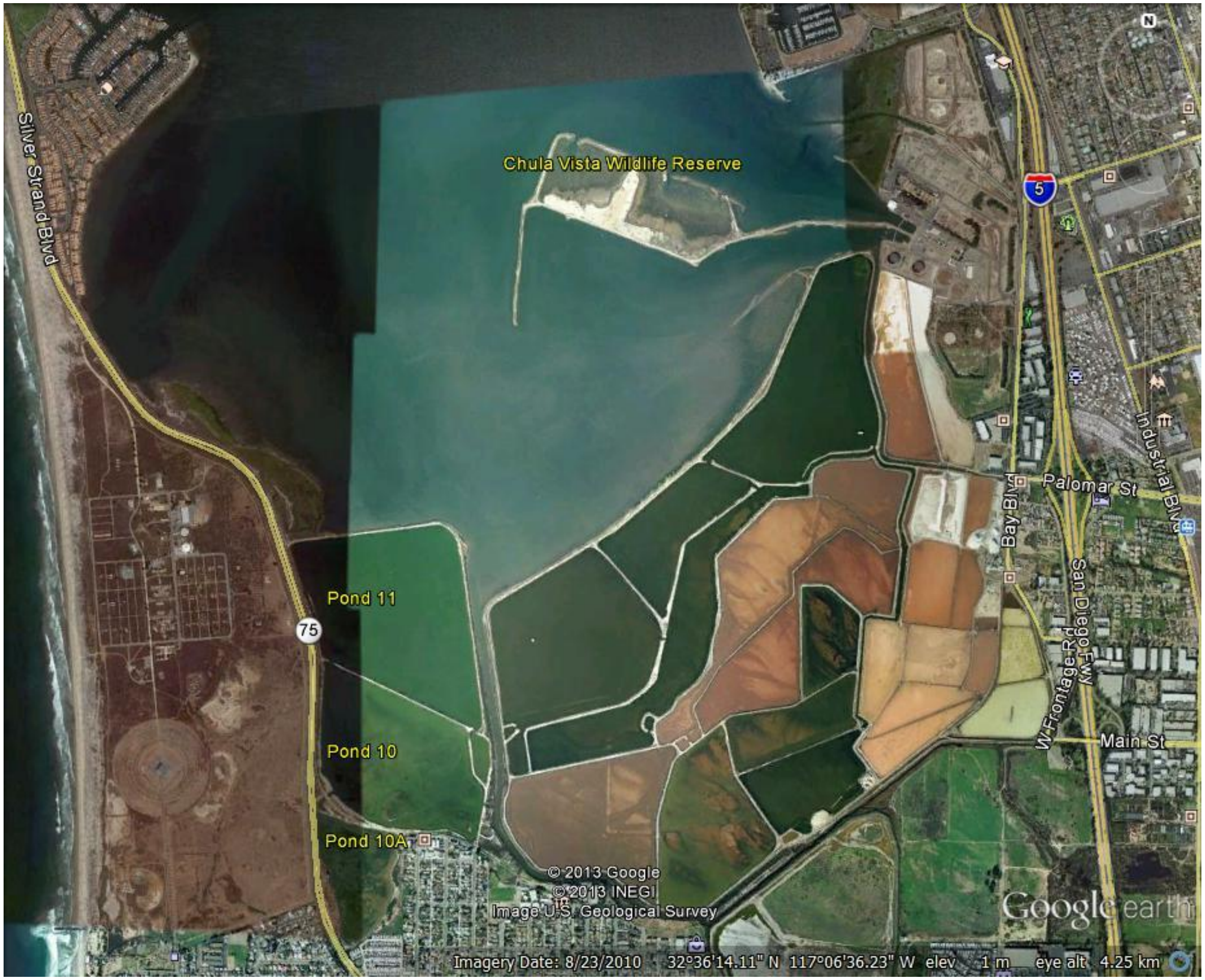


Figure 1. South San Diego Bay Coastal Wetland Restoration and Enhancement Project Locations

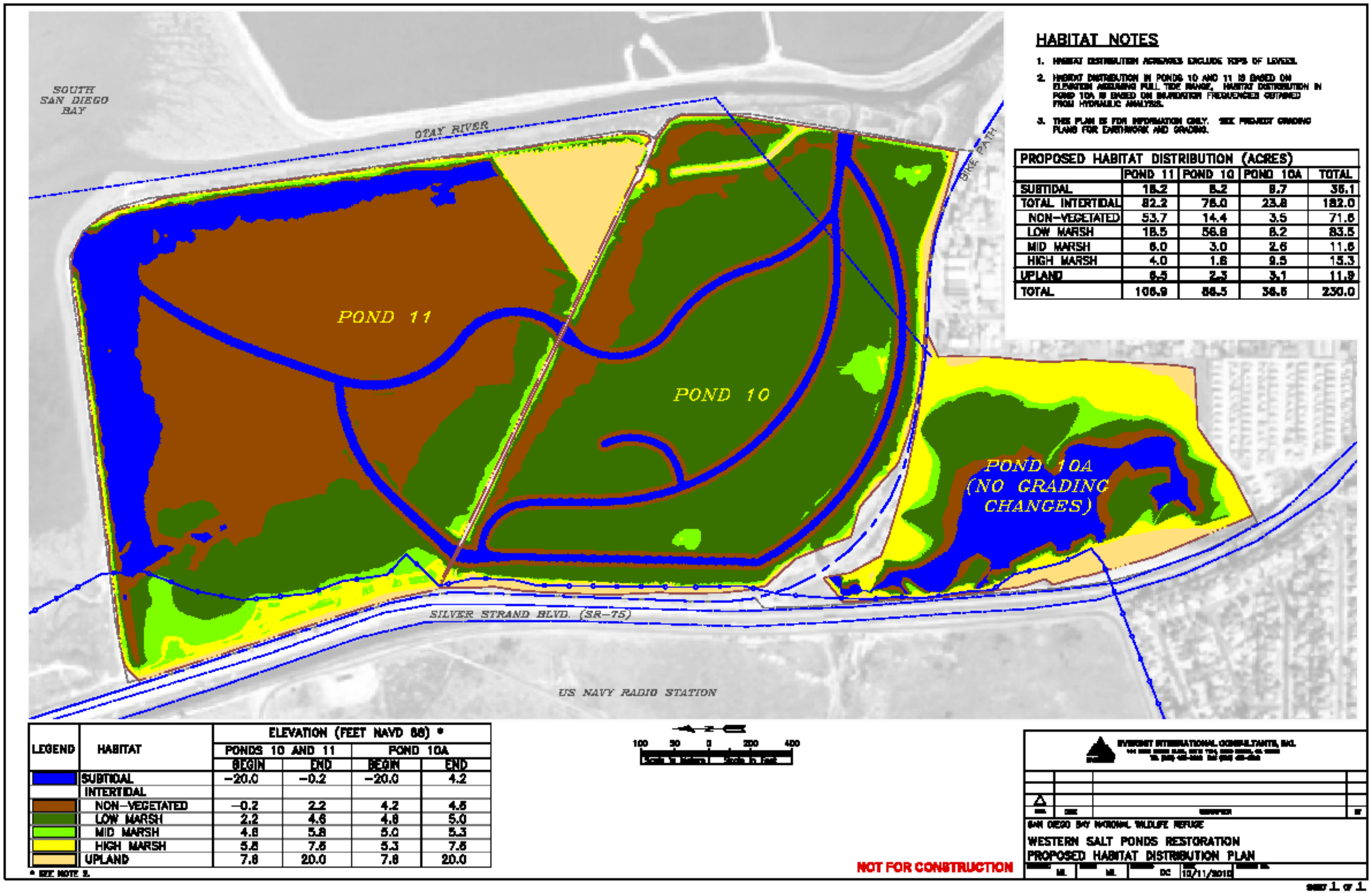


Figure 2. Proposed Habitats Western Salt Ponds.

The remaining 77 acres of restoration was comprised of unvegetated flats and mid- and high-marsh habitat. No dredging or deposition occurred in Pond 10A which was restored to tidal influence thereby enhancing approximately 33 acres of former salt evaporation pond. Following the completion of the dredging operation within the salt ponds, the outer levees were breached to allow for tidal circulation and approximately 40 acres of low marsh habitat were planted with cordgrass and 4.8 acres of mid-high salt marsh were planted with a mosaic of species. The portions of the levees not affected by breaching were retained to provide roosting habitat for various avian species. An additional 67,000 cubic yards of material from the CVWR was slurried across San Diego Bay and deposited in the southeast corner of Pond 11 to create a nesting area with high-quality sandy material. A detailed account of the design of the western salt ponds is provided in the Basis of Design Report (Everest International Consultants, 2011).

Prior to beginning construction, a preconstruction monitoring program was implemented from January 2010 to September 2010. Monitoring of fish during the period revealed low diversity and abundance within the salt ponds. Low diversity of benthic invertebrates was also observed. Bird surveys were dominated by shorebirds (dowitcher sp., western sandpiper, willet and marbled godwit) in spring and early summer and by elegant tern and western sandpiper in late summer. Brown pelican and scaup sp. were also occasionally abundant. Preconstruction water quality data confirmed that the ponds were highly saline with static water temperature.

Postconstruction monitoring of the western salt ponds was initiated in January 2012 and will continue through 2016. Postconstruction monitoring includes both physical and biological components. Physical parameters monitored include tidal amplitude, bathymetry, topography, water quality and soils. Biological parameters include vascular plants, fish, benthic invertebrates and birds. Methodologies employed are presented by parameter below.

1.1.1 Goals and Objectives of the Western Salt Ponds Restoration

Two funding sources for the Project, the NCWC and NOAA grants, identified several objectives and metrics that will be assessed through the long-term monitoring program.

The overarching objectives for the NCWC grant were:

- Complete the permitting, final design, and site preparation, including all excavation, clean-up, and grading, necessary to restore and enhance 160 acres of coastal wetland and upland habitat in south San Diego Bay by March 1, 2011.

- By the end of 2016 achieve approximately 89 acres of functional estuarine intertidal emergent wetlands, approximately 41 acres of estuarine intertidal non-vegetated wetlands, approximately 28 acres of estuarine subtidal wetlands, and 10 acres of palustrine scrub-shrub vegetation.

However, these objectives also included acreage for the Emory Cove restoration site, which was not part of the NOAA grant and was not part of this monitoring program. The Emory Cove monitoring will be completed by the Port of San Diego and will be reported separately.

For the western salt ponds, the NCWC objectives were:

- By March 2013, achieve successful recruitment of benthic invertebrates and fish within Pond 11 to support migratory shorebirds and foraging ground-nesting seabirds.

- By March 1, 2011 complete the dredging and filling activities required to achieve elevations within Pond 11 that will support a mix of shallow subtidal, intertidal mudflat, cordgrass-dominated salt marsh, and pickleweed-dominated salt marsh habitats (estuarine intertidal emergent, non-vegetated, and subtidal wetlands) and breach the pond levee to restore tidal influence to the 106-acre pond.

- By the end of 2016, achieve 50 percent coverage of cordgrass (*Spartina foliosa*), with at least 25 percent of the plants in excess of 60 centimeters (cm) in height, over approximately 30 acres within the tidally restored pond.

- Between March 2011 and February 2012, monitor and record through monthly visual surveys, the recruitment of vegetation and benthic invertebrates, bird use, and any changes in bathymetry within the pond. Based on these observations, develop recommendations for how the design of future phases of salt pond restoration in San Diego Bay could be adjusted to more effectively achieve restoration objectives.

In addition, the following metrics were determined in conjunction with NOAA based on the draft Postconstruction Monitoring Plan for the western salt ponds:

- Restore wetland elevations and channel bathymetry in Ponds 10 and 11 to within plus or minus 10% of the design plan by June 2011;
- Restore tidal amplitude in Ponds 10 and 11 to approximately equal the tidal amplitude in the Otay River; restore tidal amplitude in Pond 10A to a slightly muted amplitude relative to the Otay River by 2012;
- Achieve 50% vegetation cover by wetland vascular plants in at least 30 acres of Pond 10 by June 2016;
- Demonstrate presence of one or more of the target species (flatfish and elasmobranchs) by 2013.

Postconstruction monitoring was conducted in order to demonstrate progress made toward achievement of these goals. Although postconstruction monitoring is planned through 2016, monitoring will extend far beyond the grant period(s) in order to understand the benefits of the project to the entire San Diego Bay ecosystem and to the South San Diego Bay Unit of the San Diego Bay National Wildlife Refuge.

1.2 Chula Vista Wildlife Reserve Restoration and Enhancement

Prior to restoration, the CVWR consisted of two shallow basins divided by a higher fill area managed for seabird nesting. The site suffered from poor tidal circulation, which impeded overall habitat quality within the basins. In addition, the high salinity levels occurring at higher tidal elevations impacted vegetation growth, resulting in the lack of vegetation in some areas and poor habitat quality in other areas.

Restoration of the CVWR was initiated on September 20, 2010 and completed on February 15, 2011, according to specifications. Approximately 11 acres of intertidal habitat were restored in the basins by excavating approximately 67,000 cubic yards of material and approximately 32 acres of wetland were enhanced by improving tidal circulation. The sediment that was dredged from the CVWR was pumped to the salt ponds to create a bird nesting area. The 11 acres of salt marsh habitat restored by the Project were planted by volunteer workers from the San Diego Audubon Society.

No site-specific preconstruction monitoring was conducted for the CVWR component of the Project. Postconstruction monitoring was initiated in April 2011 and includes monitoring of vegetation, water quality, fish and benthic invertebrates.

1.2.1 Goals and Objectives of the Chula Vista Wildlife Reserve

For the CVWR, the NCWC objectives were:

- By March 2013, achieve successful recruitment of benthic invertebrates and fish within the western basin of the Chula Vista Wildlife Reserve to support migratory shorebirds and foraging ground-nesting seabirds.

- By March 1, 2011, lower approximately 3 acres within the western basin of the Chula Vista Wildlife Reserve to achieve a typical marsh plain elevation of +4.5 feet Mean Lower Low Water (MLLW) (an elevation appropriate for supporting estuarine intertidal emergent wetlands) and expand the existing tidal channel by removing 3,000 cubic yards of sediment to create deeper, more well defined tidal creeks within the western basin, thus enhancing the remaining wetland habitat.

- By the end of 2016, achieve 50 percent coverage of cordgrass and pickleweed over the 3-acre excavation area and improve vigor and plant diversity throughout the remaining 16 acres of estuarine intertidal emergent wetlands within the basin.

At CVWR, the NOAA metrics were:

- Restore wetland elevations and channel bathymetry in the restored basin to within plus or minus 10% of the design plan by June 2011;
- Restore tidal amplitude to approximately equal the tidal amplitude in San Diego Bay by 2011;
- By 2016, restore typical marsh vegetation coverage, using marsh coverage at Tijuana Estuary as a target;
- Demonstrate presence of one or more of the target taxa (gobiidae and topsmelt) by 2013.

2.0 PHYSICAL PROCESSES

2.1 Topography/Bathymetry of Western Salt Ponds

Monitoring of the topography/bathymetry of the western salt ponds was a critical element in project design, during construction and during postconstruction. Elevations of the levees that separate the western salt ponds from San Diego Bay and from each other and the bathymetry of the ponds were assessed prior to construction to determine postconstruction habitat distributions and cut-and-fill volumes. During construction, the bathymetry of the ponds was measured frequently to determine achievement of target elevations and as a method of payment for the contractor. Postconstruction monitoring focused on the topography of the marsh plain and the bathymetry of the constructed channels.

2.1.1 Methods – Monitoring of Topography/Bathymetry of Western Salt Ponds

The preconstruction topography of the western salt ponds was assessed using existing topographic data generated by Ducks Unlimited, Inc. for the USFWS in 2000 as spot-checked by Psomas Engineering using conventional stadia rod and level methods tied to existing benchmarks in 2010. It was determined that the existing topographic data was accurate for project planning and those data were incorporated into the project plans. Preconstruction, the levees around the perimeter of ponds 10 and 11 and the internal levee between ponds 10 and 11 ranged from approximately +8 ft to +10 ft NAVD88 (Everest International Consultants 2011). During project planning, it was determined that both the internal and perimeter levees would be allowed to erode after tidal influence was restored to the ponds**.** Thus, postconstruction monitoring was focused on the elevations of the marsh plain and channels and not specifically focused on the levees that were breached during construction.

Year 1 postconstruction monitoring plan methodology for topography and bathymetry relied largely on determining elevations across a number of transects. The monitoring plan called for transects to be walked with elevations recorded using conventional surveying equipment, e.g., stadia rod and level. The muddy site conditions required modification of this plan and Real Time Kinematic (RTK) GPS were used to acquire elevations, latitude and longitude from a kayak or canoe. These data were supplemented by interpreting elevations from aerial photographs performed by San-Lo Aerial Surveys using photographs taken in October 2011.

Surface elevations of all areas exposed at low tide in Pond 10 and approximately 50% of Pond 11 were determined by using stereoscopic aerial photographs taken immediately at the end of construction on October 26, 2011. Three separate photographic frames were taken at that time and it was determined that enough overlap between frames existed to use photogrammetric methods to extract elevation data for much of the restoration site. No ground control points were used as vertical and horizontal controls for this analysis.

During Year 2 monitoring, aerial imagery was again employed to determine site topography. False color aerial imagery of all three ponds was taken using a Red (R), Green (G), Blue (B) and Near Infrared (NIR) model UltraCam-X by Vexcel digital camera (Figure 3). This imagery was then converted to open water, vegetated areas and bare ground using Normalized Difference

Vegetation Index (NDVI). Vegetated areas include both salt marsh vascular plants and algae. Work continues on refining the vegetation category to differentiate between algae and vascular plants.

An orthophotograph of the western ponds was generated from the R, G, B, NIR digital image and elevation contours were generated in digital computer aided design (CAD) format and mosaiced georeferenced digital imagery within the extents of the overlapping aerial photographs (Figure 4). The resulting CAD file containing elevation contour data was converted to ArcGIS format for further processing and analysis.

2.1.2 Results - Monitoring of Topography/Bathymetry of Western Salt Ponds

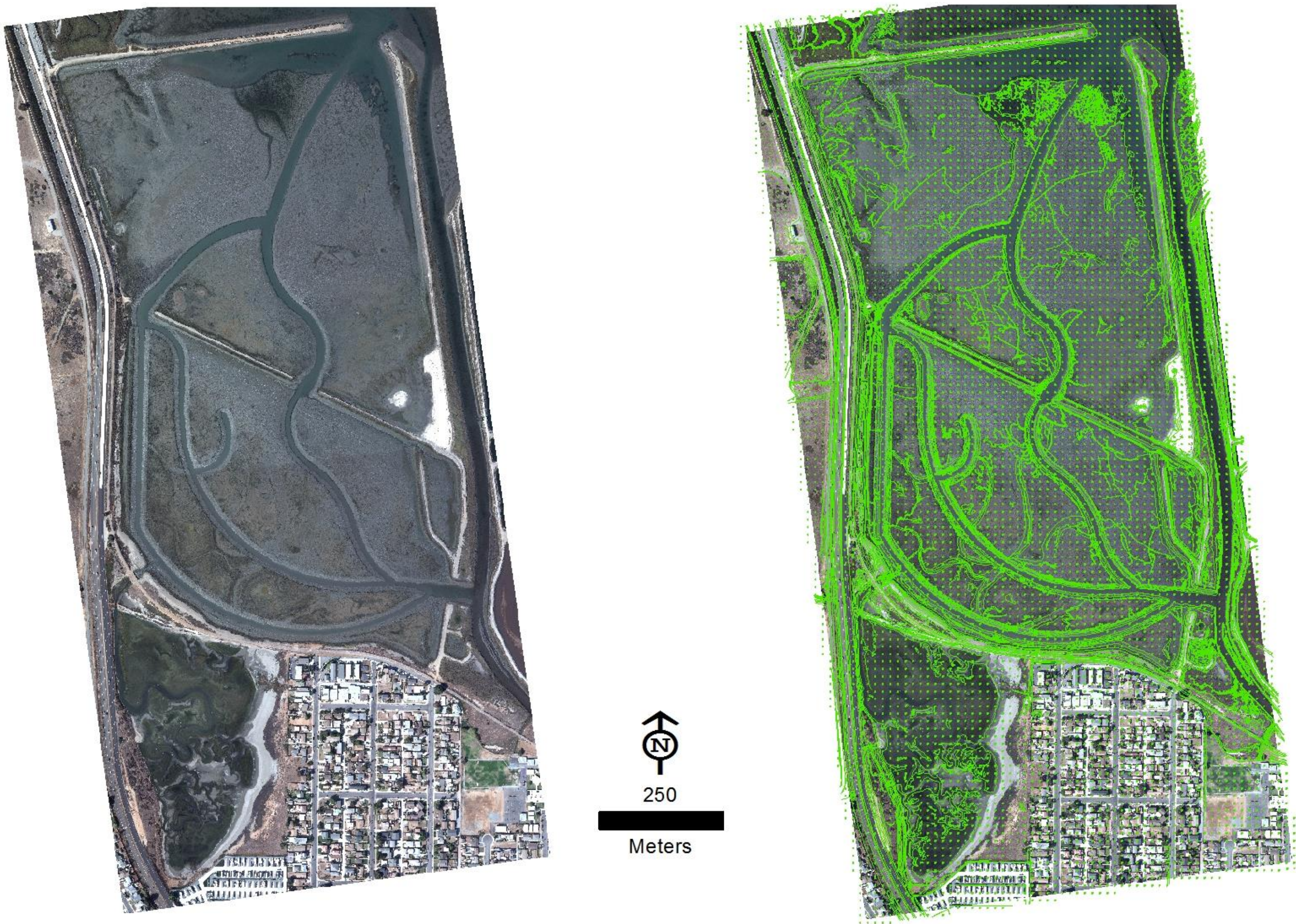
The surface area elevation contour as generated from the 2013 orthophotograph of the western salt ponds is illustrated in Figure 3. Digital terrain models of the ponds generated using the methods presented above immediately after construction in 2011 and in 2013 are illustrated in Figure 4. Channels are shown in white as the aerial photogrammetry method does not penetrate the water and, therefore, cannot determine channel bathymetry. Apparent migration of sediment is evident in both Pond 10 and Pond 11 in the 2013 model. Deeper areas in the southwestern portion of Pond 10 appear to have been filled and some of the higher areas in the southwestern portion of Pond 11 have become lower. The marsh plain between the two channels in southern Pond 11 appears to have accreted sediment. This trend is further evident in the cross-section plots of the pond elevations comparing 2013 aerial photogrammetry and RTK GPS transects (Figures 5 and 6). The correlation of the postconstruction contours derived from aerial photogrammetry and RTK GPS transects suggests that these elevation changes are accurate within tolerances of each method. The elevations determined by photogrammetry have an accuracy of ± 10% and those determined using RTK GPS have an accuracy of ± 3%.

The difference in elevation in southern Pond 10 is evident in Figure 5, Transect 1 and Transect 2. The slightly lower marsh plain in southwestern Pond 11 is illustrated by Transect 4 (Figure 6.). It appears that the sediment continues to be redistributed by tidal action in both ponds..

Although the topography of the marsh plain has increased and/or decreased in some areas relative to predicted elevation based on preconstruction surveys, the project is expected to attain the range of habitats included in the project goals and objectives. In addition, higher elevations will allow for marsh evolution and migration in the face of predicted sea level rise. The majority of the marsh plain in Pond 10 is at the elevation contour of +3.0 ft to + 5.0 ft NAVD88 which is within the predicted elevation range for cordgrass-dominated salt marsh (+2.2 ft to + 4.6 ft NAVD88). Higher areas within Pond 10 with an elevation range of +4.9 ft to + 6.6 ft NAVD88) are within the predicted range of mid- to high salt marsh +5 ft to + 7.0 ft NAVD88. These areas have been colonized by Pacific pickleweed and are expected to remain mid- to high salt marsh. Elevations in Pond 11 demonstrate a similar pattern; however, continuing consolidation and movement of sediments deposited as dredge slurry in Pond 11 render predictions of final elevations and habitats premature.

In summary, topographic analyses conducted in 2013 demonstrated that the objective that the Project be within ±10% of the design has been met. Some areas of the marsh plain are higher and some are lower. However, the elevations are within the tolerances of the habitats of the Project design.

The evolution of topography of the marsh plain will be monitored throughout the 5-year monitoring program using methods similar to those used in this report as well as supplemental data provided using LIDAR. The monitoring of the bathymetry of the tidal channel in Ponds 10 and 11 will be a major focus during Year 3 of the monitoring program.



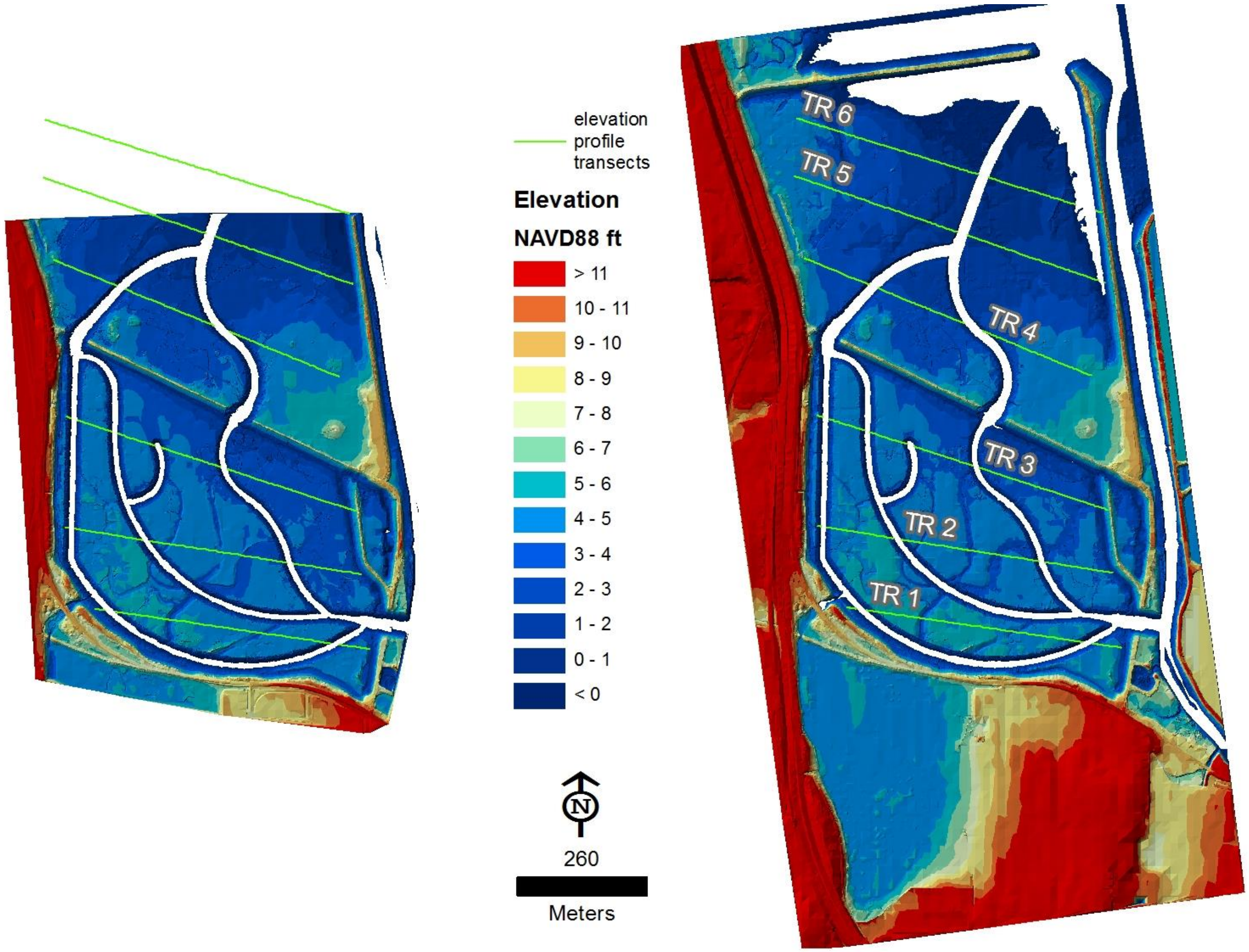
October 2013 Orthophoto

Derived from R,G,B and NIR digital imagery
taken on October 04, 2013

October 2013 Elevation Contours

Digital elevation contours created using photogrammetry from R,G,B
and NIR digital photos taken on October 04, 2013

Figure 3. Orthophotograph and Elevation Contours of the Western Salt Ponds – 2013.



Oct 2011 Elevations

Digital Terrain Model (DTM) derived from contours created using photogrammetry of 3-band aerial imagery taken October 2011.

October 2013 Digital Terrain Model

Digital Terrain Model (DTM) derived from contours created using photogrammetry of 4-band aerial imagery taken October 2013.

Figure 4. Digital Terrain Model of Ponds 10 and 11 October 2011 and October 2013..

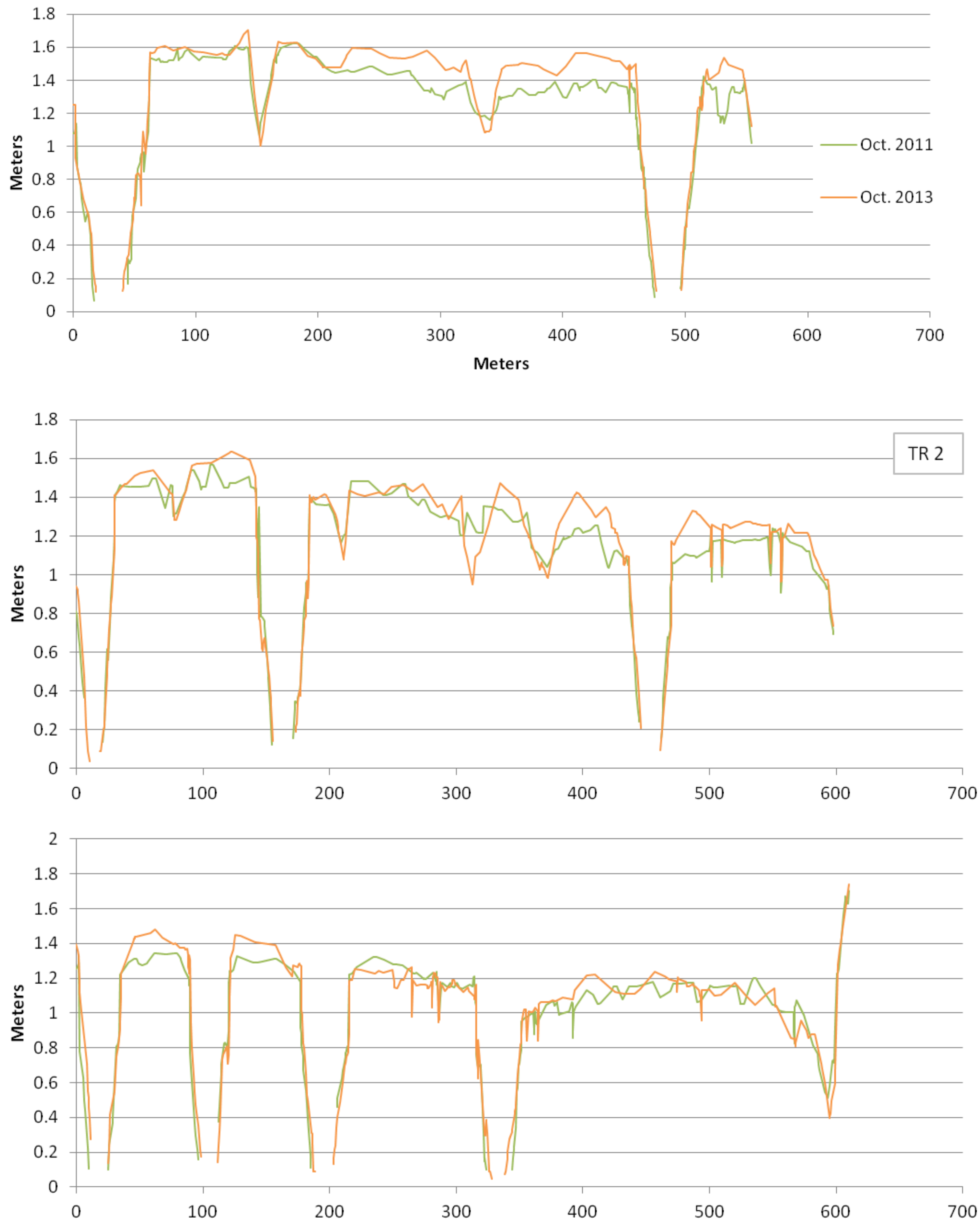


Figure 5. Elevations Along Transects in Pond 10. (X Axes Represent Length in Meters of the Transect From West to East).

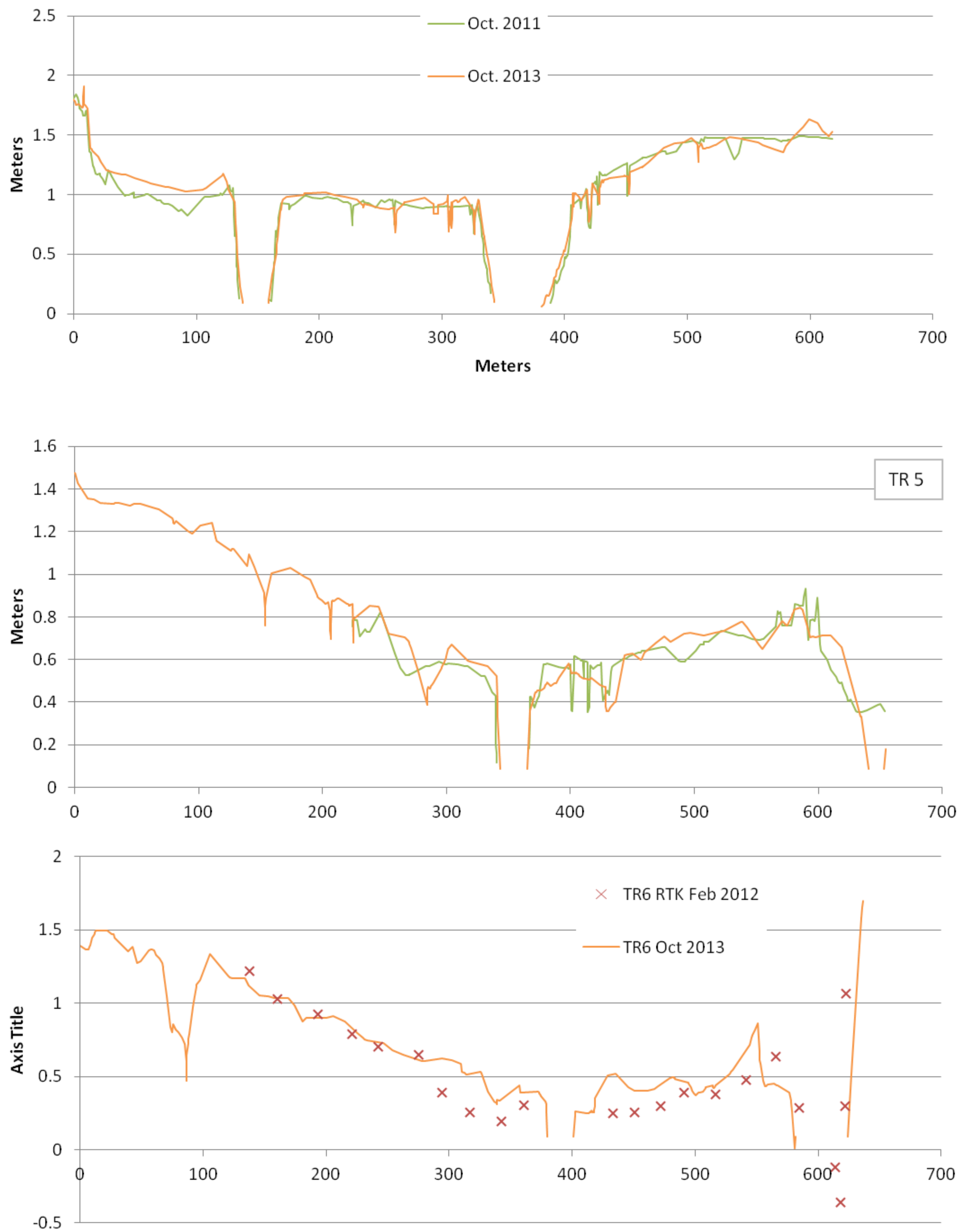


Figure 6. Elevations Along Transects in Pond 11. (X Axes Represent Length in Meters of the Transect From West to East).

2.2 Topography/Bathymetry of the Chula Vista Wildlife Reserve

Like the western salt ponds, monitoring of the topography/bathymetry of the CVWR was conducted during project design, during construction and postconstruction. Preconstruction elevations of the marsh plain and constructed channels were assessed to determine postconstruction habitat distributions and dredge volumes. During construction, the elevations of the marsh plain and constructed channels were measured frequently to determine achievement of target elevations and as a method of payment for the contractor. Postconstruction monitoring focused on the topography of the marsh plain and the bathymetry of the constructed channels.

2.2.1 Methods – Monitoring of Topography/Bathymetry of the Chula Vista Wildlife Reserve

Following completion of construction in mid-February 2011, a survey was conducted of the topography of the CVWR using aerial photogrammetry.

2.2.2 Results – Monitoring of Topography/Bathymetry of the Chula Vista Wildlife Reserve

The photogrammetry survey confirmed that the elevations were within the project specifications of $\pm$ 10% of design. Restoration activities at the CVWR lowered elevations in the 11-acre restoration area to between +3 and +6 ft MLLW.

2.3 Tidal Amplitude

Project objectives regarding tidal amplitude for both the western salt ponds and CVWR components of the Project included matching tidal amplitude at existing reference sites. For the western salt ponds, that reference was tidal amplitude at the mouth of the Otay River immediately adjacent to Pond 11. For the CVWR, that reference was the tidal amplitude of south San Diego Bay as measured at the NOAA tide gauge located on the Broadway Pier in San Diego.

Prior to construction, the western ponds were used as water storage ponds for solar salt evaporation and, thus, were not tidal. Water level and depth in the western salt ponds varied with water import and export associated with the solar evaporation activities. Water depth within Pond 11 between 2008 and 2010 varied from approximately +3 ft to +0.5 ft relative to the bottom of the pond. Prior to construction of the CVWR component, tidal amplitude was limited by existing elevations, however, there were no preconstruction data on tidal amplitude at the CVWR site.

2.3.1. Methods – Monitoring of Tidal Amplitude of the Western Salt Ponds

Tidal amplitude of the western salt ponds was measured using YSI model 6600 EDS Sonde dataloggers deployed at the eastern breach of the internal levee between Ponds 10 and 11 and at the mouth of the Otay River (Figure 7). The datalogger at the Pond 11 station was deployed using a 4-inch diameter PVC pipe that was strapped vertically to two "rail" style fence posts driven into the sediment. Multiple 1.5 inch holes were drilled around the bottom of the tube to permit unrestricted water flow to the sensors. During deployment the datalogger unit was placed into the PVC pipe and rested on a bolt fixed across the bottom of the tube. The datalogger at the mouth of the Otay River was deployed in a similar manner.

The deployment time varied from approximately two to four weeks. Measurements for water level (converted to tidal amplitude) were taken at 15 minute time intervals along with water quality data (specific conductivity, salinity, dissolved oxygen (percent saturation), dissolved oxygen (mg/l), temperature, turbidity, pH, and chlorophyll). At the end of each sampling period, the YSI dataloggers were retrieved and taken to the laboratory for data downloading, cleaning and recalibration. There are two designated dataloggers for both Pond 11 and the Otay River mouth. While one logger is in the field the other is in the laboratory.

In September 2013, a Solinst® level logger was deployed near Pond 10A sampling site 1 (see Figure 7). This depth logger measures only pressure and temperature. Pressure readings were converted to depth after being compensated for atmospheric pressure, which was recorded by the barometer at the CVWR (see Section 2.3.3).

2.3.2 Results - Monitoring of Tidal Amplitude of Western Salt Ponds

A comparison of the tidal amplitude in the breach between Pond 10 and Pond 11 with that at the mouth of the Otay River and at Pond 10A is presented in Figure 8. Also shown in Figure 8 are tidal comparisons of the Otay River mouth with the NOAA tide gauge at the Broadway Pier in mid-San Diego Bay and the Otay River mouth with CVWR site 3L**.** Comparisons included a typical 2-week spring tide series representing the higher tide scenario and a typical 2-week neap tide series representing the lower tidal cycle. During both the neap and spring tide series, tidal amplitude within the western salt ponds closely mirrors tides at both reference sites. Note that, because the loggers are not tied to any vertical datum, the values have been shifted manually along the y-axis so that comparisons can be made.

Figure 7. Monitoring Stations - Western Salt Ponds. Locations of water quality data-loggers are shown in black. Green dots = corners of experimental vegetation plots. Blue circles = enclosure traps and invertebrates. White circles = invertebrates only, both channel-bottom and tidal flat. Brown circles = sediment.

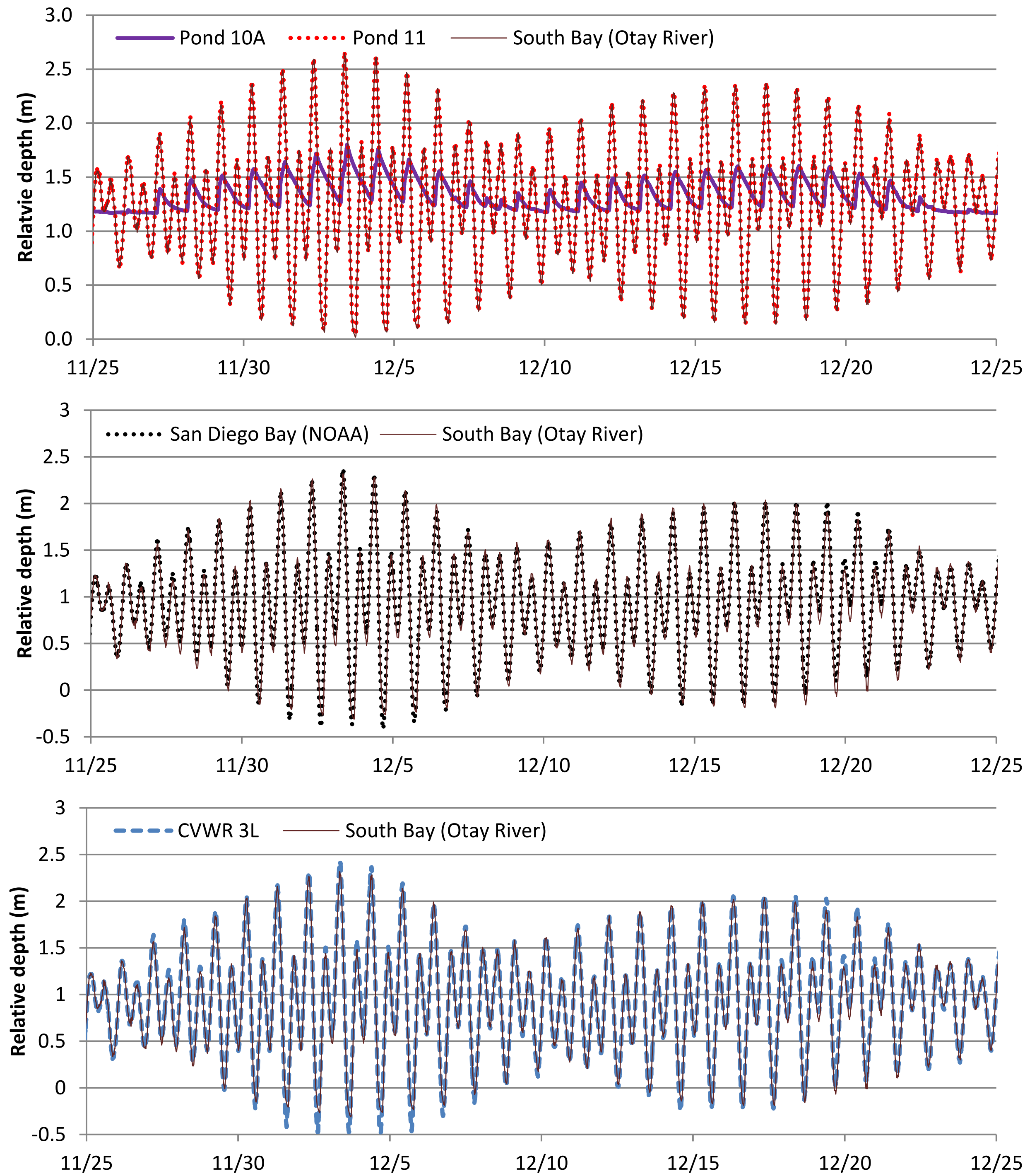


Figure 8. Tidal amplitudes: Pond 11 logger site compared to South Bay (Otay River) logger and Pond 10A depth logger sites (top), South Bay (Otay River) logger site compared to NOAA's mid-bay site (middle), and CVWR site 3L compared to South Bay (Otay River) logger site.

2.3.3 Methods - Monitoring of Tidal Amplitude of Chula Vista Wildlife Reserve

Tidal amplitude at the CVWR was assessed using Solinst® level loggers deployed at Stations 1, 2, and 3, as depicted in Figure 9. In February 2013, the level logger at Station 3 was moved outside of the wildlife refuge (labeled 3L in Figure 10) in order to compare the tidal amplitudes inside the marsh to that of the adjacent bay. Level loggers detect pressure changes associated with water depth that can be converted to tidal amplitude after barometric compensation. As happened in 2012, failures with the loggers occurred that resulted in missing data, however, enough data was obtained to show spring and neap tidal series at each site. Due to the high failure rate experienced with the Solinst® level loggers, Onset® HOBO® data loggers were deployed in late January 2014.

2.3.4 Results - Monitoring of Tidal Amplitude of Chula Vista Wildlife Reserve

A comparison of the tidal amplitude at site 3L just outside of the CVWR with that in mid-San Diego Bay is presented in Figure 10**.** Two of the sensors (1 and 2) are located on the south end of the Reserve while sensor 3L is located just outside of the tidal inlet to the bay. The sensor at site 3L experiences almost an identical inundation pattern as NOAA's mid-bay sensor; however, it experiences a slightly greater range. The other two sensors still show substantial truncation of low tides. Thus, while tidal influence may have been increased through excavation of channels at the CVWR, tides are somewhat muted relative to the open bay.

In summary, the western salt ponds met the Project objectives for tidal amplitude while the CVWR did not. Low tides at the CVWR were truncated relative to tides at reference sites within San Diego Bay. Monitoring in subsequent years may determine a need for remedial measures.

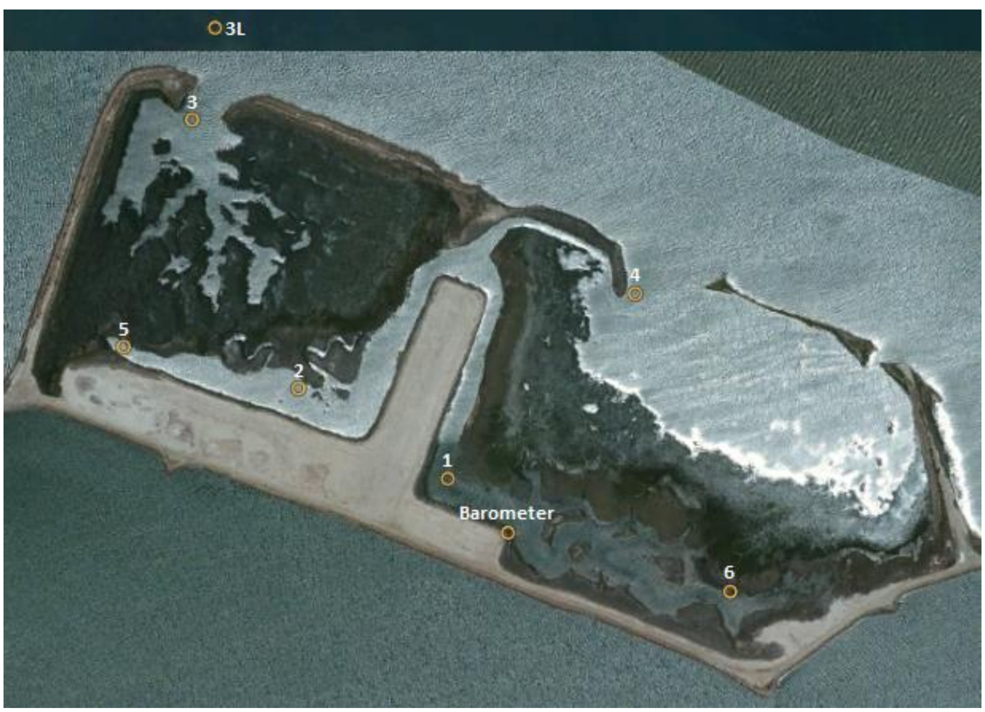


Figure 9. Monitoring Stations at the Chula Vista Wildlife Reserve.

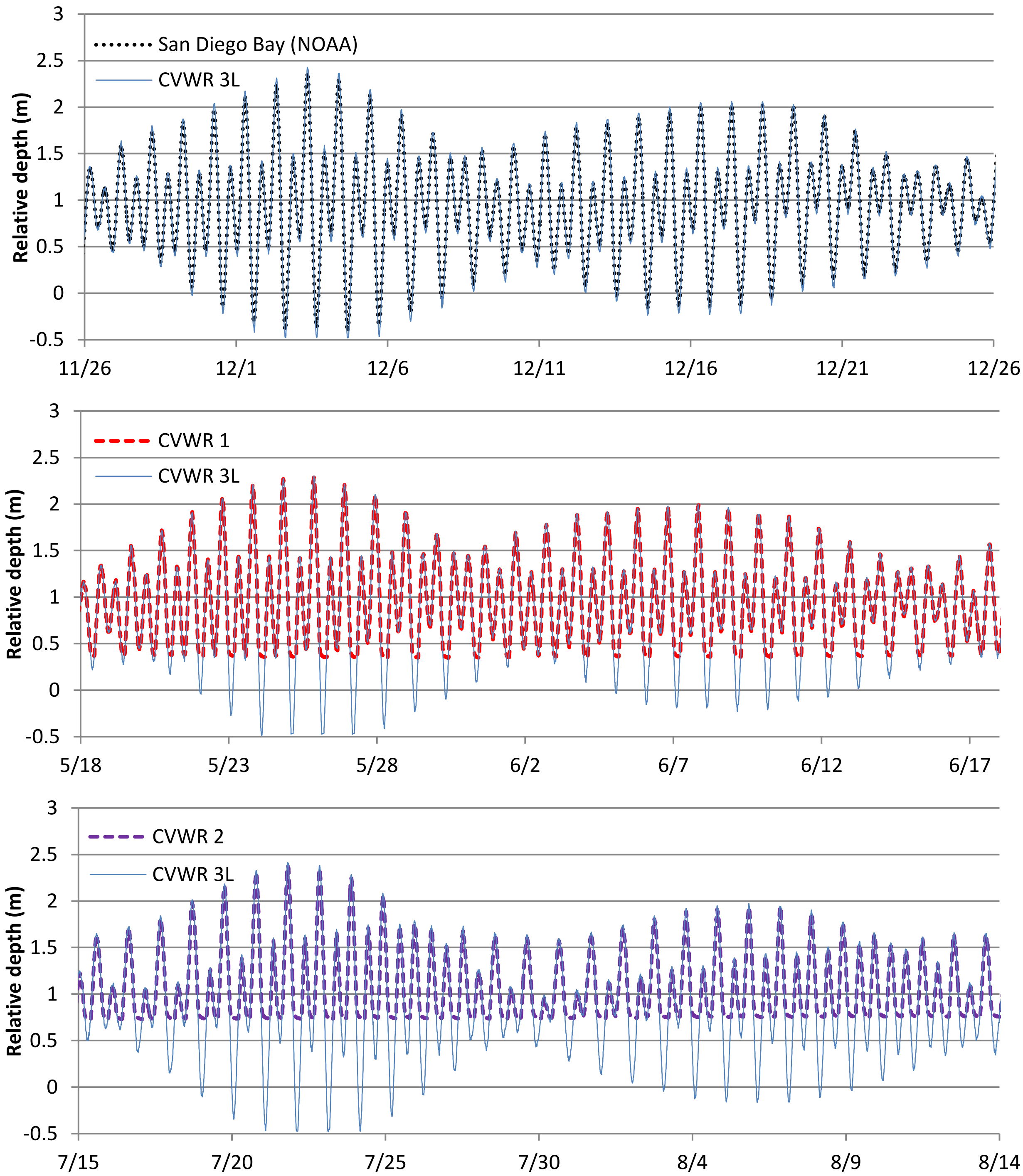


Figure 10. Tidal Amplitude at the Chula Vista Wildlife Reserve

2.4 Water Quality

Water quality objectives for the western salt ponds included developing water quality within Ponds 10 and 11 that is similar to that at the mouth of the Otay River and developing a more variable water quality in Pond 10A which has a muted tidal condition. There were no specific water quality objectives for the CVWR.

Preconstruction water quality monitoring within Pond 11, conducted from 2008 to 2010, showed variations in salinity, dissolved oxygen and temperature associated with water import and export and seasonality. Water salinities in Pond 11 varied from a high of approximately 51 ppt to a low of about 41 ppt. Dissolved oxygen varied inversely with salinity, dropping when salinities were higher and rising when salinities were lower. Water temperature varied seasonally with temperatures as high a 40 ° C in summer and as low as 12 ° C in winter. Nutrients in the water also varied widely and were affected by rainfall, turbidity, temperature, dissolved oxygen and other physical factors.

2.4.1 Methods – Monitoring of Water Quality of Western Salt Ponds

As presented above, water quality monitoring of the western salt ponds and mouth of the Otay River was conducted using YSI model 6600 EDS Sonde dataloggers. The dataloggers measure specific conductivity, salinity, dissolved oxygen (percent saturation), dissolved oxygen (mg/l), temperature, turbidity, pH, and chlorophyll at 15 minute intervals for a sampling period of 2-4 weeks before retrieval, downloading, cleaning, recalibration and redeployment.

2.4.2 Results – Monitoring of Water Quality Monitoring of Western Salt Ponds.

Water Quality monitoring results as measured by the datalogger in the eastern breach between Ponds 10 and 11 (Pond 11) and the Otay River Mouth (Otay River) during 2013 are presented in figures 11 through 19. Water depths were similar at both sites with similar maximum and minimum readings (Figure 11). Gaps in Otay River water quality data during February were the result of failure of the temperature/conductivity probe. This probe affects all other sensors and all data collected during that time period were rejected.

Salinity was similar at both monitoring stations (Figure 12). Salinity readings near zero were recorded on two dates in winter 2013 likely in response to rain events.

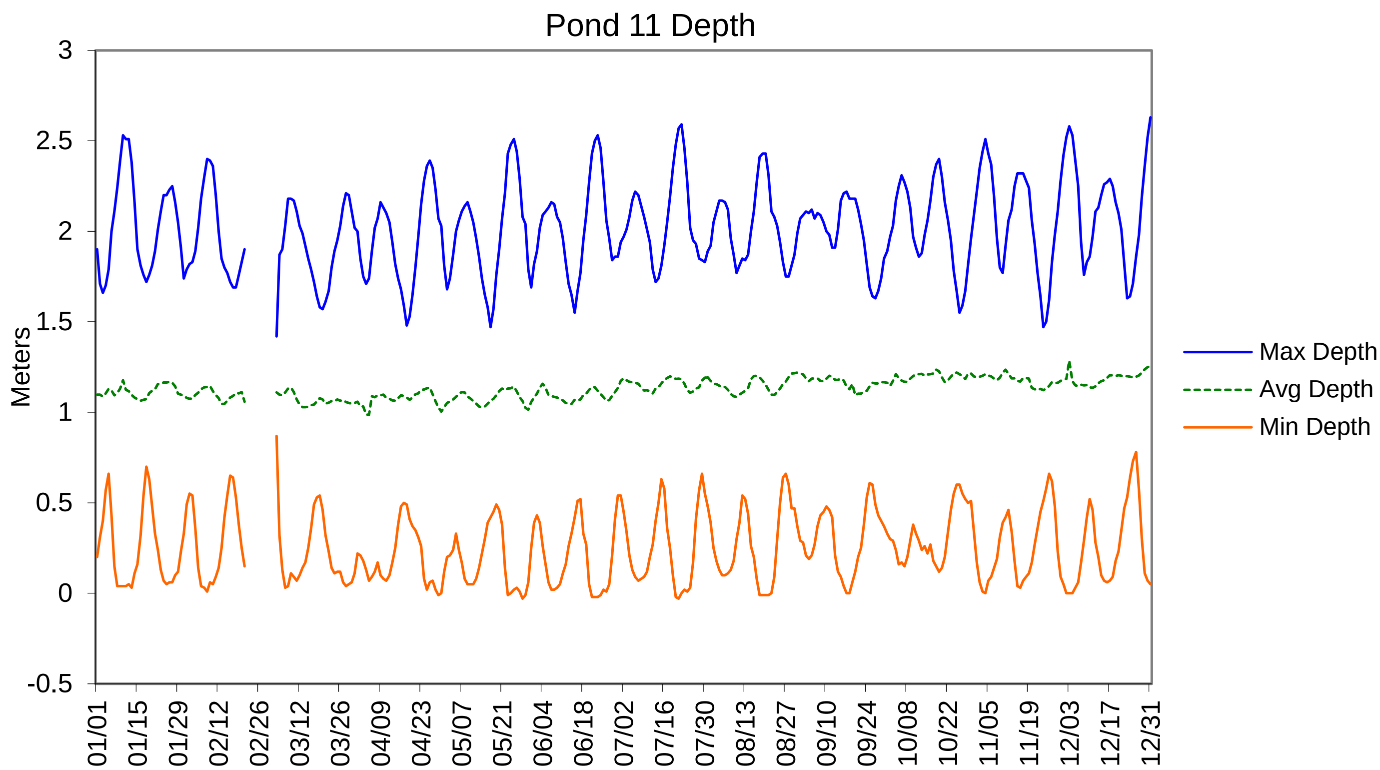
Water temperature varied seasonally with the highest temperatures occurring in July and August and lowest in January (Figure 13). Maximum and minimum temperatures varied by approximately 5° C. Trends in water temperature at both monitoring stations were very similar over the 12-month monitoring period.

Maximum chlorophyll levels as measured by the data logger were generally higher within Pond 11 compared to the Otay River (Figure 14) and maximum turbidity levels were substantially higher in Pond 11 than in the Otay (Figure 15). Higher turbidity within Pond 11 might be expected as the sediment deposited in the pond as slurry during construction has not yet consolidated and is subject to suspension in the water column by tidal action.

Dissolved oxygen levels varied seasonally and inversely with water temperature (Figure 16). Dissolved oxygen was highest during the cool winter months and lowest during summer. This parameter was similar for Pond 11 and the Otay River Mouth. Minimum dissolved oxygen levels near zero mg/l were recorded for both sites in summer 2013.

Recorded pH levels were similar at both datalogger locations (Figure 17). Minimum, average and maximum pH at both dataloggers were generally around 8.0. Orthophosphate levels varied considerably but were generally similar in Pond 11 and the Otay River (Figure 18). Ammonia and nitrate levels were considerably higher in the Otay River than Pond 11, presumably in response to upstream inputs from the Otay River watershed (Figures 18 and 19). Chlorophyll levels as measured in the laboratory were always highest in Pond 11 (Figure 19). .

In summary, the Project objective that water quality within Ponds 10 and 11 be similar to water quality at the mouth of the Otay River has been met. Variations in certain parameters, i.e., ammonia, nitrate and chlorophyll, may be attributed to the physical differences in the two monitoring stations. Runoff containing residues from fertilizers would be conveyed to San Diego Bay via the Otay River but would not necessarily enter the western ponds, depending upon tide. Higher chlorophyll levels in Pond 11 may be associated with higher turbidity at that monitoring station.



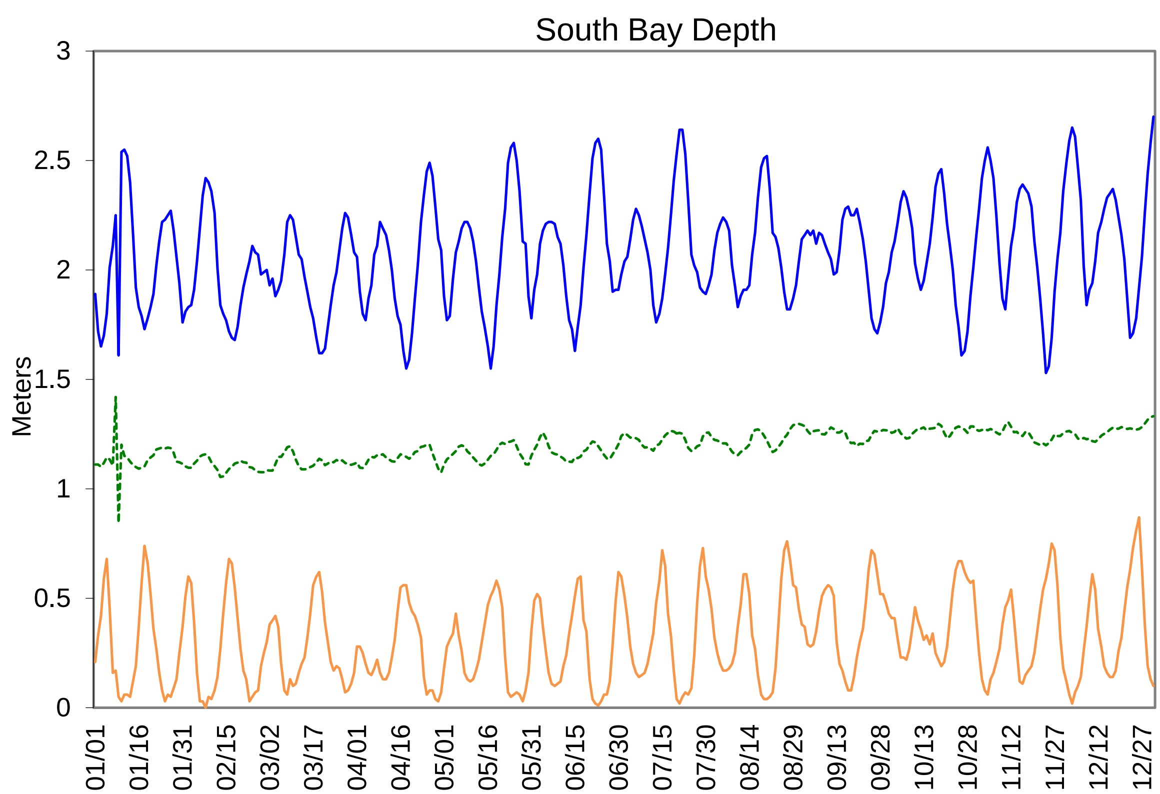
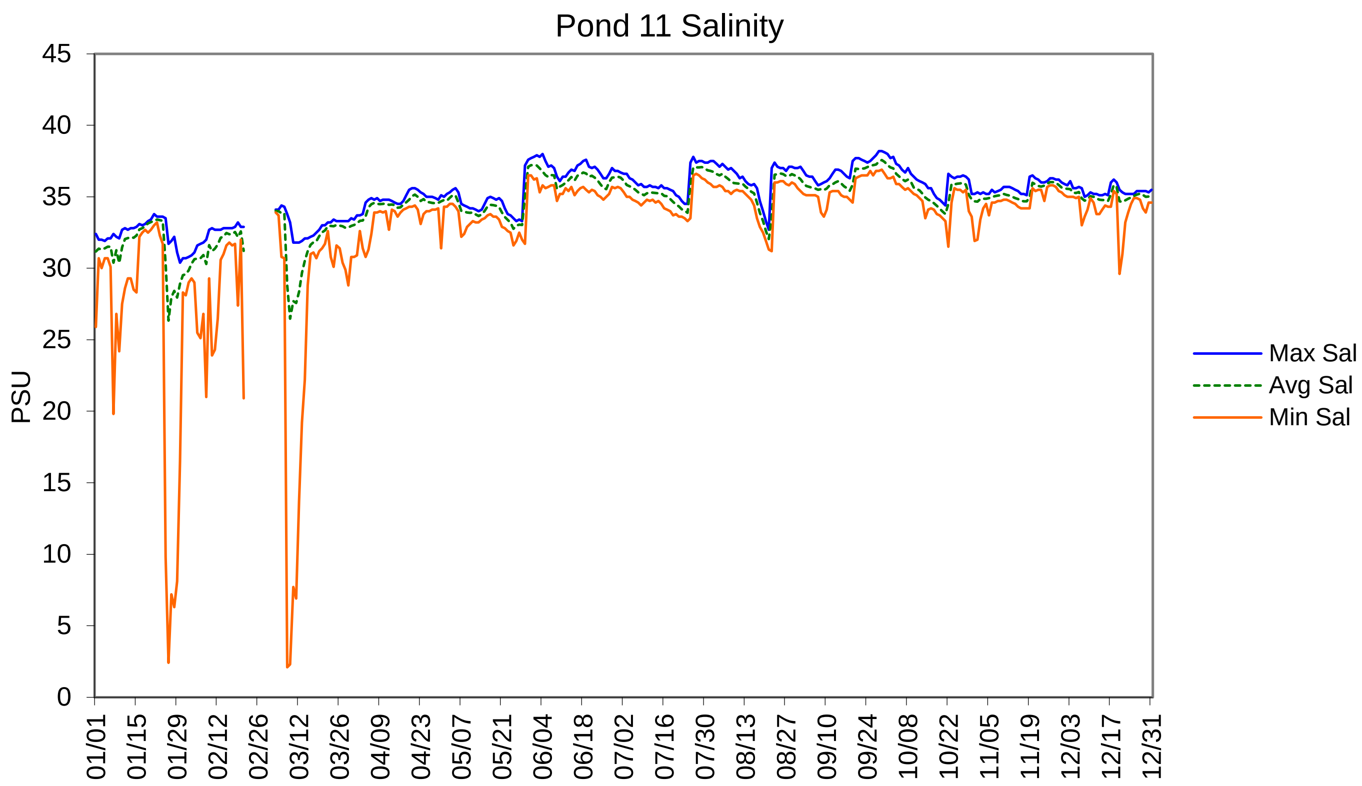


Figure 11. Water Depth in Pond 11 (above) and at the Otay River Mouth (below).



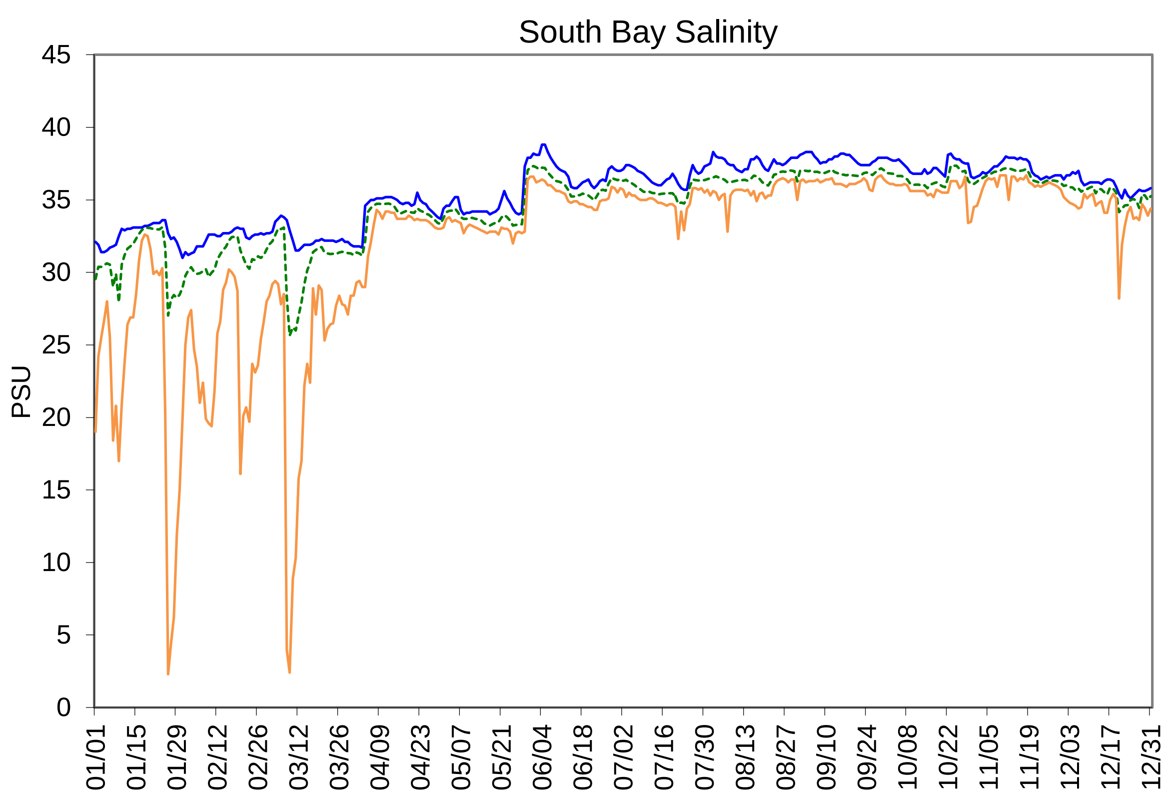
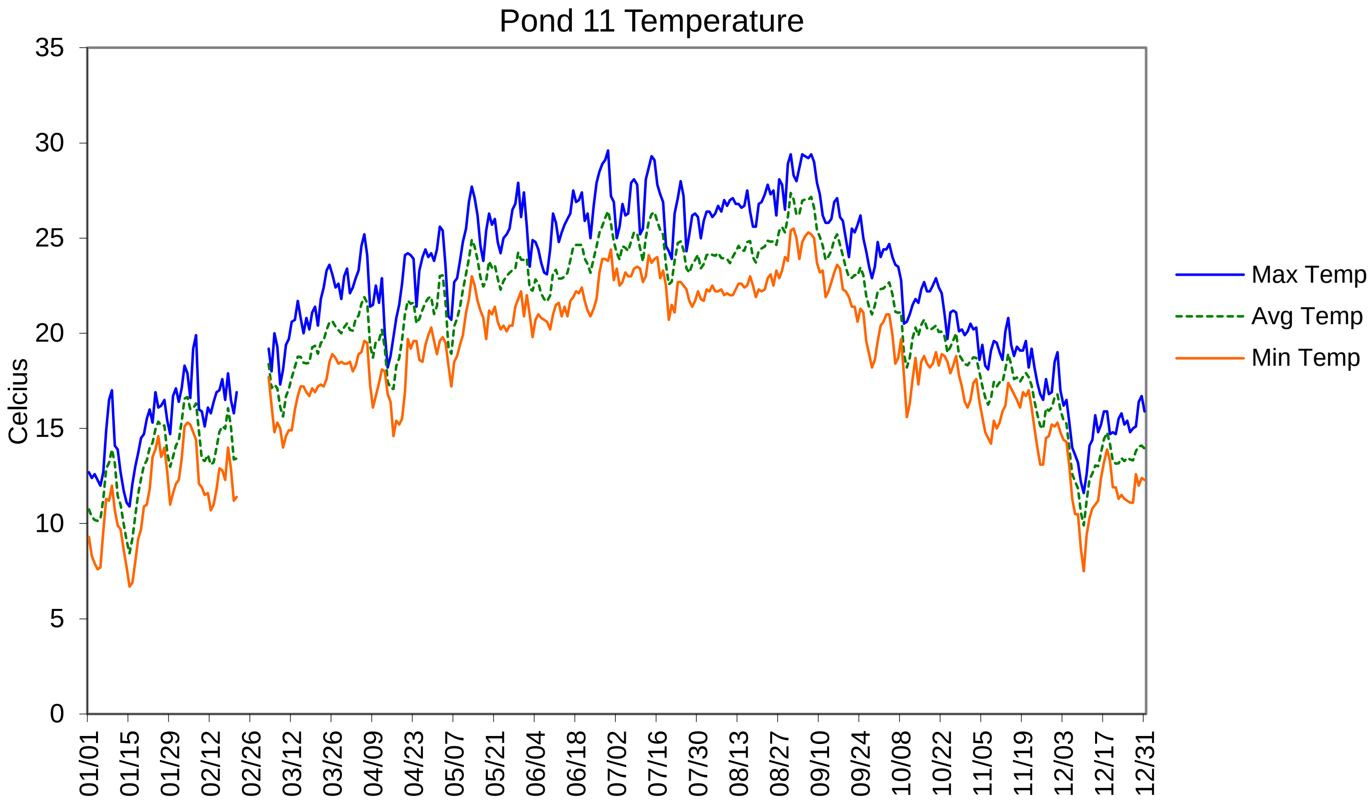


Figure 12. Water Salinity in Pond 11 (above) and the Otay River Mouth (below).



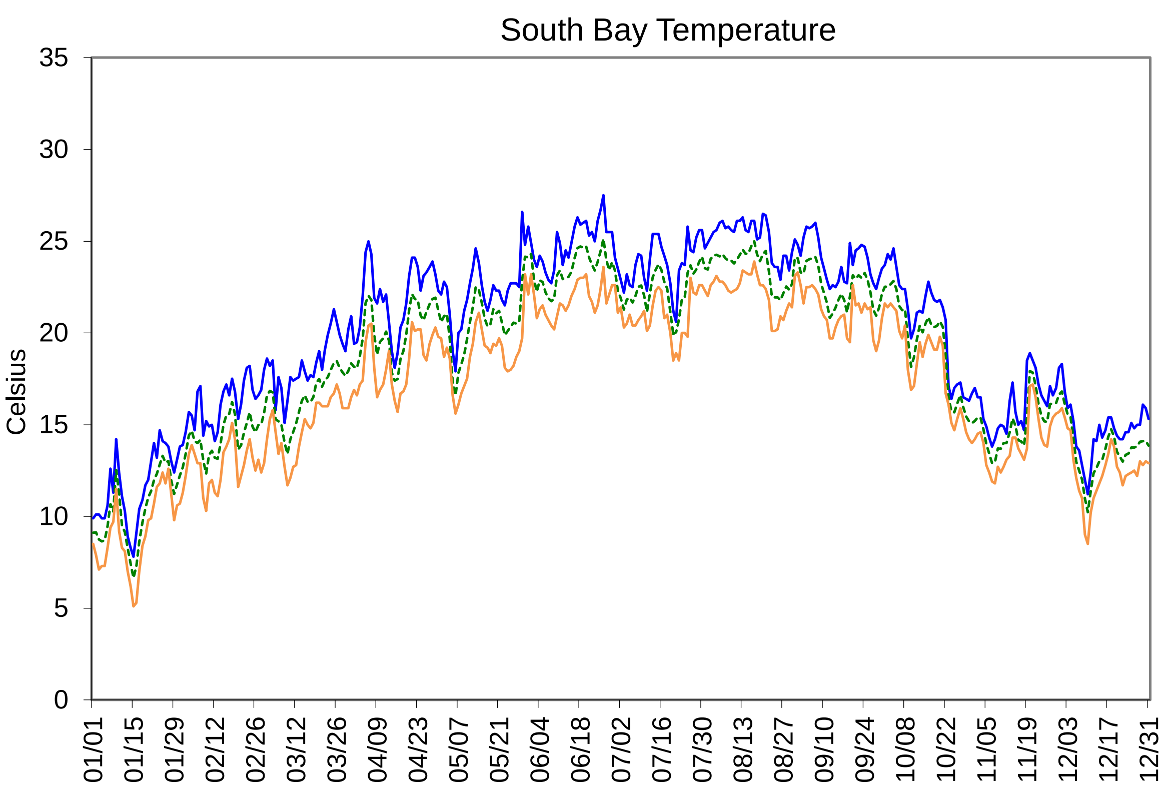


Figure 13. Water Temperature in Pond 11 (above) and the Otay River Mouth (below).

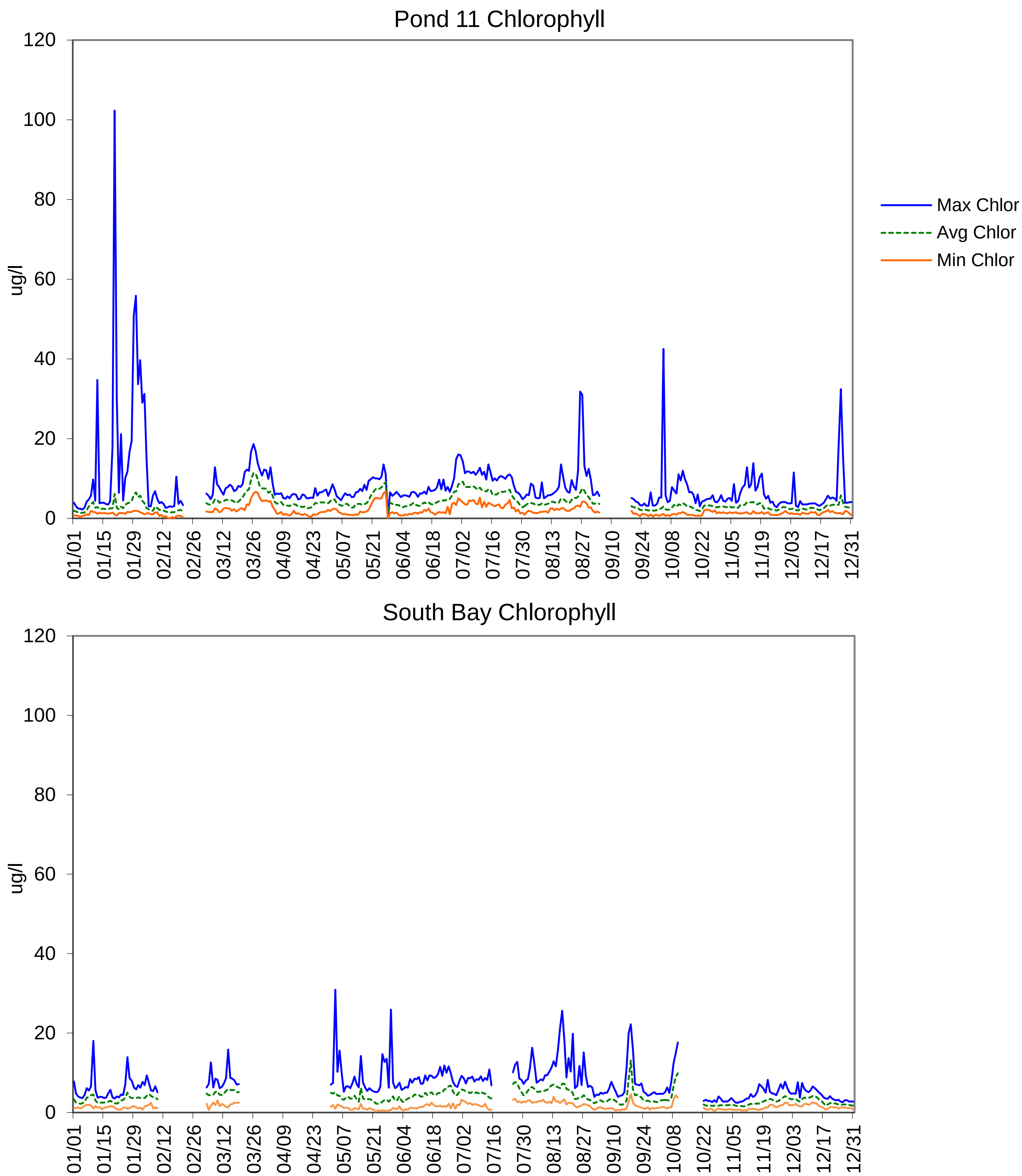


Figure 14. Chlorophyll in Pond 11 (above) and the Otay River Mouth (below).

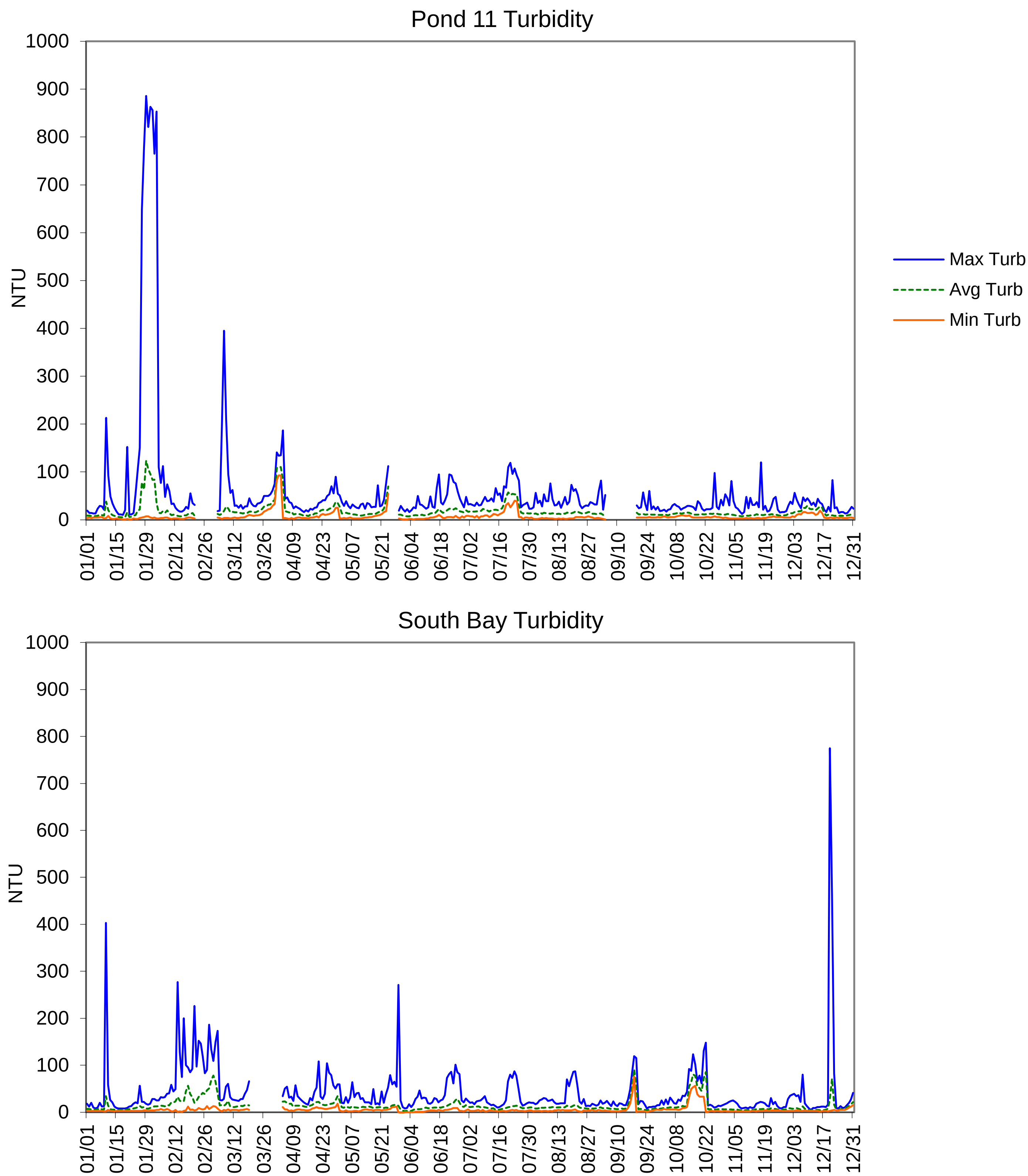
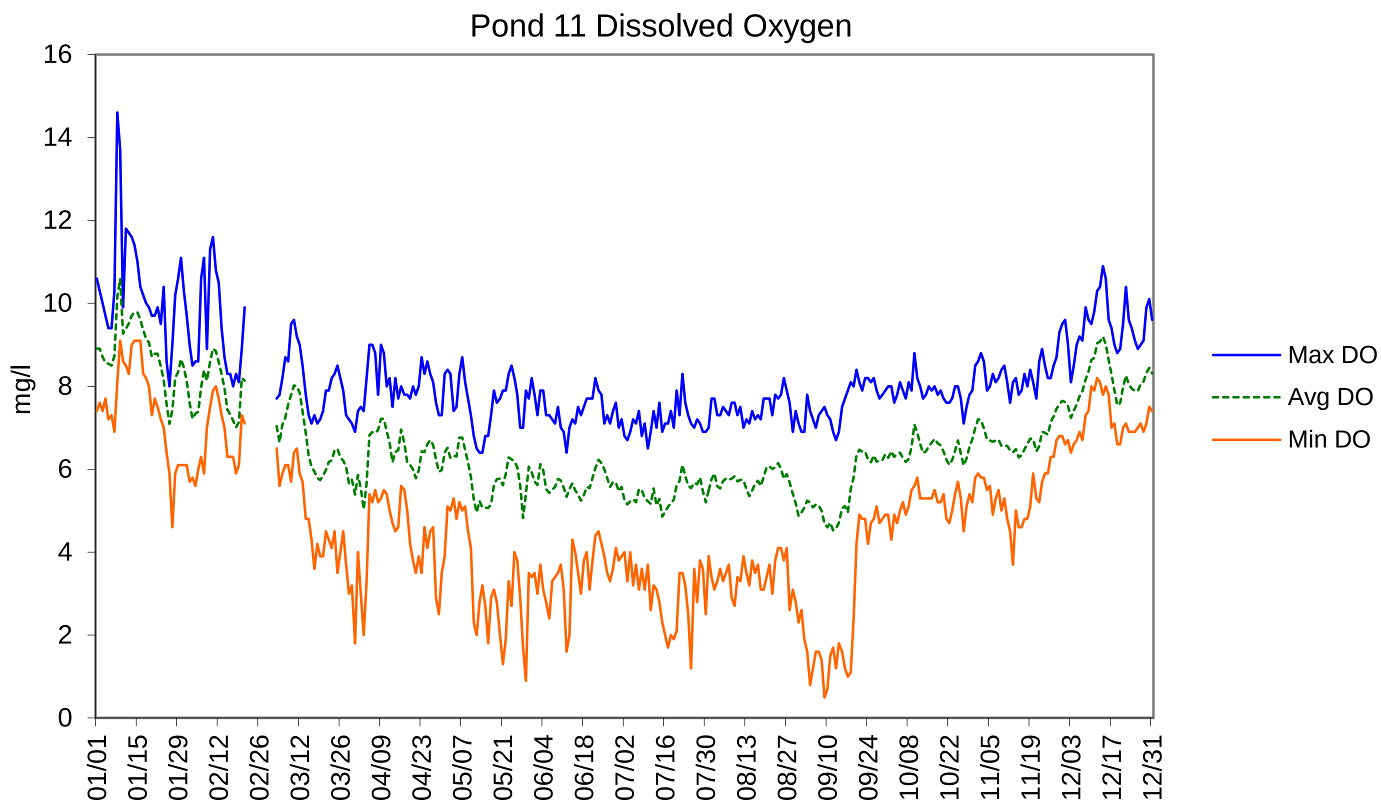


Figure 15. Water Turbidity in Pond 11 (above) and the Otay River Mouth (below).



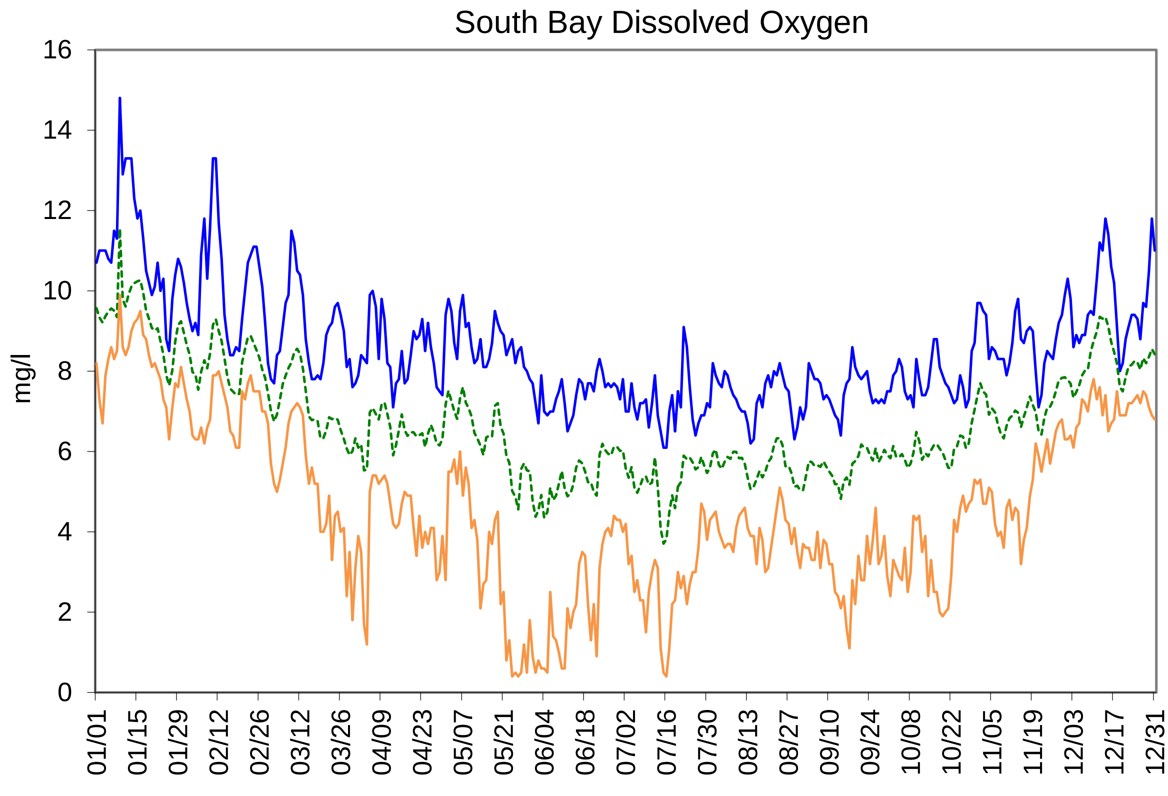
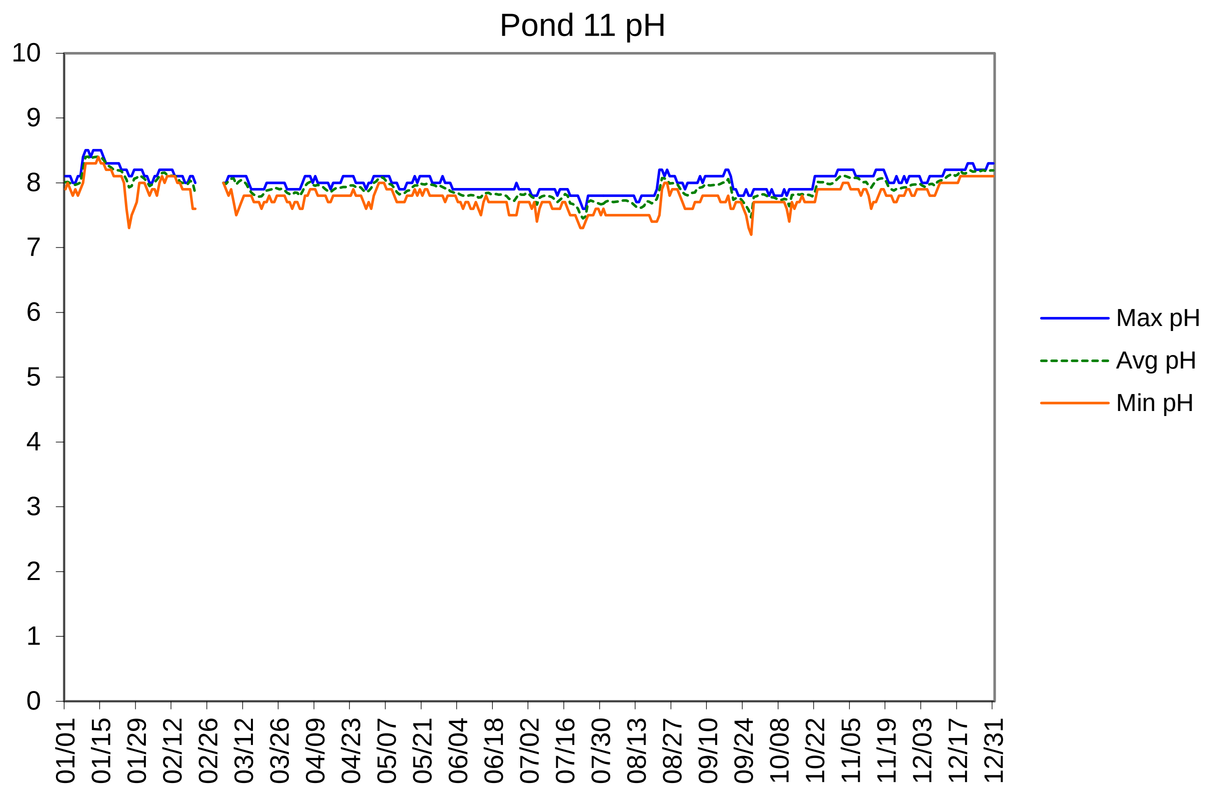


Figure 16. Dissolved Oxygen in Pond 11 (above) and the Otay River Mouth (below).



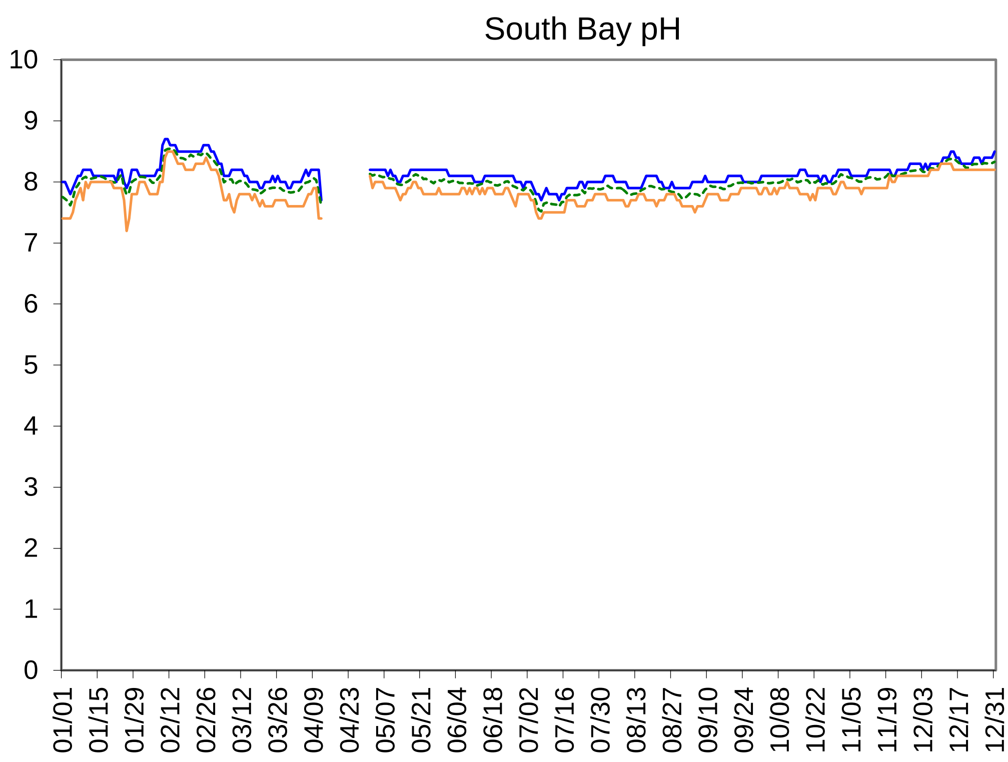
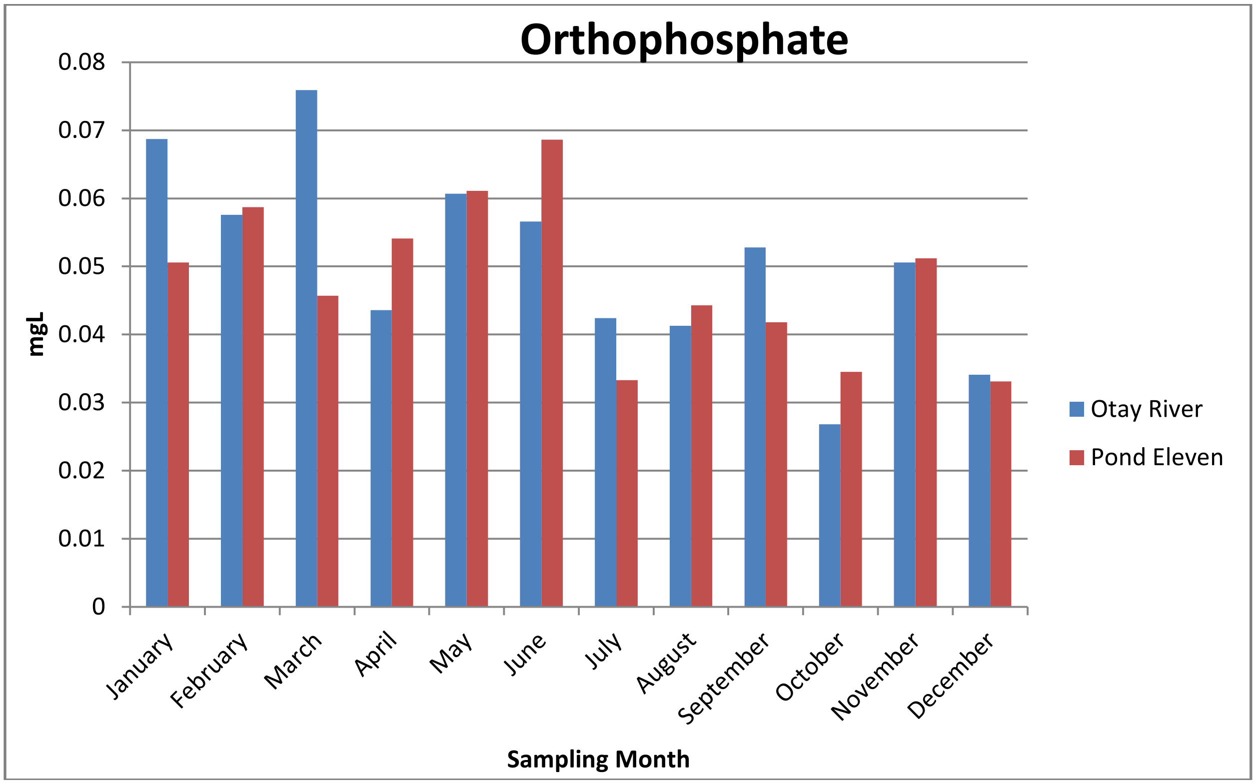


Figure 17. Water pH in Pond 11 (above) and the Otay River Mouth (below).



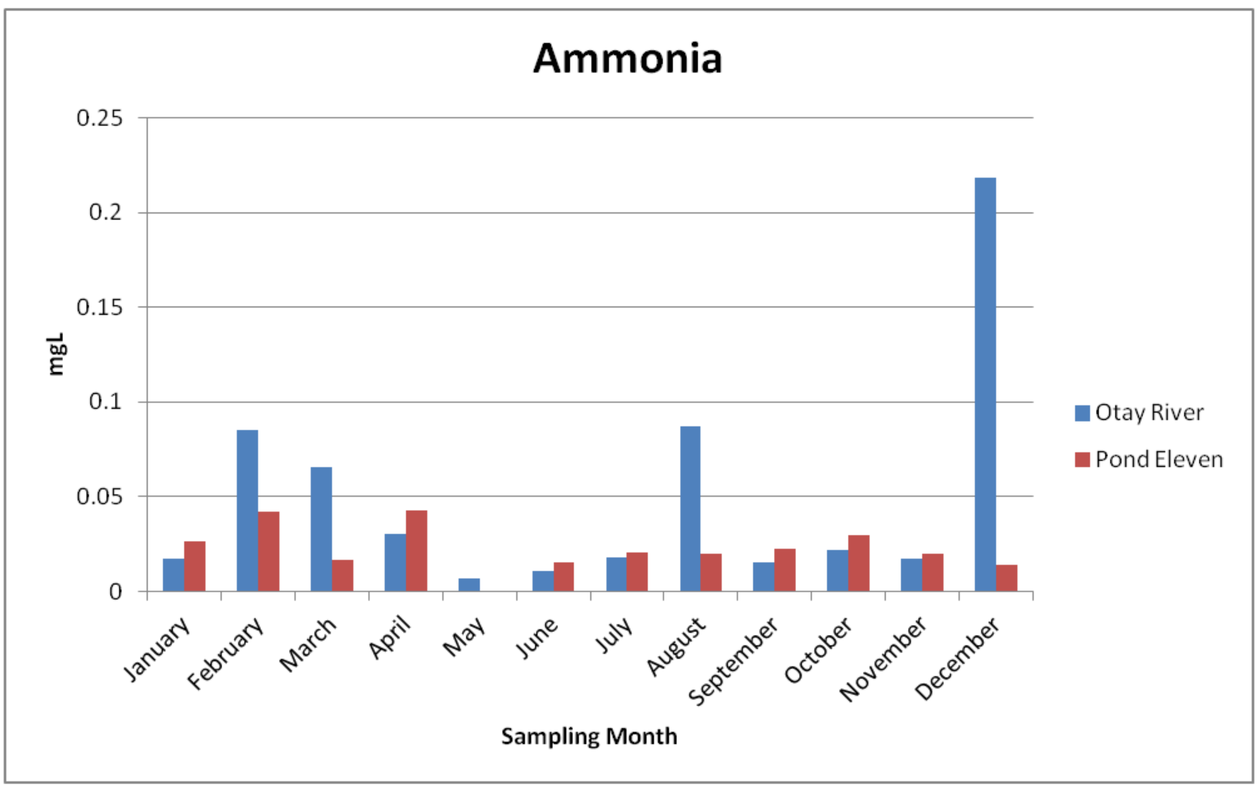
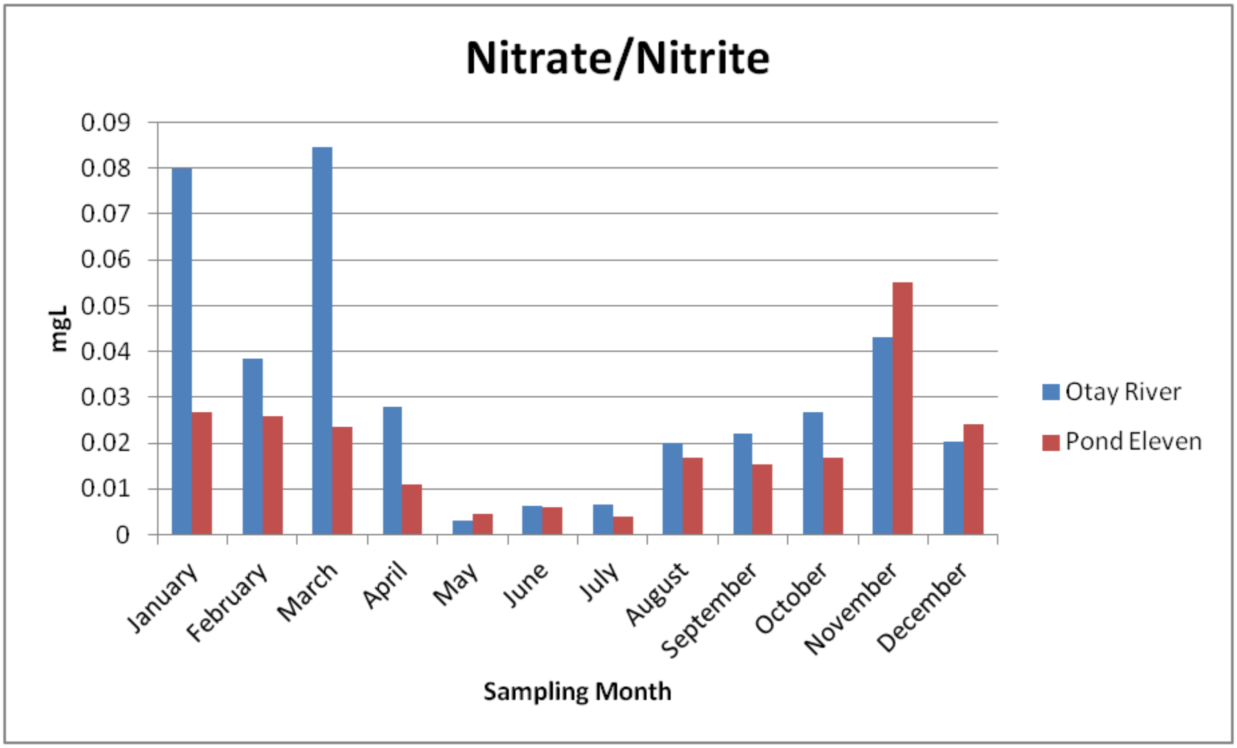


Figure 18. Orthophosphate (above) and Ammonia (below) in Pond 11 and the Otay River Mouth.



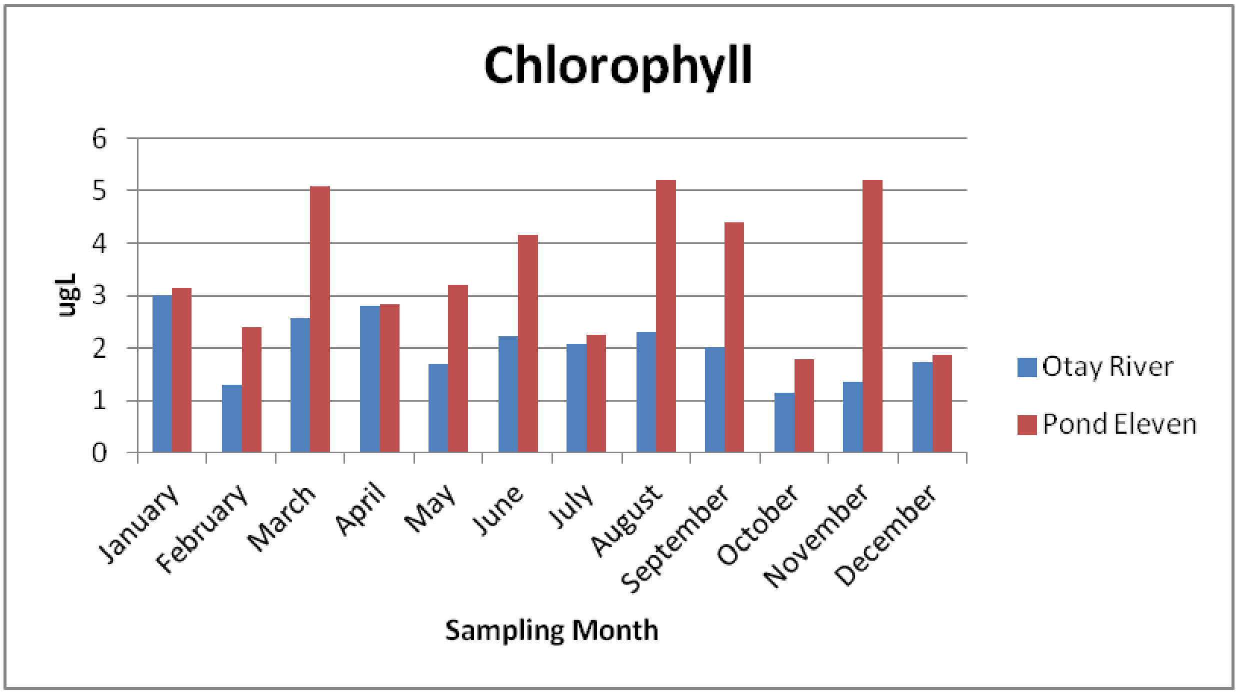


Figure 19. Nitrate/Nitrite (above) and Chlorophyll (below) in Pond 11 and the Otay River mouth.

2.4.3 Methods – Monitoring of Water Quality Monitoring of Chula Vista Wildlife Reserve

Water quality data at the CVWR were collected by Merkel & Associates under contract to the San Diego Unified Port District. Data on dissolved oxygen, temperature, turbidity, pH were collected from five tidal channel stations (Figure 20) just prior to low tide on March 7, 2013 using a Hydrolab Quanta multiprobe water quality meter. Water samples were collected from tidal channels on the same date prior to low tide for laboratory analysis of nitrogen (as total Kjeidahl Nitrogen), total phosphorus and ammonia.

2.4.4 Results – Monitoring of Water Quality Monitoring Results of Chula Vista Wildlife Reserve

The results of water quality monitoring at the CVWR are summarized in Table 1. All parameters were within the expected ranges. It was concluded that there was no evidence of ponding or poor tidal circulation that could result in extremes in temperature or dissolved oxygen.

Table 1. Water Quality Data Collected from the Chula Vista Wildlife Reserve 2013

March 7, 2013									
Station	**Time**	**Depth (m)**	**Temp. (C)**	**Dissolved Oxygen (mg/l)**	**Salinity (ppt)**	**Turbidity (NTU)**	**Nitrogen TKN (mg/l)**	**Total Phosphorous (mg/l)**	**Amonia (mg/l)**
1	11,52	0.1	19.2	7.9	35.9	18.2	ND	ND	ND
2	13.22	0.1	20.7	12.9	35.8	18.9	ND	ND	0.061
3	113.58	0.1	20.7	11.4	36.7	36.2	ND	ND	0,074
4	114.20	0.1	20.3	10.1	36.9	10.6	ND	ND	0.072
5	15.23	0.2	19.3	9.8	37.3	10.9	ND	0.06	ND

ND = None detected

2.5 Soils Monitoring

There were no specific Project goals and objectives for either the western salt ponds or CVWR regarding soils and their development over the life of the monitoring program.

2.5.1. Methods – Monitoring of Soils of Western Salt Ponds

Soils of Ponds 10A, 10, and 11 were collected at the stations shown in Figure 7 on September 16 through September 18, 2013. Soil sampling locations were designed to correlate with monitoring of the experimental planting blocks in Pond 10 and fish enclosure traps/invertebrate sampling stations. Soils were collected using a 6 cm long PVC pipe with an interior diameter of 4.8 cm and were analyzed in the laboratory for grain size, salinity, and organic matter content. Two samples were taken at each site and dried in an oven at 105°C. One sample was wet-sieved through 2-mm and 63-µm mesh screens to obtain weight percentages of silt/clay, sand, and pebbles/shell hash.

Figure 20. Monitoring Stations Chula Vista Wildlife Reserve.

The second sample was homogenized using a coffee grinder, and, from this sample, soil salinity and loss-on-ignition organic matter content were measured. Soil salinity was measured by rehydrating a portion of the homogenized sediment with deionized water to form soil pastes, and then expressing interstitial water onto a handheld, temperature-compensated optical salinity refractometer that measures salinity (primarily sodium chloride) in parts per thousand (ppt).

Percent weight of organic matter was estimated by heating a portion of the homogenized sediment at 550°C for 4 hours in a muffle furnace, and weighing the remainder of the sediment that did not combust after it was allowed to cool to room temperature in a desiccator. It is important to note that the method of loss-on-ignition tends to overestimate the organic carbon content in sediments due to various occurrences and losses of volatile salts, organic compounds, structural water, sulfide oxidation and/or inorganic carbon. Generally, studies have shown that the organic carbon content is approximately half the amount of organic matter determined by loss-on-ignition. It has been shown, however, that geochemical properties and grain size of the sediment strongly affects this method's reliability. More specifically, a rise in clay content leads to a larger discrepancy (Veres, 2002). For a more thorough explanation on the method of loss-on-ignition and its accuracy in determining organic carbon content, see Veres 2002 and references therein.

Lastly, *in-situ* measurements of sediment stability were conducted using a Torvane shear strength gauge that measures soil stability in units of kg/cm.

2.5.2. Results - Monitoring of Soils of Western Salt Ponds

The results of the sediment analyses are presented in Table 2. Soils of all three ponds were dominated by silts and clays. Percent silts and clays by weight were highest in Ponds 10 and 11, with means of 87% and 91%, respectively, and lower in Pond 10A, with a mean of 75%. Average organic matter weight percentages were fairly consistent among the three ponds: 10.6%, 10.8%, and 10.8% in Ponds 10A, 10, and 11, respectively. Soil salinity ranged from 43 to >160 ppt in Pond 10A, 67 to 126 ppt in Pond 10, and 66 to 121 ppt in Pond 11. It should be noted that the method used here to measure salinity often results in salinity values that are elevated relative to the method of extracting interstitial pore water in the field and expressing it directly onto the refractometer. Thus, salinities measured using the latter method during the October 3 2013 survey of experimental planting blocks of *Spartina foliosa* in Pond 10 (see section 3.1.3) had a mean value of 42.6 ppt. The homogenizing and rehydrating method was adopted in order to compare upland soils with little or no pore water to wetland soils that in some cases are saturated. It provides a basis for comparison but results in elevated readings.

The results of the Torvane shear strength gauge (Table 3) provide a general comparison of the stability of the soils in each pond. Shear strengths were again highest in Pond 10A, intermediate in Pond 10, and lowest in Pond 11, with little change from last year. These values can be compared to observations in the field over the sampling period. Soils in 10A can support foot traffic in almost all areas except for remnant channels. Soils in Pond 10 are softer than those in 10A and researchers often sunk knee or thigh deep when conducting field work. The soils in

Pond 11, the recipient of dredge slurry from Pond 10, are unconsolidated and may remain unconsolidated for up to 5 years following deposition.

Table 2. Sediment Grain Size, Organics and Salinity Results – Western Salt Ponds

South San Diego Bay Salt Ponds Soil Analyses - September 2013						
		pebbles/ shell hash (> 2mm)	weight percentages sand (2mm>x>63µm)	silt and clay (< 63µm)	Loss-on-Ignition Organics	Salinity (‰)
Pond 10A	1 - 1	0.0	18.7	81.3	11.9	90
	1 - 2	14.3	73.8	11.9	2.6	82
	1 - 3	7.3	57.2	35.5	5.5	105
	2 - 1	0.2	54.5	45.3	10.2	123
	2 - 2	0.5	5.6	93.9	10.2	51
	2 - 3	0.5	4.8	94.7	9.3	43
	3 - 1	3.4	11.3	85.3	16.7	> 160
	3 - 2	3.0	14.7	82.3	7.7	88
	3 - 3	0.3	43.5	56.2	4.0	66
	4 - 1	2.4	26.6	71.0	6.0	59
	4 - 2	0.1	7.4	92.6	18.4	> 160
	4 - 3	0.9	21.8	77.3	5.1	70
	4 - 4	1.3	28.9	69.8	5.0	75
	4 - 5	3.5	16.3	80.1	13.8	147
	5 - 1	0.1	17.0	82.8	16.5	> 160
	5 - 2	0.6	4.2	95.2	8.6	71
	5 - 3	1.2	22.4	76.4	7.3	76
	1	2.8	23.3	73.9	11.1	134
	2	3.6	16.5	79.9	17.0	> 160
	3	0.7	9.3	90.1	17.9	> 160
	4	1.6	13.6	84.8	17.5	159
Pond 10	1 - 1	0.0	1.2	98.8	13.7	107
	1 - 2	0.0	18.5	81.4	10.1	91
	1 - 3	0.9	33.2	65.9	5.6	67
	5 - 1	0.0	0.7	99.3	11.5	126
	5 - 2	0.1	2.9	97.0	18.7	99
	5 - 3	3.0	50.1	46.9	6.1	82
	7 - 1	0.0	3.2	96.8	10.9	100
	7 - 2	1.1	2.8	96.1	11.1	79
	7 - 3	0.1	5.1	94.7	10.3	78
	8 - 1	0.4	4.2	95.4	10.2	112
	8 - 2	0.0	1.0	99.0	11.7	76
	8 - 3	10.3	14.9	74.8	9.9	100
Pond 11	1 - 1	0.0	13.9	86.1	9.1	85
	1 - 2	3.8	30.4	65.9	8.3	114
	1 - 3	0.0	16.0	84.0	8.0	100
	3 - 1	0.1	3.4	96.5	10.7	107
	3 - 2	0.0	2.1	97.9	10.0	110
	3 - 3	0.0	4.7	95.3	16.0	121
	3 - 4	0.0	0.7	99.3	9.9	112
	3 - 5	0.0	1.4	98.6	10.4	82
	6 - 1	1.2	5.3	93.5	9.6	66
	6 - 2	0.0	5.9	94.1	8.9	80
	6 - 3	0.0	16.5	83.5	11.1	103
	6 - 4	0.0	4.0	96.0	12.1	93
	6 - 5	0.0	6.2	93.8	15.8	80

Table 3. Soil Torvane Shear Strength – Western Salt Ponds

Site Number	Average Shear Strength of Soil kg/cm^2	Standard Error of Mean	Percent Change
Pond 10A			
1	0.050	0.000	-0.50
2	0.167	0.014	-0.56
3	0.367	0.036	0.84
4	0.317	0.036	0.46
5	0.200	0.024	-0.48
6	0.267	0.036	-0.27
Pond 10			
1	0.067	0.014	-0.44
2	0.133	0.014	-
3	0.057	0.003	-
4	0.183	0.036	1.10
5	0.087	0.007	0.30
6	0.070	0.009	-
7	0.117	0.014	-0.18
8	0.050	0.000	-0.59
9	0.023	0.003	-0.80
10	0.033	0.003	-
Pond 11			
1	0.010	0.000	0.00
2	0.017	0.003	4.67
3	0.017	0.005	0.70
4	0.017	0.003	1.43
5	0.183	0.027	0.56
6	0.133	0.027	0.11

- Shear strength was not measured at these sites in 2012

3.0 BIOLOGICAL PROCESSES

3.1 Vascular Plants

Project goals for the western salt ponds included achieving 50% cover by wetland vascular plants in at least 30 acres of Pond 10 by June 2016 and achieving a height of California cordgrass (*Spartina foliosa*) of 60 cm or more for 25% of the cordgrass population within the minimum 30 acres of such habitat in Pond 10 by June 2016. Project goals for the CVWR included: by the end of 2016, achieve 50 percent coverage of cordgrass and pickleweed over the 3-acre excavation area and improve vigor and plant diversity throughout the remaining 16 acres of estuarine intertidal emergent wetlands within the basin; and, by 2016, restore typical marsh vegetation coverage, using marsh coverage at Tijuana Estuary as a target.

In an effort to achieve these goals, salt marsh vascular plants were planted in low, mid- and high marsh elevation zones in Pond 10 and similar habitats at the CVWR as described below.

3.1.1 Mid-Salt Marsh, High Salt Marsh and Transition Zone Plantings in Pond 10

The perimeter of Pond 10, consisting primarily of the slopes and tops of the levees, was planted with 12 species of mid- and high salt marsh and transition zone species (Table 4). Plants were grown in 2.25 by 3-inch rosepot containers by Tree of Life nursery in San Juan Capistrano, California. Pond 11 was not planted as the sediment disposed there during channel dredging was unconsolidated and therefore was subject to change in elevation over time. In addition, the unconsolidated sediments could not support foot traffic nor were they solid enough to retain plants. Pond 10A was not planted due to the high salinity of the soil. In both Pond 10A and Pond 11, natural recruitment by Pacific pickleweed (*Salicornia pacifica*) and Bigelow's pickleweed (*S. bigelovii*) has established relatively large areas of the low and mid-marsh. Several individual California cordgrass (*Spartina foliosa*) were noted in Pond 11. It is assumed that these were established from bare root ramets that were planted in Pond 10 and not from seed. All three ponds are expected to recruit salt marsh species as the physical conditions in each pond change over time.

Planting of mid- and high salt marsh species and transition zone was conducted by Merkel & Associates under contract to SWIA. These plantings were completed on October 17, 2011. The areas planted are depicted in Figure 21 (Figure 2 of the as-built report Merkel & Associates, December 2011). Mid-marsh species were planted between +4.6 and +5.8 ft NAVD88. High marsh species were planted between +5.8 and + 7.6 ft NAVD88. Transition zone plantings were installed above +7.6 ft NAVD88. All transition zone plants were installed with two quart size DriWater© time release gel packs to provide moisture for approximately 90 days. All plants were installed on approximately 6-foot centers.

3.1.2 Monitoring of Mid-Salt Marsh, High Salt Marsh and Transition Zone Plantings in Pond 10

Mid-salt marsh, high salt marsh and transition zone plantings were not monitored in 2013 due to low initial survival in 2012 and the inability to access the mid-marsh plain. Casual observations in 2012 suggested a survival rate in mid-high marsh of less than 50% and less than 25% in the transition zone..

Table 4. Mid- and High Salt Marsh and Transition Zone Plant Species Planted in Pond 10

Common Name	Scientific name	Quantity	Planting Zone
Saltwort	*Batis maritima*	885	Mid-marsh
Jaumea	*Jaumea carnosa*	885	Mid-marsh
Bigelow's Pickleweed	*Salicornia bigelovii*	885	Mid-marsh
Sea-Blite	*Suaeda esteroa*	885	Mid-marsh
Saltgrass	*Distichlis spicata*	405	High marsh
Alkali Heath	*Frankenia salina*	405	High marsh
Watson's saltbush	*Atriplex watsonii*	425	High marsh
Sea Lavender	*Limonium californicum*	405	High marsh
Shoregrass	*Distichlise littoralis*	830	High marsh/Transition

Parish's Pickleweed	*Arthrocnemum subterminale*	830	High marsh/Transition
Boxthorn	*Lycium californicum*	425	Transition zone
Palmer's Frankenia	*Frankenia palmeri*	425	Transition zone
Total		**7,690**	

3.1.3. Monitoring of Low Marsh Plantings in Pond 10

Low salt marsh elevations dominated by California cordgrass (*Spartina foliosa*) were planted in two phases. Phase I occurred between October 17 and October 21, 2011 during which 4,000 nursery grown cordgrass plants (2.25 x 3-inch rose pots) were planted on approximately 6-foot centers and arrays as illustrated in Figure 21 (Figure 2 of the as-built report; Merkel & Associates 2011). Each array was comprised of approximately 30 individual cordgrass plants and were planted at the appropriate elevations along the constructed channels and extended onto the marsh plain for a distance of approximately 20 feet.

Arrays were staggered along the channels approximately every 100 feet. In addition to the arrays, ten 60 ft by 60 ft randomized block study plots were planted with 100 cordgrass plants each on 6-ft centers (Figure 21). These study plots were expanded in Phase II as discussed below.

During Phase II, conducted between November 17 and December 3 2011, 35,700 individual cordgrass were planted. These consisted of additional nursery grown plants as well as plants harvested from a donor site immediately adjacent to Ponds 10 and 11 in the salt marsh of the Otay River. Of these 35,700 individuals 2,800 were nursery grown; 1,000 were harvested "plugs" of cordgrass and sediment defined as a small sod-like block about 6 inches deep and 4 – 6 inches in diameter containing substantial amounts of rhizomes and native soil that serves to buffer the plants during transplanting; and 31,900 plants were planted as "bare root planting units" defined as a ramet of 2 - 3 aerial stems of cordgrass with 2 – 6 inches of rhizome with a minimal amount of native soil attached to the rhizomes.

Figure 21. As-built Salt Marsh Planting in Pond 10 (Figure 2 from As-built Report)

Phase II planting included expansion of the study blocks to include ten 60 by 60 ft randomized study plots with cordgrass plugs each planted with 100 cordgrass plants on 6-ft centers for a total of 1,000 plugs; ten 60 by 60 ft study plots planted with bare root cordgrass on 6-ft centers for a total of 1,000 bare root plants; ten 60 by 60 ft study plots planted with cordgrass grown from seed in the nursery on 6-ft centers for a total of 1,000 bare root plants; and ten unplanted control plots. Thus, each of the 10 study plots included equal size randomized blocks of the three propagation methods (nursery, plugs and bare roots) plus a control plot. The remaining 30,900 bare root plants were planted as shown in Figure 21. Those nursery plants not planted in study plots were planted in area K.

The project originally called for planting approximately 52 acres of low marsh habitat in Pond 10 with 56,874 nursery-grown cordgrass propagated from seed. This decision was based on the restoration team's desire to minimize impacts to existing cordgrass populations associated with the more standard practice of harvesting plugs of cordgrass and transplanting them to the restoration site. The low yield of plants propagated from seed required a change in the planting and also suggested the experimental planting blocks designed to test the effectiveness of each planting and transplantation method. The survival of planted individuals through Year 2 of the Project was monitored as described below. Future monitoring of cordgrass expansion and, potentially, recruitment into control plots, will be conducted using aerial photography.

3.1.4 Methods - Monitoring of Randomized Block Cordgrass Study Plots in Pond 10

Cordgrass canopy development within each treatment block was assessed on October 3, 2013 and consisted of estimating per cent cover of live individuals within each block. Treatment blocks were accessed by canoe. The soil salinity of each block was measured by expressing a sample of soil at approximately 5 – 10 cm below surface through a syringe with filter paper onto a salinity refractometer.

3.1.5 Results – Monitoring of Randomized Cordgrass Study Plots in Pond 10

The results of the survey are summarized in Table 5. Nursery-grown plants and transplanted plugs achieved similar estimated mean coverage by cordgrass at 13% and 12%, respectively, although results were somewhat variable. Percent cover of nursery grown cordgrass ranged from 1% to 30% while cover by plugs ranged from 4% to 20%. Bare root plantings had an estimated mean cover of 2.9% with a low of 0% and a high of 15%. The 15% estimated cover by bare root plantings in block 9 is noteworthy as initial assessment of survival of the bare root treatment in this block was 0% in 2012. Similarly, the initial assessment for bare root plantings in blocks 6 and 10 were 0% while each was estimated to have 2% cover in 2013. Transplanted cordgrass rhizomes frequently survive below ground while above ground biomass appears dead or has decomposed and subsequently support aerial shoots one or more growing seasons afterward. This appears to be the case in some of the bare root treatments; however, mean coverage remains well below plugs and nursery grown plants.

Table 5. Estimated Percent Cover of *Spartina foliosa* in Pond 10 October 3, 2013. Cover of *S. foliosa* and *Salicornia bigelovii* combined in parentheses.

Plot	Bare Root	Nursery-Grown	Plugs	Control	Soil Salinity
1	0% (25%)	7.5% (15%)	20% (25%)	0 (0%)	54 ppt
2	1% (22.5%)	7.5% (17.5%)	17.5% (22.5%)	0 (3%)	50 ppt
3	<1% (2%)	4% (6%)	20% (21%)	1% (2%)	46 ppt
4	4% (20%)	3% (25%)	4% (25%)	2% (5%)	47 ppt
5	2% (12%)	20% (35%)	7% (15%)	3% (15%)	46 ppt
6	2% (3%)	25% (26%)	10% (18%)	<1% (4%)	63 ppt
7	2% (4%)	30% (50%)	4% (45%)	1% (30%)	45 ppt
8	<1% (<1%)	1% (1.5%)	10% (12%)	<1% (1%)	47 ppt
9	15% (20%)	7% (17%)	12.5% (13%)	2% (2.5%)	46 ppt
10	2% (4%)	25% (26%)	15% (15.5%)	2% (3%)	45 ppt
Mean*	2.9% (11.3%)	13% (21.9%)	12% (21.2%)	1.2% (7.6%)	48.9 ppt
Standard Deviation	4.4 (9.7)	10.7 (14)	6 (9.6)	1.0 (8.9)	5.7

* Estimated coverage values of <1% were assigned a value of 0.5% for determination of mean and standard deviation.

It should be noted that cordgrass did occur at low percent cover in the control plots in Year 2. This appeared to be the result of vegetative spread of the planted cordgrass (bare roots, plugs and nursery) in adjacent plots and not from germination from seed.

There was substantial natural recruitment of both the perennial Pacific pickleweed (*Salicornia pacifica*) and the annual Bigelow's pickleweed (*S. bigelovii*) during the Year 2 growing season. While *S. pacifica* colonized the mid-high marsh plain, *S. bigelovii* colonized the low marsh intended for cordgrass. This is typical of south San Diego Bay where cordgrass and Bigelow's pickleweed co-occur; however, it is unclear at this time whether cover by *S. bigelovii* during the growing season will inhibit the formation of monotypic stands of cordgrass favored by the light-footed clapper rail. Thus, beginning in Year 2, cover by *S. bigelovii* was monitored in all treatments of the randomized block planting experiment. In many cases, *S. bigelovii* accounted for the majority of the cover in the treatment plots. Most notably, *S. bigelovii* and *S. foliosa* combined cover in plot 7 plugs was estimated at 45% while *S. foliosa* alone was estimated at 4% cover (Table 5). In the control plot for plot 7, cordgrass cover was estimated at 1% while combined cover was estimated at 30%. Thus, annual pickleweed has become established in all treatment blocks, often at relatively high density. *S. bigelovii* becomes senescent at the end of each growing season while cordgrass continues to grow below ground during fall and winter. It is possible that this life history strategy could impart a competitive advantage to cordgrass leading to successful establishment of dense monotypic stands. Future monitoring will focus on the interaction of these two species as well as estimates of cover using aerial photography.

3.1.6 Monitoring of Vascular Plants in the Chula Vista Wildlife Reserve

The CVWR component of the Project restored 11 acres of salt marsh habitat and enhanced 32 acres of salt marsh through improved tidal influence at the site. The restored habitats included low, mid- and high salt marsh planted from existing marsh that was salvaged prior to construction impacts and supplemented with nursery grown plants. The enhanced habitats were expected to benefit from increased tidal circulation associated with a series of new tidal channels excavated in the existing marsh plain.

Nine species of salt marsh vascular plants were planted at the CVWR. These were salvaged from existing salt marsh on-site and supplemented with nursery stock as presented in Table 6. All species were replanted following completion of construction.

Table 6. Salt Marsh Plant Species Planted in the Chula Vista Wildlife Reserve

Habitat Zone	Species	Planting Unit	Count
Low Salt Marsh	*Batis maritima*	Plugs	181 Salvaged Plugs
	Salicornia pacifica	72” X 36” X 10” sods	129 Salvaged Sods
	Spartina foliosa	Bare Root Plugs	1,432 Bare Root Plugs
Mid Salt Marsh	*Batis maritima*	Plugs	96 Salvaged Plugs
	Frankenia salina	1-Gallon	214 Containers
	Spartina foliosa	Bare Root Plugs	190 Bare Roots Plugs
	Salicornia pacifica	72” X 36” X 10” sods	137 Salvaged Sods
	Suaeda taxifolia	1-Gallon	69 Containers
High Salt Marsh	*Distichlis spicata*	Plugs	74 Nursery Plugs
	Frankenia salina	1-Gallon	74 Containers
	Distichlise littoralis	Plugs	132 Salvaged Plugs
	Suaeda taxifolia	1-Gallon	47 Containers
	Salicornia subterminalis = Arthrocnemum subterminale	1-Gallon	81 Salvaged Containers
Total			2,856 Units

3.1.7 Methods – Monitoring of Vascular Plants in the Chula Vista Wildlife Reserve

The success of the salt marsh plantings at the CVWR was assessed at four monitoring stations: three restoration stations and one reference station (see Figure 20). At each station a baseline was established perpendicular to the tidal channel, extending from the low marsh up to the mid-marsh. Four 50-m transects were established perpendicular to the baseline. Two extended across low marsh plain and two across the mid-marsh plain. Point intercept data were recorded along each transect at 1-m intervals and data was presented as percent cover.

3.1.8 Results – Monitoring of Vascular in the Chula Vista Wildlife Reserve

Monitoring of planted salt marsh habitats in Year 1 using the point intercept method revealed that the planted area was largely bare with an average of 4% cover (Merkel & Associates, May10, 2012). The dominant species was naturally recruited Bigelow’s pickleweed (2.3%) followed by Pacific pickleweed (0.7%), naturally recruited sea-blight (0.3%) and shoregrass

(0.2%). Additional species present included California cordgrass, saltwort and alkali heath – all of which were planted. Low percent cover is common following planting of wetland restoration sites and is not necessarily indicative of poor survival.

In Year 2, mean percent cover in the planted marsh was 25.5% (SD = 25.7%). By comparison, mean percent cover in the reference marsh was 96.0% (SD = 3.2%) in Year 1 and 99.5 % (SD = 1) during Year 2. Like Pond 10 salt marsh habitat, planted species at the CVWR are expected to expand in cover in subsequent years.

During Year 2, the dominant species observed was *S. bigelovii*. Mean cover of this species at the three monitoring stations ranged from 5.5% to 34.0%. Pacific pickleweed mean cover ranged from 0.5% to 3.5%. Future monitoring will provide additional data on the interaction between *S. bigelovii* and *S. foliosa*.

In summary, initial plantings of low, mid- and high salt marsh vascular plant species in Pond 10 had low to moderate survival. However, natural recruitment by Pacific pickleweed in the mid-high marsh and by Bigelow's pickleweed in the low marsh, along with survival of planted cordgrass indicates that Project goals for vascular plants and salt marsh habitats will be achieved by 2016. Similarly, planted species at the CVWR are expected to benefit from improved tidal influence and expand in subsequent years to meet the 2016 goals for this portion of the Project.

3.2 Fish Monitoring

The NOAA metric for fish at the western salt ponds was to demonstrate presence of one or more of the target taxa (flatfish and elasmobranchs) by 2013. At CVWR, the NOAA metric for fish was to demonstrate presence of one or more of the target taxa (gobiidae and topsmelt) by 2013. At both sites, NCWC objectives were to achieve successful recruitment of benthic invertebrates and fish within Pond 11 to support migratory shorebirds and foraging ground-nesting seabirds by 2013.

In Year 2, fish were monitored using a variety of sampling gear, including minnow traps, enclosure traps and otter trawls. The Project monitoring plan had specified the use of beach seines and blocking nets; however, the soft substrate in Ponds 10 and 11 precluded this method and the trawls, traps and enclosures were used exclusively in Year 1 and Year 2.

3.2.1 Methods - Fish and Invertebrates Collected Using Otter Trawls in the Western Salt Ponds

Otter trawls were conducted in Ponds 10 and 11 on September 25, 2013. The otter trawl was a 12-foot semi-balloon otter trawl with 1-inch mesh netting lined with 0.25-inch knotless mesh netting.

The trawls were towed behind a small, shallow-draft vessel at approximately 2.5 – 3.5 knots. All trawls were towed for approximately 100 meters once the net was on the bottom. All collected trawls were towed within a tide range of approximately +3.0 to +4.5-ft MLLW (+2.82 to +4.32-ft

NAVD88). This tidal range allowed most trawls to be performed with mudflats visible to aid navigation. Weather conditions were good for the survey with clear skies, light winds and calm water.

A total of 11 otter trawls were collected (Figure 22). The otter trawls were designated as stations 15-23. Stations 1 – 12 were sampled with a beam trawl in 2012. That methodology was dropped for the current effort. All stations were performed as planned except for station 18 which was moved slightly relative to the 2012 sampling.

All captured fish were identified to species, weighed, and measured. Fish lengths were measured as total length. For stingrays, length measurements consisted of disc length. When more than 30 individuals of a given species were captured, the remaining individuals were counted and weighed. In the event that there were very high numbers of a species captured, 100 individuals were counted and weighed; the data allowed the remaining number of individuals to be estimated by weighing the remaining fish as a batch.

In addition to the captured fish, data were collected for invertebrates and marine debris captured within each trawl. Marine debris was simply noted as present in the trawls. Marine debris generally consisted of pieces of drift or unattached algae and were not part of the investigation. Invertebrates were noted for presence.

3.2.2 Results – Monitoring of Fish and Invertebrates Using Otter Trawls in the Western Salt Ponds

Fish

A total of 1,915 individuals representing 11 species and 9 families were collected (Table 7). In terms of relative abundance, otter trawls were dominated by juvenile slough anchovy (*Anchoa delicatissima*; 1,388) and juvenile deepbody anchovy (*A. compressa;* 454) which combined comprised 96.2% of the catch. The majority of the slough and deep body anchovies measured approximately 2-5 cm and weighed approximately 0.1 to 0.5 gm. Round stingrays (*Urobatis halleris*) dominated the otter trawls in terms of biomass. Photographs of representative fish species collected during the trawling effort are presented in Figure 23.

By comparison, otter trawls conducted in 2012 captured a total of 501 individuals representing 7 families in 11 trawls for an average capture of 45.5 fish per effort. The trawls were dominated by juvenile slough anchovy (267) and juvenile topsmelt (*Atherinops affinis*; 40). The majority of slough anchovy and topsmelt measured approximately 3-4 cm and weighed approximately 0.5 gm. Round stingrays dominated the otter trawls in terms of biomass.

The presence of round stingray, bat ray, California halibut (*Paralichthys californicus*) and diamond turbot (*Hypsopsetta guttulata*) in the 2013 surveys meets the NOAA metric for fish (elasmobranchs and flatfishes). Recruitment of fish species that provide forage for ground nesting seabirds meets the NCWC Project objectives. Thus, the Project goals for fish in Ponds 10 and 11 are considered met.

Invertebrates and Marine Algae

Thirteen species of invertebrates were collected in the trawls, including gastropods, bivalve molluscs, decapod crustaceans, and one species of sponge (Table 8). Three species of marine algae were also collected. The sessile invertebrate *Zoobotryon verticillatum* and Asian mussel (*Muscalista senhousia*) were the most common.

Figure 22

Otter Trawl Sampling Locations – Western Salt Ponds.

Table 7. Fish Collected Using Otter Trawls Western Salt Ponds.

Family	Species	Common Name	Total Collected	% of Total
Family	**Species**	**Common Name**	**Total Collected**	**% of Total**
Engraulidae	*Anchoa delicatissima*	slough anchovy	1,388	72.5%
	Anchoa compressa	deepbody anchovy	454	23.7%
Dasyatidae	*Urobatis halleris*	round stingray	58	3.0%
Bothidae	*Paralichthys californicus*	California halibut	4	0.2%
Pleuronectidae	*Hypsopsetta guttulata*	diamond turbot	3	0.2%
Sciaenidae	*Cynoscion parvipinnis*	shortfin corvina	3	0.2%
	Seriphus politus	yellowfin croaker	1	0.1%
Myliobatidae	*Myliobatis californica*	bat ray	1	0.1%
Carcharhinidae	*Mustelus californicus*	gray smoothhound shark	1	0.1%
Syngnathidae	*Syngnathus leptorynchus*	bay pipefish	10	0.1%
Clinidae	*Cynoscion parvipinnis*	giant kelpfish	1	0.1%

Table 8. Invertebrates and Algae Collected Using Otter Trawls Western Salt Ponds

Scientific Name	Common Name	Taxon
Muscalista senhousia	Japanese oyster	Bivalve mollusc
Macoma sp.	bent-nosed clam	Bivalve mollusc
Alpheus californiensis	pistol shrimp	Decapod crustacean
Hemisquilla californiensis	mantis shrimp	Decapod crustacean
Hippolyte californiensis	California glass shrimp	Decapod crustacean
Hemigrapsus oregonensis	yellow shore crab	Decapod crustacean
Cerithidia californica	California hornsnail	Gastropod mollusc
Navanax inermis	navanax	Gastropod mollusc
Crassostrea gigas	Pacific oyster	Bivalve mollusc
Aphrocallistes sp.	cloud sponge	Porifera
Obelia sp.	obelia	Hydozoa
Crepidula sp.	slipper limpet	Gastropod mollusc
Ophiuriodea sp.	brittle star	Ophiuroid echinoderm
Zoobotryon verticillatum.	zoobotryon	Bryozoa
Gracillaria sp.	gracillaria	Algae
Ulva intestinalis	enteromorpha	Algae
Ulva lactuca	sea lettuce	Algae

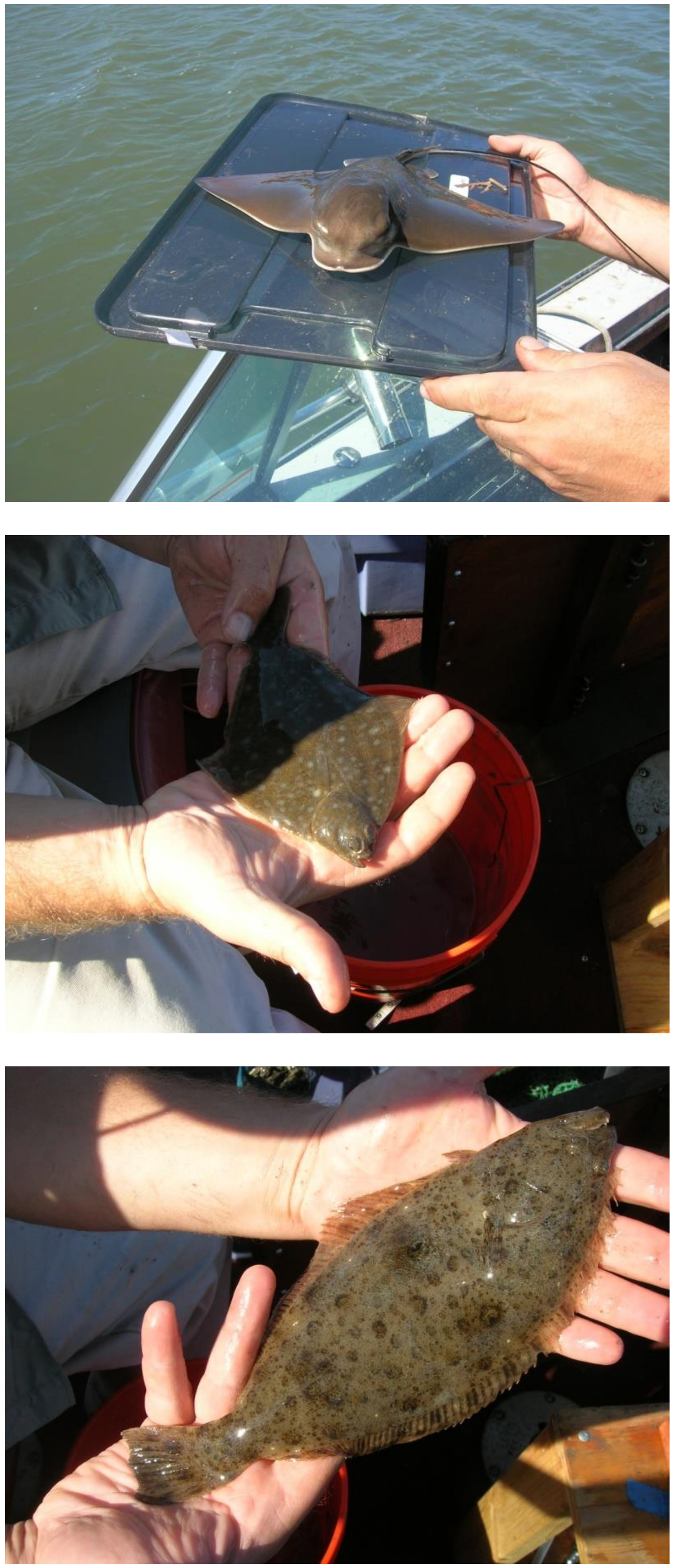


Figure 23. Photograph of Trawl Results [bat ray (top); diamond turbot (middle) and California halibut (bottom)]

3.2.3 Methods - Fish and Invertebrates Collected Using Minnow Traps in the Western Salt Ponds

In order to provide a general characterization of fish populations in the salt ponds, minnow traps were deployed in Ponds 10A, 10, and 11 (Figure 24). The traps were deployed just offshore at low tide to a depth of complete submersion and left for 24 hours. Due to the traps resting on the substrate, the fish sampled were primarily limited to those that reside or feed in the benthic zone. The locations of trap deployment were based on the availability to safely walk without disturbing bird nesting areas along the levees and ease of accessing the site without significantly sinking in the mud. Due to the transport of fine sediment, resulting in local shoaling in the northwest corner of Pond 11 it was impossible to, on foot, deploy a minnow trap at site 9 and have it submerged during low tides. Site 9 was abandoned and moved to a location between sites 10 and 11 (see 423).

Minnow traps were deployed on 6 occasions – once each in January, March, May, July, September and November, 2013. Sampling consisted of retrieving the traps at low tide, emptying the trap in a bucket of site water, measuring the lengths of the first 20 fish of each species to the nearest centimeter, and counting the remaining fish, grouped by species. Most of the species were identified in the field and the majority was released alive. Those species not identified in the field were brought back to the lab, identified, and released.

3.2.4 Results – Monitoring of Fish and Invertebrates Using Minnow Traps in the Western Salt Ponds

A total of 262 individual fish representing 4 species and 4 families were collected at the 11 sampling sites within the western salt ponds using minnow traps (Table 9). This is down significantly from last year's total of 642 individuals. The dominant species collected was again longjaw mudsucker (*Gillichthys mirabilis*) with 172 individuals representing 61% of the catch (55% last year). California killifish (*Fundulus parvipinnis*) was the second most abundant species with 88 individuals collected over the 6 monitoring dates (31%; 46% last year). One individual of each of the following species were also caught: diamond turbot and a species of bass (*Paralabrax sp.*).

The majority of all individuals, 90%, were collected from Pond 10A, compared to 9% in Pond 10. Only 1 individual was caught in Pond 11. This bias was likely caused by the location of the traps. The traps in Pond 10A were restricted to the narrow inlet in the northwest corner through which fish must traverse to enter the pond. Three of the 4 traps in pond 10 were located in the farthest southeast corner of the pond and all of the Pond 11 traps were located along the northern most shore of the pond. Fish populations, particularly benthic fishes, are likely still adjusting to the sediment movement in both ponds. Populations are expected to increase as the sediment consolidates. Future monitoring will determine whether this hypothesis is valid.

Figure 24. Minnow Trap Sampling Stations Western Salt Ponds.

Invertebrates collected using minnow traps in the western salt ponds included 6 species of decapod crustaceans and one species of gastropod mollusc (Table 9). Decapod crustaceans were dominated by oriental shrimp (*Palaemon macrodactylos*) and yellow shore crab (*Hemigrapsus oregonenisis*). Of the 88 individuals collected, approximately 80% were yellow shore crab and 13% were oriental shrimp. The remainder consisted of 2 striped shore crabs (*Pachygrapsus crassipes*), 1 black-clawed crab (*Lophopanopeus bellus*), and 2 nassa mud snails (*Nassarius sp.*). The majority of invertebrates were collected in Ponds 10A and 10.

3.2.5 Methods – Monitoring of Fish and Invertebrates Using Minnow Traps in the Chula Vista Wildlife Reserve

Minnow traps were deployed within the CVWR at sampling sites 2, 3, 4 and 6 (see Figure 9) on September 19, 2013. Like the traps set at the western salt ponds, traps were deployed in the channels at low tide to a depth of complete submersion and left for 24 hours.

3.2.6 Results – Monitoring of Fish and Invertebrates Using Minnow Traps in the Chula Vista Wildlife Reserve

A total of 17 fish were captured in the minnow traps at the CVWR (Table 9). California killifish had the highest total, representing 94% of the total catch. Only 1 longjaw mudsucker was caught. Four California green shrimp (*Hippolyte californiensis*) and 3 yellow shore crabs were also caught.

Table 9. Fish and Invertebrates Collected Using Minnow Traps Western Salt Ponds.

Species		Minnow Traps																							
		Pond 10A																							
Scientific Name	Common Name	January				March				May				July				September				November			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Fundulus parvipinnis	California Killifish											4	21	10		4		31		14					
Gillichthys mirabilis	Longjaw Mudsucker		1	1			1	1	2	15	2	23	37	20	5	7	32		2		4				
Paralabrax sp.	Bass																								
Hypsopsetta guttulata	Diamond Turbot																								
Alpheus Californiensis	Californial Pistol Shrimp																								
Hippolyte californiensis	California Green Shrimp																								
Palaemon macrodactylos	Oriental Shrimp																								
Pachygrapsus crassipes	Striped Shore Crab																		1			1			
Hemigrapsus oregonensis	Yellow Shore Crab	14	6	10		2	1	4	8											2		3	3	1	5
Lophopanopeus bellus	Black-clawed crab																				1				
Nassarius sp.	Nassa Mud Snail																								
	Total ***Fish*** Abundance per Site	0	1	1	0	0	1	1	2	15	2	27	58	30	5	11	32	31	2	14	4	0	0	0	0
	Mean ***Fish*** Abundance per Site	0.5				1.0				25.5				19.5				12.8				0.0			
	Mean ***Fish*** Abundance per Site per Pond, All Surveys	9.9																							
	Fish Species Richness per Pond, All Surveys	2																							
	Total ***Invertebrate*** Abundance per Site	14	6	10	0	2	1	4	8	0	0	0	0	0	0	0	0	0	1	2	1	4	3	1	5
	Mean ***Invertebrate*** Abundance per Site	7.5				3.8				0.0				0.0				1.0				3.3			
	Mean ***Invertebrate*** Abundance per Site per Pond, All Surveys	2.6																							
	Invertebrate Species Richness per Site per Pond, All Surveys	3																							

Species		Minnow Traps																							
		Pond 10																							
Scientific Name	Common Name	January				March				May				July				September				November			
		5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
Fundulus parvipinnis	California Killifish					3				1															
Gillichthys mirabilis	Longjaw Mudsucker									19															
Paralabrax sp.	Bass																								
Hypsopsetta guttulata	Diamond Turbot									1															
Alpheus Californiensis	Californial Pistol Shrimp															1				1					
Hippolyte californiensis	California Green Shrimp																								
Palaemon macrodactylos	Oriental Shrimp					3	3			2	2														
Pachygrapsus crassipes	Striped Shore Crab																								
Hemigrapsus oregonensis	Yellow Shore Crab	3	2	1	1	3																			
Lophopanopeus bellus	Black-clawed crab																								
Nassarius sp.	Nassa Mud Snail																								
	Total ***Fish*** Abundance per Site	0	0	0	0	3	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean ***Fish*** Abundance per Site	0.0				0.8				5.3				0.0				0.0				0.0			
	Mean ***Fish*** Abundance per Site per Pond, All Surveys	1.0																							
	Fish Species Richness per Pond, All Surveys	3																							
	Total ***Invertebrate*** Abundance per Site	3	2	1	1	6	3	0	0	2	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0
	Mean ***Invertebrate*** Abundance per Site	1.8				2.3				1.0				0.3				0.3				0.0			
	Mean ***Invertebrate*** Abundance per Site per Pond, All Surveys	0.9																							
	Invertebrate Species Richness per Site per Pond, All Surveys	1																							

Species		Minnow Traps																					
		Pond 11																		CVWR			
Scientific Name	Common Name	January			March			May			July			September			November			September			
		9	10	11	9	10	11	9	10	11	9	10	11	9	10	11	9	10	11	2	3	4	6
Fundulus parvipinnis	California Killifish																			15			1
Gillichthys mirabilis	Longjaw Mudsucker																						1
Paralabrax sp.	Bass														1								
Hypsopsetta guttulata	Diamond Turbot																						
Alpheus Californiensis	Californial Pistol Shrimp																						
Hippolyte californiensis	California Green Shrimp																					3	1
Palaemon macrodactylos	Oriental Shrimp											1											
Pachygrapsus crassipes	Striped Shore Crab																						
Hemigrapsus oregonensis	Yellow Shore Crab			1																			3
Lophopanopeus bellus	Black-clawed crab																						
Nassarius sp.	Nassa Mud Snail							2															
	Total ***Fish*** Abundance per Site	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	15	0	0	2
	Mean ***Fish*** Abundance per Site	0.0			0.0			0.0			0.0			0.3			0.0			4.3			
	Mean ***Fish*** Abundance per Site per Pond, All Surveys	0.1																					
	Fish Species Richness per Pond, All Surveys	1																		2			
	Total ***Invertebrate*** Abundance per Site	0	0	1	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	3	4
	Mean ***Invertebrate*** Abundance per Site	1			0			2			1			0			0			1.75			
	Mean ***Invertebrate*** Abundance per Site per Pond, All Surveys	0.2																					
	Invertebrate Species Richness per Site per Pond, All Surveys	3																		2			

3.2.7 Methods - Monitoring of Fish Using Enclosure Traps in the Western Salt Ponds and Chula Vista Wildlife Reserve

Following the sampling protocol of the San Onofre Nuclear Generating Station (S.O.N.G.S.) Wetland Mitigation Program, an enclosure trap (Figure 25) was employed to sample primarily gobies (family *Gobiidae*), small, burrowing fishes that are often poorly sampled by other methods. The enclosure trap is composed of a polypropylene sheet fixed as a 1m-tall cylinder with a $0.4m^2$ sampling area. The trap is thrown away from the sampler in an attempt to minimize the startling of any fish nearby. A BINCKE net is then swept inside the trap and fish were identified by species, counted, measured for length, and released. This was repeated until no fish were caught a total of 3 times. The trap was deployed at 6 sites in each of ponds 10A and 10 (see Figure 7) and at the 6 sampling sites at the CVWR (see Figure 9).

3.2.8 Results – Monitoring of Fish Using Enclosure Traps in the Western Salt Ponds and Chula Vista Wildlife Reserve

The results of enclosure trap sampling at the western salt ponds and the CVWR are presented in Table 10. Three individuals, including two longjaw mudsuckers and one California killifish were captured at the 6 sites within Pond 10A. The enclosure traps deployed at the 6 sites in Pond 10 caught a total of 14 fish; 11 arrow gobies (*Clevelandia ios*) and 3 slough anchovies.

Figure 25 - Enclosure Trap.

Table 10. Fish and Invertebrates Collected Using Enclosure Traps Western Salt Ponds and Chula Vista Wildlife Reserve

Species		Enclosure Traps																	
Scientific Name	Common Name	Pond 10A						Pond 10						Chula Vista Wildlife Reserve					
		1	2	3	4	5	6	1	4	5	7	8	9	1	2	3	4	5	6
Atherinops affinis	Topsmelt													1					
Clevelandia ios	Arrow Goby							5			1	1	4	7	1	1	1		
Acanthogobius flavimanus	Yellowfin Goby														1				
Fundulus parvipinnis	California Killifish					1													1
Anchoa delicatissima	Slough Anchovy												3					1	
Gillichthys mirabilis	Longjaw Mudsucker		2															1	
Syngnathus leptorhynchus	Bay Pipefish													1					
Urobatis halleris	Round Stingray																1		
Alpheus californiensis	Pistol Shrimp									2		3						2	
Pseudosquilliopsis marmorata	Mantis Shrimp									1		1							
Hippolyte californensis	California Green Shrimp																1	1	
Hemigrapsus oregonensis	Yellow Shore Crab	3						2											2
Cerithidea californica	California Horn Snail			7															117
Macoma nasuta	Bent-nosed Clam								3	4		2	10	1	26	13	14	2	5
Protothaca staminea	Pacific littleneck clam													1			1		1
Tagelus californianus	California Jackknife Clam																	1	
Musculista senhousia	Asian Mussel								1		1		2			104	18		
Total ***Fish*** Abundance per Site		0	2	0	0	1	0	5	0	0	1	1	7	9	2	1	2	2	1
Mean ***Fish*** Abundance per Site		0.5						2.3						2.8					
Fish Density per Pond (#/m^2)		1.3						5.8						7.1					
Fish Species Richness per Pond		2						2						8					
Total ***Invertebrate*** Abundance per Site		3	0	7	0	0	0	2	4	7	1	6	12	2	26	117	34	6	125
Mean ***Invertebrate*** Abundance per Site		1.7						5.3						51.7					
Invertebrate Density per Pond (#/m^2)		4.2						13.3						129.2					
Invertebrate Species Richness per Pond		2						5						8					

A total of 17 individual fish were collected from the 6 sampling sites located at the CVWR, down from 79 the previous year. The arrow goby was the dominant species collected at 10 individuals, comprising 59% of the catch (Table 10). Seven other species, including a bay pipefish (*Syngnathus leptorhynchus*) and a round stingray (*Urobatis halleris*), were caught throughout the reserve. Eight invertebrate species, for a total of 310 individuals, were also captured (Table 10). The dominant species were the Asian mussel (*Musculista senhousia*; 39%), the California horn snail (*Cerithidea californica*; 38%), and the bent-nose clam (*Macoma nasuta*; 20%).

3.2.9 Methods - Monitoring of Fish Using Seines in the Chula Vista Wildlife Reserve

Due to the lack of great success catching fish with either minnow traps or enclosure traps, it was deemed suitable to seine at two locations at the CVWR. Following the protocols of the monitoring plan of the S.O.N.G.S. Wetland Mitigation Program, a small purse seine (6m wide) and blocking nets were used to help better characterize the fish populations there. Blocking nets were spaced approximately 5 meters apart. The seine was hauled 5 times before closing and retrieving the blocking nets, for a total of 7 hauls. After each haul, organisms were retrieved from the nets, placed in buckets, identified, measured (first 30 of each species), counted, and released.

3.2.10 Results - Monitoring of Fish Using Seines in the Chula Vista Wildlife Reserve

Upon setting the blocking nets at site 1, the width of the channel was approximately 4.5 m, resulting in an area being seined of about 22.5 m^2. A total of 9 species of fish were caught, totaling 284 individuals (Table 11). The majority were California killifish which comprised 60% of the catch, followed by topsmelt (21%) and arrow goby (15%). Two species of demersal fish, round sting ray and California butterfly ray (*Gymnura marmorata*) were also caught. The density of fish at this site was 12.6 individuals/m^2.

When setting the blocking nets at site 2, the width of the channel was approximately 4 m, resulting in an area being seined of about 20 m^2. Fewer species (5) were caught at site 2, totaling 161 individuals. The majority were California killifish comprising 66%; arrow goby 21%; and shadow goby (*Quietula y-cauda*) 9%. The density of fish at this site was 8.1 individuals/m^2.

Table 11.Fish and Invertebrates Collected Using a Purse Seine and Blocking Nets at the Chula Vista Wildlife Reserve

Species		Seines CVWR	
Scientific Name	Common Name	1	2
Atherinops affinis	Topsmelt	60	4
Clevelandia ios	Arrow Goby	42	34
Quietula y-cauda	Shadow Goby	3	14
Fundulus parvipinnis	California Killifish	170	106
Anchoa compressa	Deepbody Anchovy	2	
Gillichthys mirabilis	Longjaw Mudsucker	1	3
Syngnathus leptorhynchus	Bay Pipefish	4	
Urobatis halleris	Round Stingray	1	
Gymnura marmorata	California Butterfly Ray	1	
Alpheus californiensis	Pistol Shrimp		26
Hippolyte californensis	California Green Shrimp	7	2
Hemigrapsus oregonensis	Yellow Shore Crab	5	1
Lophopanopeus bellus	Black-clawed Crab	1	
	Total ***Fish*** Abundance per Site	284	161
	Fish Species Richness	9	5
	Fish Density per Site (#/m^2)	12.6	8.1
	Overall ***Fish*** Abundance	445	
	Overall ***Fish*** Species Richness	9	
	Overall ***Fish*** Density (#/m^2)	10.5	
	Total ***Invertebrate*** Abundance per Site	13	29
	Invertebrate Species Richness	3	3
	Invertebrate Density per Site (#/m^2)	0.6	1.5
	Overall ***Invertebrate*** Abundance	42	
	Overall ***Invertebrate*** Species Richness	4	
	Overall ***Invertebrate*** Density (#/m^2)	1.0	

The presence of gobies and topsmelt found in enclosure traps and purse seines at the CVWR meets the NOAA metric for target taxa (gobies and topsmelt). In addition, the recruitment of fish in the restored site demonstrates the NCWC objective for support of foraging shorebirds and ground-nesting birds.

3.3 Benthic Macroinvertebrates

NCWC grant objectives for both the CVWR and western ponds included: by March 2013, achieve successful recruitment of benthic invertebrates and fish to support migratory shorebirds and foraging ground-nesting seabirds. In order to demonstrate such a trend, benthic macroinvertebrate infauna and epifauna were monitored using the methods described below.

3.3.1 Methods – Monitoring of Benthic Macroinvertebrates in the Western Salt Ponds

Two sets of cores were collected to characterize the infaunal invertebrate assemblage at the western salt ponds. These included large cores for taxa such as bivalves and large crustaceans, and small cores for smaller macrofuana. The large cores were 10 cm in diameter and were expressed into the sediment to a depth of 50 cm. The cores were then sieved through a 3-mm screen in the field with organisms identified, counted and released. Six channel-bottom sites were sampled in each pond using the large cores, and an additional 6 tidal flat sites (i.e. on the flat adjacent to the channel site) were sampled in Pond 11 (see Figure 7).

For the large infauna, two large cores were taken at each sampling site in 2012. Because very few invertebrates were sampled that year, it was decided to increase the number of cores taken per site. In 2013, a total of 9 cores were taken at each site, 3 in the middle of the channel and 3 near the edges on either side of the channel.

Methods and results for smaller infauna collected in the western ponds using small cores were not available for the Year 1 report. Therefore, this Year 2 report includes the methods and results in preconstruction sampling as well as sampling in Year 1 and Year 2.

The cores for the smaller infaunal invertebrates were collected at each site using a small push core (6 cm long, 4.8 cm diameter). The cores were preserved in the field in 8% buffered formalin and Rose Bengal and processed in that laboratory at California State University, Long Beach (CSULB). In the laboratory, the cores were sieved through a 300 micron mesh, identified, counted and preserved in 70% ethanol. All individuals in each replicate sample were sorted to the lowest practical taxonomic level. Sampling methodologies are the same used in the Huntington Beach Wetlands Restoration Project Monitoring Program, allowing for comparison across these two restoration efforts.

Sampling station locations for collection of smaller cores are illustrated in Figure 26. In fall 2011 (preconstruction), sampling was not completely replicated with six total samples collected, two each in Pond 10 subtidal, Pond 10 intertidal and Pond 11 panne (marsh plain). Cores were only 2 cm in depth. These were used as baseline comparisons with future years.

In fall 2012 (Year 1), 6 samples were collected at each of four sampling stations: Pond 10A subtidal; Pond 10 subtidal; Pond 11 subtidal and Pond 11 intertidal (mudflat). Cores included 0-6 cm depths, but only 0-2 cm depths were reported for comparison with preconstruction results. In spring 2013, the 2012 methodology was replicated and only the 0-2 cm depths were reported. In addition, organisms collected using small cores were analyzed by CSULB for stable carbon and nitrogen isotopes. The results are expected to be available for the Year 3 report.

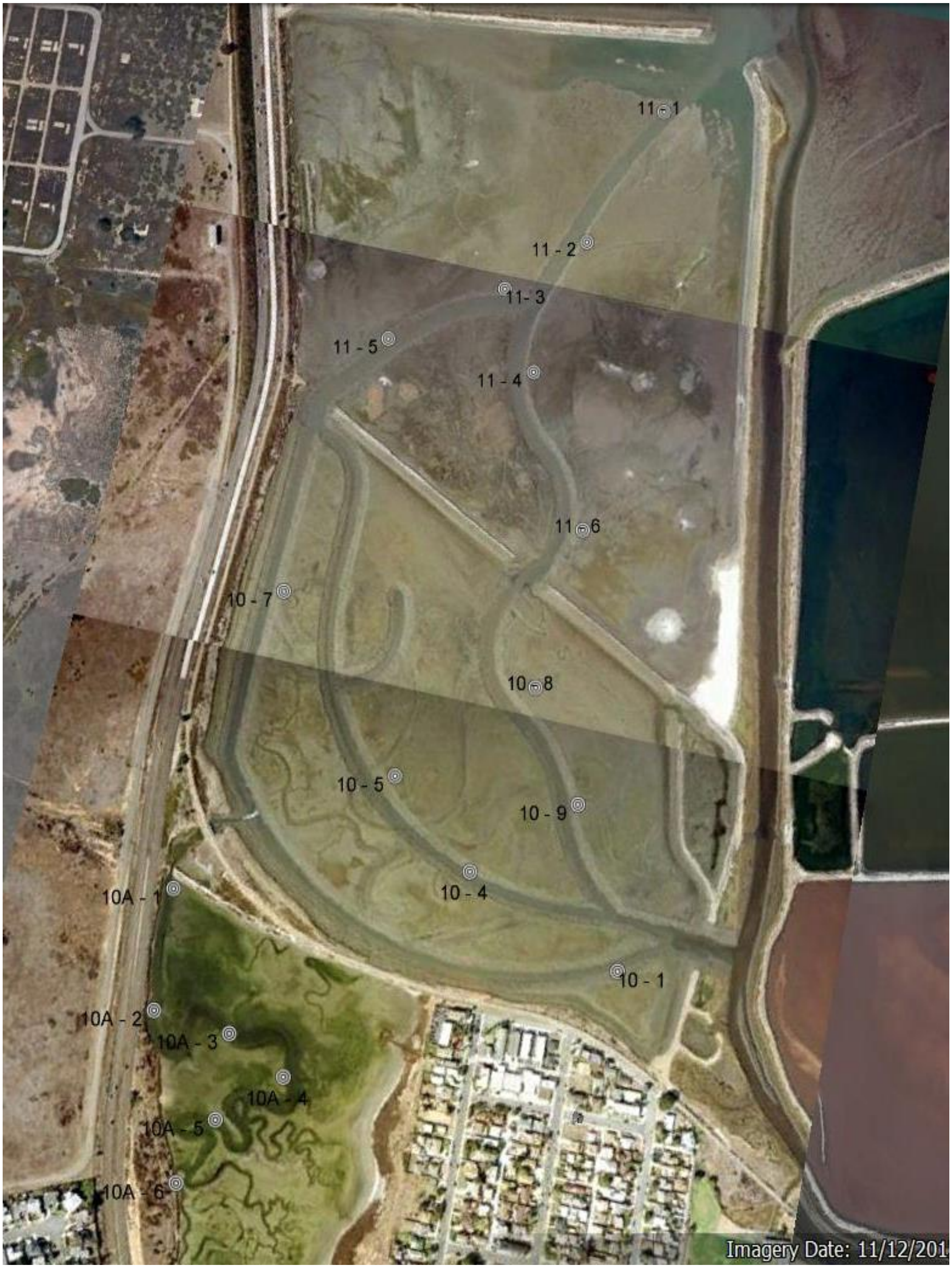


Figure 26. Locations of Sampling Stations – Small Cores.

3.3.2 Results – Monitoring of Benthic Macroinvertebrates in the Western Salt Ponds

Large Cores. The results of infaunal monitoring at the western salt ponds using large cores and 3 mm mesh sieve are presented in Table 12. Pond 10A had a total of 50 individual invertebrates, with the majority (94%) of them being the California horn snail (*Cerithidea californica*). Pond 10 had the highest species richness with respect to invertebrates, exhibiting 7 species and a total of 61 individuals. The California jackknife clam (*Tagelus californianus*) was the most abundant (43%), followed by the California horn snail (31%) and the Asian mussel (*Musculista senhousia*; 13%). A total of 59 individuals were sampled in Pond 11, with the majority being the Asian mussel (88%) and the California jackknife clam (9%). Mean densities per site for Ponds 10A, 10, and 11 were 118, 144, and 139 individuals/m^2, respectively.

Table 12. Infauna and Epifauna Collected at the Western Salt Ponds Using Large Cores.

Species		Pond 10A						Pond 10						Pond 11					
Scientific Name	Common Name	1	2	3	4	5	6	1	4	5	7	8	9	1	2	3	4	5	6
		Macroscopic Infauna - 10 cm Core* (# in all 9 cores)																	
Cerithidea californica	California Horn Snail	6	24	7	10			15		1	3								
Tagelus californianus	California jackknife clam	2						4	8	6			8				2		3
Macoma nasuta	Bent-nose macoma									1		1		1					
Musculista senhousia	Asian Mussel								1	6			1	1	38	11			2
Alpheus californianus	Pistol Shrimp	1																	
Neotrypaea californiensis	Bay Ghost Shrimp										1								
Hemigrapsus oregonensis	Yellow Shore Crab										1					1			
Polychaete sp.								2		2									
	Density per Site (#/m^2)	127	340	99	142	0	0	297	127	226	71	14	127	28	538	170	28	0	71
	Mean Density per Site (#/m^2)	118						144						139					
	Species Richness per Pond	3						7						4					
		Epifauna - Two .25m x .25m Quadrats† (# in both quadrats)																	
Cerithidea californica	California Horn Snail	38	18	20	13	0	0	36	45	92	12	28	9	0	0	0	0	16	2
	Density per Site (#/m^2)	304	144	160	104	0	0	288	360	736	96	224	72	0	0	0	0	128	16
	Mean Density per Site (#/m^2)	119						296						24					
*core area = 0.00785m^2	† quadrat area = .0625m^2																		

Small Cores. In 2011 (preconstruction) the subtidal habitat in Pond 10 was dominated by polychaetes although oligochaetes and crustaceans were well represented (Figure 27). Samples collected in intertidal areas of Pond 10 were nearly equally represented by polychaetes, oligochaetes, molluscs and crustaceans. The single sample collected from the marsh plain in Pond 11 was represented by a single taxon – molluscs.

Postconstruction monitoring in fall 2012 included infauna from Pond 10A which was dominated by polychaetes; Pond 10 subtidal dominated by crustaceans and polychaetes; Pond 11 subtidal dominated by polychaetes and insects; and Pond 11 intertidal dominated by polychaetes (Figure 28).

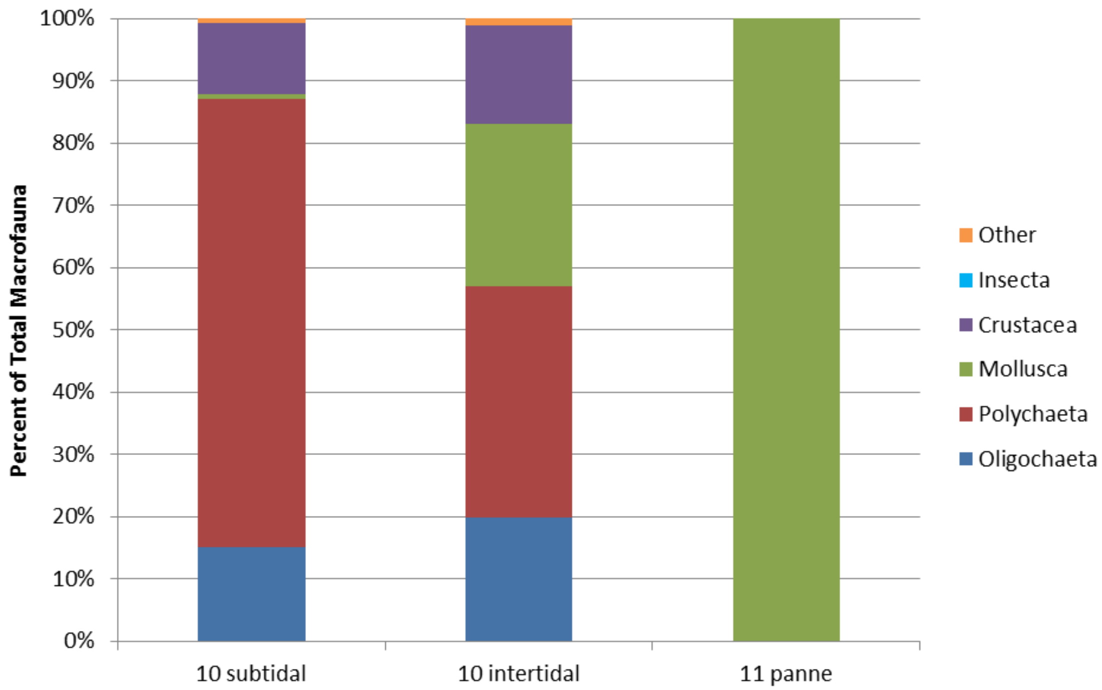


Figure 27. Relative Abundance of Macrofaunal Taxa Collected Using Small Cores - Fall 2011 Prerestoration

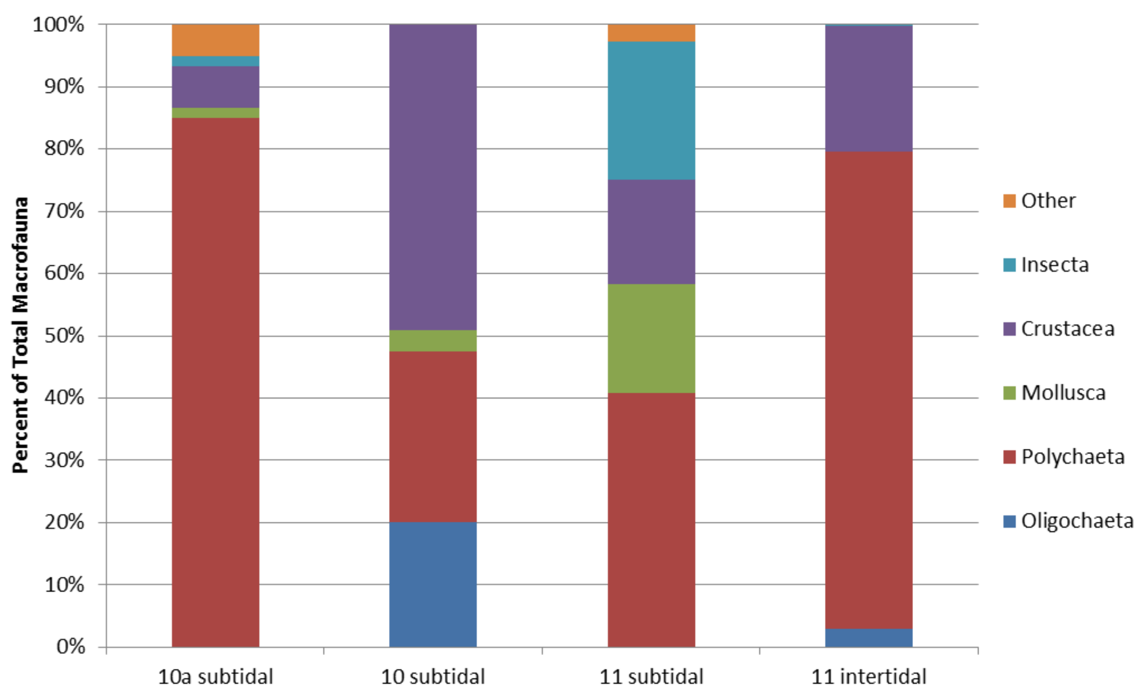


Figure 28. Relative Abundance of Macrofaunal Taxa Collected Using Small Cores – Fall 2012 Postconstruction

By spring 2013, the invertebrate communities of the salt ponds were strongly dominated by polychaetes with the exception of Pond 10A in which insects were the dominant taxa (Figure 29). When all three years are compared (Figure 30) several patterns are evident. In Pond 10, the percentage of crustaceans increased but the community as a whole did not shift significantly. In Pond 11 intertidal, discounting the single sample collected in 2011, the community was relatively stable. In terms of abundance, there was a significant decrease in the number of organisms per core postconstruction in Ponds 10A and 10 while Pond 11 showed a gradual increase (Figure 31).

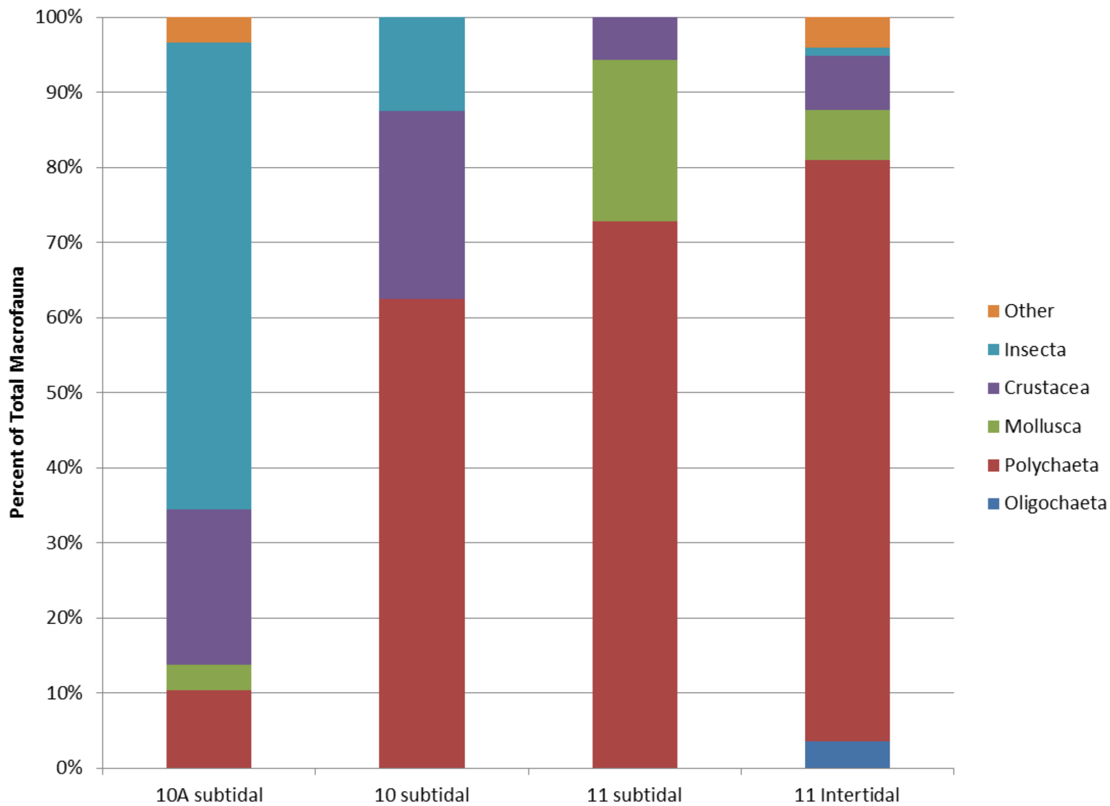


Figure 29. Relative Abundance of Macrofaunal Taxa Collected Using Small Cores – Spring 2013 Postconstruction

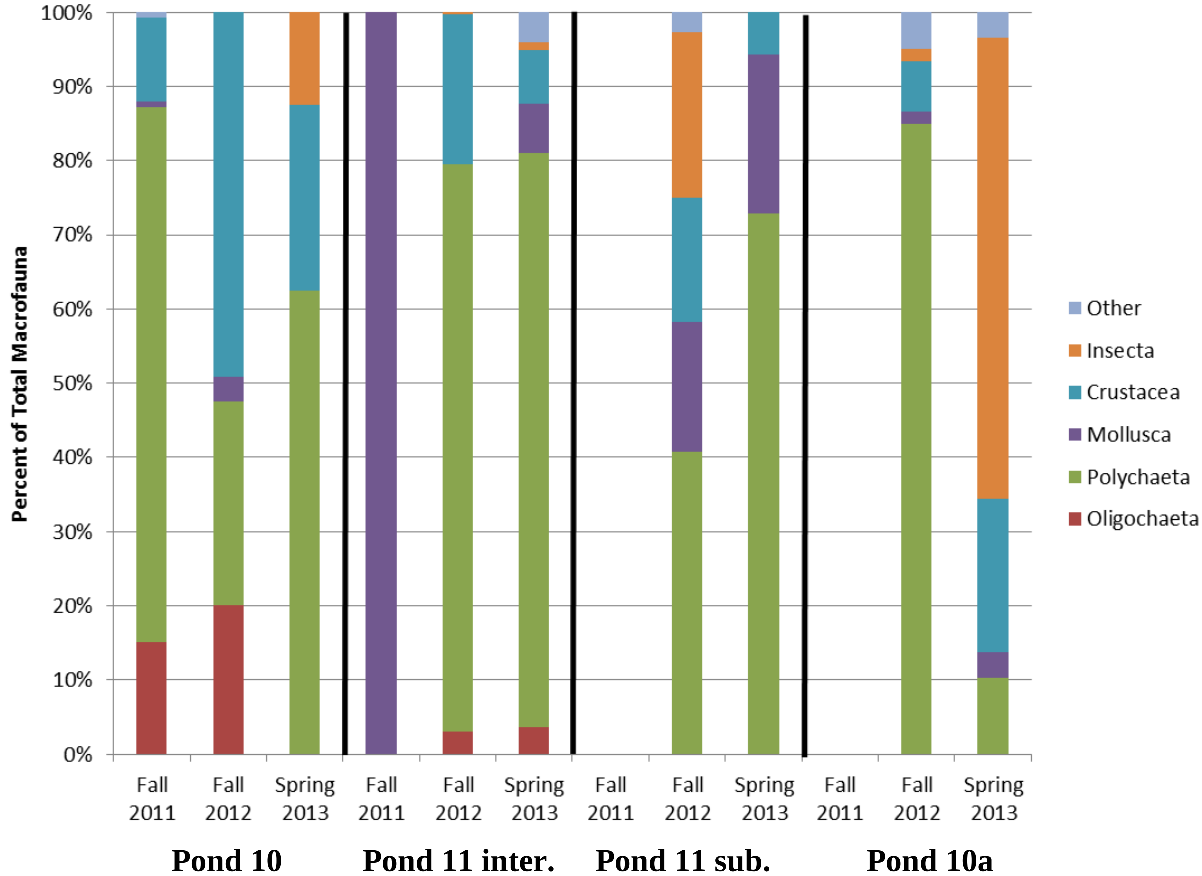


Figure 30. Relative Abundance of Macrofaunal Taxa Collected Using Small Cores From All Ponds on All Dates.

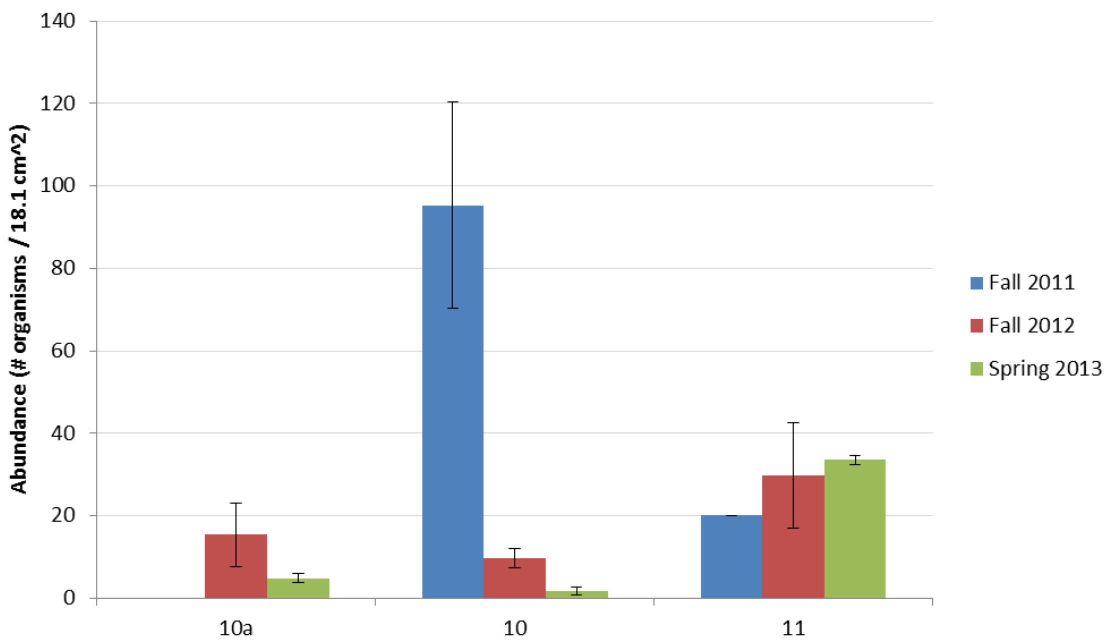


Figure 31. Number of Organisms Collected Using Small Cores by Pond and Sampling Date

3.3.3 Methods – Monitoring of Benthic Macroinvertebrates in the Chula Vista Wildlife Reserve

At the CVWR, two sets of the large cores (50 cm long, 10 cm diameter) were taken at the 6 sampling stations (see Figure 9). Smaller cores were not collected at the CVWR.

3.3.4 Results – Monitoring of Benthic Macroinvertebrates in the Chula Vista Wildlife Reserve

The results of infaunal monitoring at the CVWR are presented in Table 13. A total of 119 individuals, representing 6 species of invertebrates, were sampled in the cores. The California horn snail (*Cerithidea californica)* represented the majority (76%), with the California jackknife clam (*Tagelus californianus*) representing the second most abundant (13%). Mean density per site was 281 individuals/m^2.

3.3.5 Methods – Monitoring of Epifauna in the Western Salt Ponds and Chula Vista Wildlife Reserve

At each sampling site (6 sites in each salt pond and 6 sites at the CVWR), a .25 m x .25 m quadrat was used to sample epifauna assemblages. The quadrat was thrown near the channel's edge and those species found alive were counted. The quadrat was then flipped along one of its edges and the sampling was repeated.

3.3.6 Results – Monitoring of Epifauna in the Western Salt Ponds and Chula Vista Wildlife Reserve

California horn snails were the only epifaunal species encountered at both the western salt ponds and CVWR. Horn snails were present in relatively high densities at both sites (Tables 12 and 13). At the western salt ponds, mean densities per site were again highest in Pond 10 at 296 individuals/m^2, up from 111 individuals/m^2 the previous year. Densities in Pond 11 and Pond 10A were significantly less at 119 and 24 individuals/m^2, respectively. Mean horn snail density per site at the CVWR was significantly greater than last year at 273 individuals/m^2, up from 72 individuals/m^2 (Table 13). Densities varied from 0 individuals/m^2 at site 4 to 560 individuals/m^2 at site 6.

Table 13. Infauna and Epifauna Collected at the Chula Vista Wildlife Reserve.

Species		Chula Vista Wildlife Reserve					
Scientific Name	Common Name	1	2	3	4	5	6
		Macroscopic Infauna*					
Cerithidea californica	California Horn Snail	2				29	59
Tagelus californianus	California jackknife clam	2	2	3	2	5	2
Macoma nasuta	Bent-nose macoma		2	4			
Musculista senhousia	Asian Mussel				4		
Alpheus californianus	Pistol Shrimp						
Neotrypaea californiensis	Bay Ghost Shrimp						
Hemigrapsus oregonensis	Yellow Shore Crab	1			1		
Polychaete sp.				1			
	Density per Site (#/m^2)	71	57	113	99	481	863
	Mean Density per Site (#/m^2)	281					
	Species Richness at CVWR	6					
		Epifauna†					
Cerithidea californica	California Horn Snail	29	35	2	0	69	70
	Density per Site (#/m^2)	232	280	16	0	552	560
	Mean Density per Site (#/m^2)	273					
*core area = 0.00785m^2	† quadrat area = .0625m^2						

In summary, the NCWC Project goal of demonstrating recruitment of infauna and epifauana for support of foraging shorebirds and ground-nesting seabirds by March 2013 has been met. Relatively high densities of infauna and epifauna were collected using a variety of sampling techniques. Large cores revealed greater diversity and densities than in Year 1 at both the western ponds and the CVWR. Small cores revealed high densities of polychaetes, crustaceans, molluscs and insects available as food sources for foraging birds. Benthic invertebrates collected in fish enclosure traps and fish trawls included motile organisms, such as shrimp and crabs, demonstrating a greater diversity of benthic invertebrates than those collected in the large cores.

3.4 Monitoring of Avian Use of the Western Salt Ponds

There were no specific objectives or metrics for avian use at the western salt ponds. However, it was postulated that the avian assemblage would shift from one dominated by species that prefer open water habitat to one that included shorebirds and wading birds during low tide combined with species that utilize open water during high tides. In order to assess this predicted trend, avian use of the western salt ponds was monitored by the San Diego Natural History Museum (SDNHM) and Avian Research Associates (ARA) prior to and following construction of the Project.

3.4.1 Methods – Monitoring of Avian Use of Western Salt Ponds

SDNHM and ARA conducted surveys of the general use of the western ponds by water-dependent birds, including shorebirds, waterfowl, gulls, terns and others, and their behaviors. Surveys were conducted monthly from January 2013 to December 2013 and included the shallow water habitat and berms of the ponds as well as the shallow tidal habitats of the adjacent bay as far north as Emory Cove. Monthly monitoring will continue through 2016. Surveys were conducted using the methods employed in the multi-year bay-wide survey of avian species (Tierra Data Incorporated 2009). Those methods included:

- Surveys were conducted in the four hours before low tide to capture bird use of foraging habitats, such as mudflats and other habitats, that become exposed by receding water;
- Surveys conducted using a system of grids (= cells) previously established for the bay-wide survey (Tierra Data Incorporated 2009);
- Data collected included species abundance and diversity; general location/habitat categories, including wetland, upland, and aerial; and noted general behavior categories, including foraging, resting/rafting, courting/breeding.

Avian surveys of the entire South San Diego Bay Unit of the San Diego Bay National Wildlife Refuge were conducted as part of the monitoring project. These included surveys of the general use of the interior salt ponds by water-dependent birds, including shorebirds, waterfowl, gulls, terns and others, and their behaviors. Surveys were conducted monthly as described above and included the shallow water habitat and berms of the ponds, and adjacent upland habitats. Surveys also included the Otay River channel, tidal mudflats adjacent to the outer salt pond levees, and the grids of the bay within practical viewing range of those levees. Surveys were conducted using the methods described above for the western ponds, including use of the grid system, species abundance and diversity, location/habitat, and behavior (Figure 32). In addition, data from surveys of the same protocol conducted at adjacent Pond 20A were included in the data set for analysis since birds regularly shift between Pond 20A, the western ponds, and interior ponds.

3.4.2 Results – Monitoring of Avian Use of Western Salt Ponds

In order to assess shifts in bird usage following restoration of the salt ponds, a subset of the data collected during pre- and postconstruction monitoring was analyzed. Specifically, all birds observed using wetland habitats, defined as occurring below the high tide line, were summarized and compared. Birds observed using upland habitats, i.e., above the high tide line, were excluded as these habitats, primarily pond levees, remained following restoration and it was assumed that their use was not changed significantly following restoration. Furthermore, birds observed flying overhead (aerial) were excluded as it was assumed that many were in transit to other habitats, such as the open bay and ocean. In general, the majority of the birds observed during the monthly surveys were wetland species.

Figure 32. Avian Monitoring Grid – South San Diego Bay and Salt Works

The number of avian species observed in wetland habitat during the 2013 surveys varied seasonally with peaks in winter months declining to lows in late summer (Figure 33). Ponds 10 and 11 generally had the greatest number of species and Pond 10A the least. A high of 35 species was recorded in January and December. The mean number of species over the 2013 monitoring period was 11 species in Pond 10A, 19 species in Pond 10, and 21 species in Pond 11. By comparison, in 2012 the number of species peaked in April with a lesser peak in December. Numbers of species observed ranged from 44 in Pond 11 in April to 4 species in Pond 10A in January. The number of species present was generally greatest in ponds 10 and 11 and less in Pond 10A. The mean number of species in Pond 10 was 24 with a mean of 23 in Pond 11. The mean number of species in Pond 10A was 11. Thus, the number of species was down in all ponds relative to 2012.

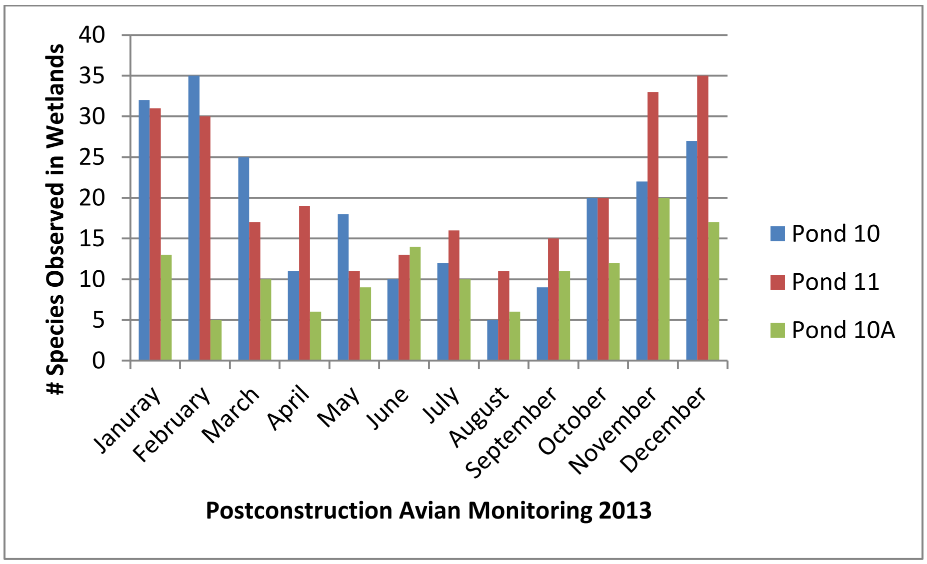


Figure 33. Number of Avian Species Observed in Wetland Habitats – 2013

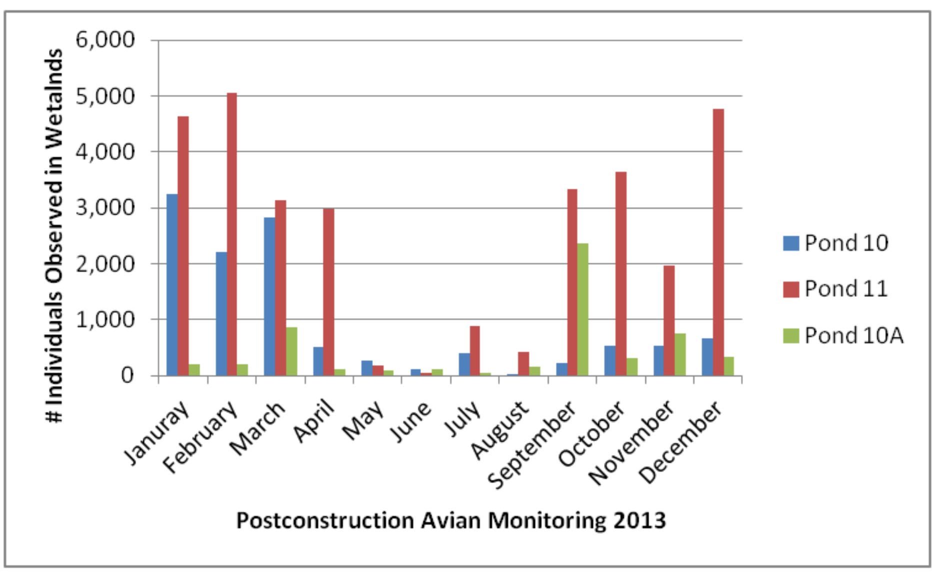


Figure 34. Number of Individual Birds Observed in Wetland Habitats – 2013

The number of individuals observed in wetland habitat during 2013 monitoring also varied seasonally with the greatest numbers occurring in fall and winter and the fewest in late spring and summer (Figure 34). A peak of 5,061 individuals was recorded in Pond 11 in February 2013 and a low of 30 individuals were observed in August in Pond 10. The highest number of individuals was generally observed in Pond 11 while ponds 10 and 10A were highly variable. There was a trend in decreasing numbers of individuals in Pond 10 as the year progressed, presumably in response to the developing salt marsh vegetation in that pond.

The number of individuals observed in 2012 was highest in October in Pond 10 (5,988) and lowest in Ponds 10A and 11 in May (83 and 68, respectively). In a pattern similar to the number of species observed, the number of individuals observed was typically highest in Ponds 10 and 11 and lower in Pond 10A. Despite the seasonal and annual variability, bird usage of the ponds increased in both 2012 and 2013 relative to preconstruction surveys in 2011, demonstrating that restoration of intertidal habitats was beneficial to resident and migratory species.

The numerically dominant species observed in wetland habitats of the western salt ponds during 2013 monitoring are summarized in Table 14. The numerically dominant species were shorebirds, including western sandpiper, least sandpiper, semipalmated plover, dowitcher species, willet, marbled godwit and dunlin. Notable exceptions were American widgeon in Pond 10 and brant in Pond 11 during the November – March period and elegant terns in Ponds 11in July

The numbers of western sandpiper observed in 2013 in Ponds 10 and 11 closely mirrored the overall numbers of individuals observed (Figures 35 and 36). This species was by far the numerically dominant species during 2013 surveys (Table 14). Western sandpipers were also among the numerically dominant species in 2012, and their numbers heavily influenced the overall number of individuals observed that monitoring year

Table 14. Total Numbers and Numerically Dominant Species of Birds Observed in Wetland Habitats of the Western Salt Ponds During Postconstruction Surveys 2013.

	Month Surveyed					
	January	**February**	**March**	**April**	**May**	**June**
Pond 10A	Total = 250 west sandpiper 103	Total = 202 Semipalm plover 85 least sandpiper 58 west sandpiper 50	Total = 857 west sandpiper 500 semipalm plover 280	Total = 105 semippalm plover 78	Total = 85 semipalm plover 63	Total = 105 semipalm plover 57
Pond 10	Total = 3,252 west sandpiper 2,160 Am widgeon 233 dunlin 226 black bellied plover 119	Total = 2,219 west sandpiper 1,490 dowitcher sp. 200 Am widgeon 129	Total = 2,830 west sandpiper 2,050 dowitcher sp 236 northern shoveler 142 Am widgeon 151	Total = 498 west sandpiper 340 least sandpiper 101	Total = 274 willet 185	Total = 106 semipalm plover 28 willet 27
Pond 11	Total = 4,641 west. sandpiper 3.758 short-billed dowitcher 223 least sandpiper 197 brant 165	Total = 5,061 west sandpiper 4,450 least sandpiper 160 brant 96 dunlin 95	Total = 3,146 west sandpiper 2,843 least sandpiper 144 dunlin 80	Total = 2,972 west sandpiper 2,820 dunlin 57	Total = 174 west sandpiper 50 semipalm plover 76	Total = 37 No dominants

	Month Surveyed					
	July	**August**	**September**	**October**	**November**	**December**
Pond 10A	Total = 629 west sandpiper 550 black-necked stilt 39	Total = 164 West sandpiper 150	Total = 2,353 west sandpiper 2,275	Total = 318 west sandpiper 200 marbled godwit 38 least sandpiper 28	Total = 748 west sandpiper 186 dunlin 85 willet 157 marbled godwit 83	Total = 324 west sandpiper 120 Am widgeon 129 northern pintail 26
Pond 10	Total = 405 west sandpiper 155 dowitcher sp. 79 willet 67	Total = 30 least sandpiper 14 willet 14	Total = 225 west sandpiper 157	Total = 525 west sandpiper 392 marbled godwit 23 least sandpiper 26	Total = 538 Am widgeon 313 northern shoveler 47 northern pintail 46 willet 42	Total = 664 west sandpiper 439 Am widgeon 47 willet 43 marbled godwit36
Pond 11	Total = 876 western sandpiper 630 elegant tern 180	Total = 410 west sandpiper 348 willet 29	Total = 3,328 west sandpiper 2,938 semipalm plover 75	Total = 3,643 west sandpiper 3,150 dunlin 110 semipalm plover 89	Total = 1,067 willet 683 west sandpiper 357 marbled godwit 271 brant 216	Total = 4,774 west sandpiper 2,925 blk-bellied plover 309 marbled godwit 211 dunlin 205

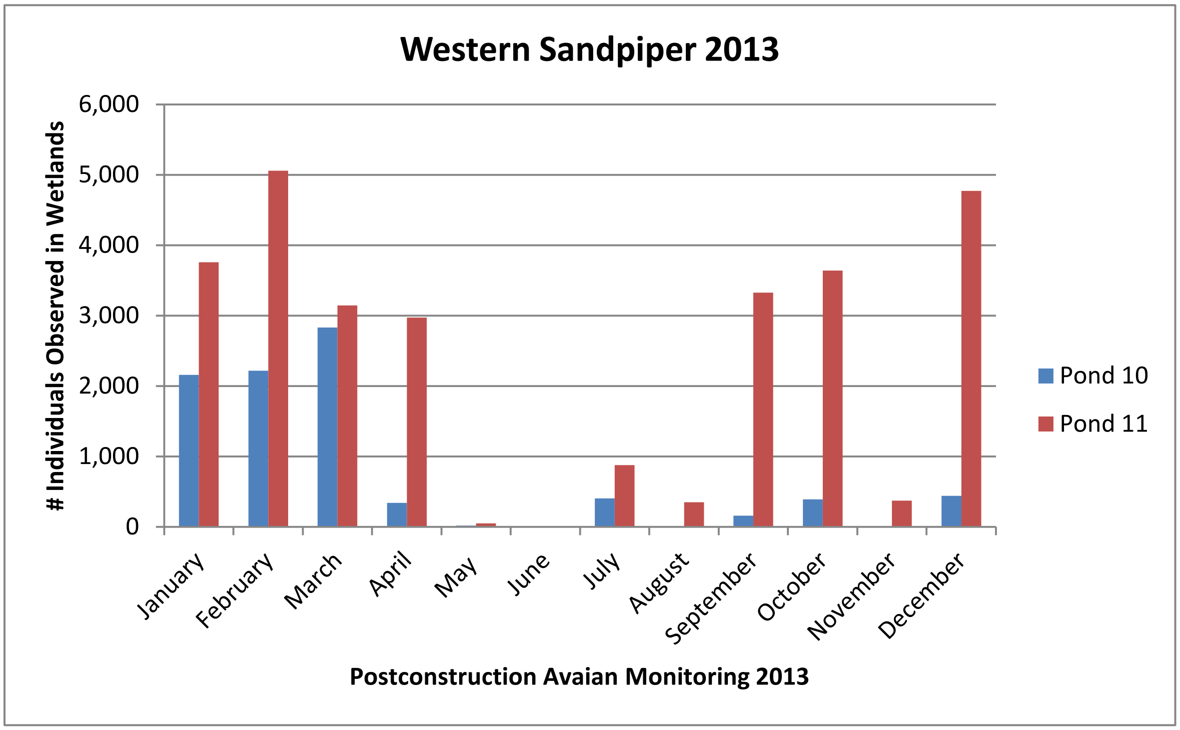


Figure 35. Number of Individual Western Sandpiper Observed in Wetland Habitats in Ponds 10 and 11 - 2013

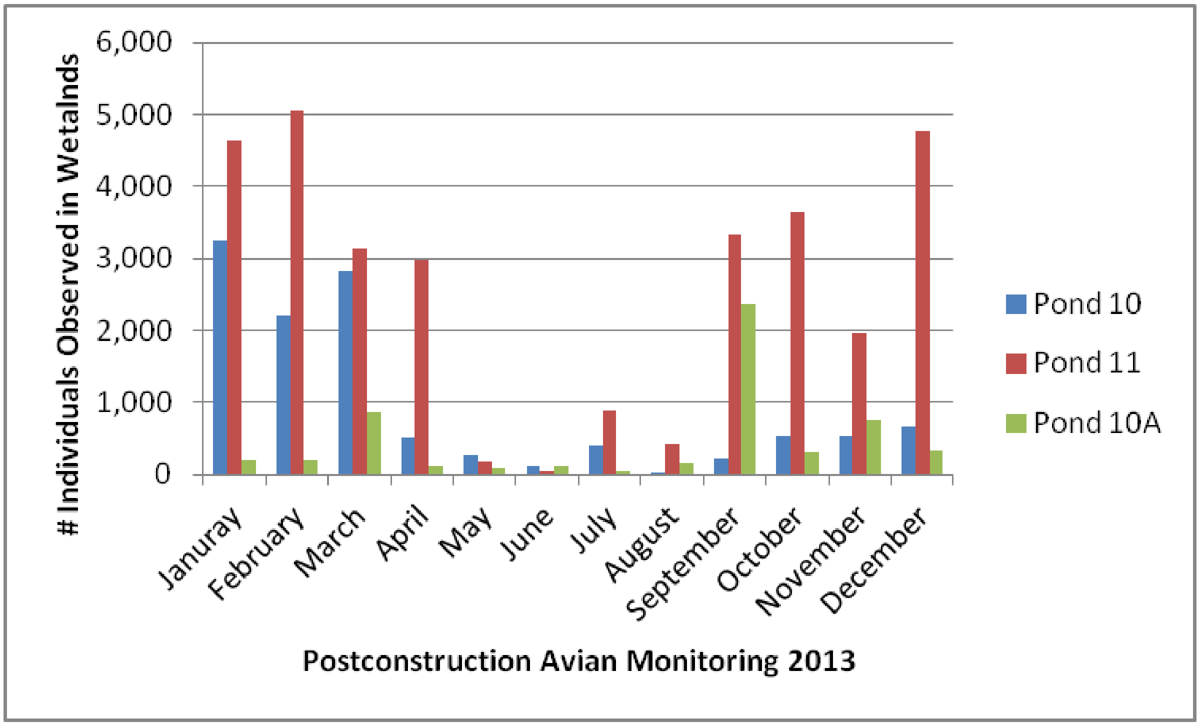


Figure 36. Number of Individual Birds Observed in Wetland Habitats – 2013

5.0 CONCLUSIONS

The majority of the goals and objectives developed for the Project were either met in Year 2 or are expected to be met in subsequent years. Goals and objectives that are considered met include:

- Complete the permitting, final design, and site preparation, including all excavation, clean-up, and grading, necessary to restore and enhance 160 acres of coastal wetland and upland habitat in south San Diego Bay by March 1, 2011.

This overarching goal is considered met with the exception that project delays resulted in a completed project by December 2011.

- By the end of 2016 achieve approximately 89 acres of functional estuarine intertidal emergent wetlands, approximately 41 acres of estuarine intertidal non-vegetated wetlands, approximately 28 acres of estuarine subtidal wetlands, and 10 acres of palustrine scrub-shrub vegetation.

This overarching goal is considered to be on track for achievement by the end of 2016.

- Within the western salt ponds, by March 2013, achieve successful recruitment of benthic invertebrates and fish within Pond 11 to support migratory shorebirds and foraging ground-nesting seabirds.

This objective has been met.

- Within the western salt ponds, by March 1, 2011 complete the dredging and filling activities required to achieve elevations within Pond 11 that will support a mix of shallow subtidal, intertidal mudflat, cordgrass-dominated salt marsh, and pickleweed-dominated salt marsh habitats (estuarine intertidal emergent, non-vegetated, and subtidal wetlands) and breach the pond levee to restore tidal influence to the 106-acre pond.

This objective is considered met with the exception that project delays resulted in a project completion date of December 2011.

- Within the western salt ponds, by the end of 2016, achieve 50 percent coverage of cordgrass (*Spartina foliosa*), with at least 25 percent of the plants in excess of 60 centimeters (cm) in height, over approximately 30 acres within the tidally restored pond.

This objective is considered to be on track for achievement by the end of 2016.

- Within the western salt ponds, between March 2011 and February 2012, monitor and record through monthly visual surveys, the recruitment of vegetation and benthic invertebrates, bird use, and any changes in bathymetry within the pond. Based on these observations, develop recommendations for how the design of future phases of salt pond

- restoration in San Diego Bay could be adjusted to more effectively achieve restoration objectives.

This objective is considered met with the exception that Year 1 monitoring occurred between January 2012 and January 2013. Recommendations for future phases of salt pond restoration in San Diego Bay will be developed at the end of the monitoring program.

- By March 1, 2011 lower approximately 3 acres within the western basin of the Chula Vista Wildlife Reserve to achieve a typical marsh plain elevation of +4.5 feet Mean Lower Low Water (MLLW) (an elevation appropriate for supporting estuarine intertidal emergent wetlands) and expand the existing tidal channel by removing 3,000 cubic yards of sediments to create deeper, more well defined tidal creeks within the western basin, thus enhancing the remaining wetland habitat.

This objective has been met.

- By the end of 2016, achieve 50 percent coverage of cordgrass and pickleweed over the 3-acre excavation area of the Chula Vista Wildlife Reserve and improve vigor and plant diversity throughout the remaining 16 acres of estuarine intertidal emergent wetlands within the basin.

This objective is considered to be on track for achievement by the end of 2016.

- Restore wetland elevations and channel bathymetry in Ponds 10 and 11 to within plus or minus 10% of the design plan by June 2011.

This objective has been met.

- Achieve 50% vegetation cover by wetland vascular plants in at least 30 acres of Pond 10 by June 2016.

This objective is considered to be on track for achievement by the end of 2016.

- Within Ponds 10 and 11 demonstrate presence of one or more of the target species (flatfish and elasmobranchs) by 2013.

This objective has been met.

- Restore wetland elevations and channel bathymetry the restored Chula Vista Wildlife Reserve basin to within plus or minus 10% of the design plan by June 2011.

This objective has been met.

- By 2016, restore typical marsh vegetation coverage at the Chula Vista Wildlife Reserve, using marsh coverage at Tijuana Estuary as a target;

This objective is considered to be on track for achievement by the end of 2016.

- At the Chula Vista Wildlife Reserve demonstrate presence of one or more of the target species (gobiidae and topsmelt) by 2013.

This objective has been met.

- By March 2013, achieve successful recruitment of benthic invertebrates and fish within the western basin of the Chula Vista Wildlife Reserve to support migratory shorebirds and foraging ground-nesting seabirds.

This objective has been met.

- Restore tidal amplitude in Ponds 10 and 11 to approximately equal the tidal amplitude in the Otay River; restore tidal amplitude in Pond 10A to a slightly muted amplitude relative to the Otay River by 2012.

This objective has been met.

One Project objective has not been fully met. That objective is presented below.

- At the Chula Vista Wildlife Reserve, restore tidal amplitude to approximately equal the tidal amplitude in San Diego Bay by 2011.

Low tides are moderately to severely truncated within the channels of the restored basins, suggesting that these channels do not drain completely. This may be caused by shoals forming at the connections to the bay. Further monitoring will assess the presence of shoals and the effect on Project success.

5.0 LITERATURE CITED

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