Malibu Lagoon Restoration and Enhancement Project
Comprehensive Monitoring Report

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Prepared for: State of California, Department of Parks and Recreation

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Photo: Malibu Lagoon Restoration at sunrise (C. Piechowski; January 2013).

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Introduction

Malibu Lagoon is a 31-acre shallow water estuarine embayment occurring at the terminus of the Malibu Creek Watershed, the second largest watershed draining into Santa Monica Bay. It receives year-round freshwater from sources upstream and is periodically open to the ocean via a breach across a sandbar at the mouth of the estuary. Malibu Creek and Lagoon empties into the Pacific Ocean at world renowned surfing and recreational destination, Malibu Surfrider Beach, which receives approximately 1.5 million visitors every year.

Malibu Lagoon was restored the first time in 1983, when the California Department of Parks and Recreation (CDPR) purchased the property and restored what was formerly a Caltrans dump site, later converted into ballfields, and then back into a lagoon. The original lagoon configuration was developed by a landscape architect that had minimal hydrologic information available. While the small channels extending into the western area of the park and accessed by the pedestrian walkway that bisected the lagoon provided a nice experience for visitors, they quickly became sediment traps. The number of benthic invertebrate species, as well as fish species, observed in Malibu Lagoon has declined since the baseline survey was completed in 1989 (Manion and Dillingham 1989).

In the 1990's, several important efforts took place to try and improve the water circulation and reduce sedimentation. The fingers of the channels were connected and the contour of the lagoon bottom was altered. These efforts ultimately did not help solve the sediment deposition and circulation problems.

The California State Coastal Conservancy (SCC), in partnership with the Resource Conservation District of the Santa Monica Mountains (RCDSMM), Heal the Bay, and California State Department of Parks and Recreation (CDPR) have developed the Malibu Lagoon Restoration and Enhancement Project (Project) to enhance water quality and restore habitat conditions at Malibu Lagoon. The restoration plan for Malibu Lagoon evolved over a nearly 20-year time frame with extensive input from the public, coastal wetland experts, biologists, and responsible agencies. The Project involved the excavation of 12 acres in the western half of the Lagoon, which began on 1 June 2012. On 29 October 2012, the earthen berm separating the construction area from the main Lagoon was removed and water was allowed back into the western portion of the lagoon; the entire estuary is currently tidal (M. Abramson, SMBRF, pers. comm. February 2013).

Monitoring and capture/relocation of animals during construction was conducted according to permit requirements for each group of organisms; permit requirements, methods, and results are described within this report for each group. The baseline post-construction monitoring was conducted as described in the "Malibu Lagoon Restoration and Enhancement Plan, Hydrologic and Biological Monitoring Plan" and the "Malibu Lagoon Plant Communities Restoration, Monitoring, and Reporting Plan" which each specify hydrologic and biological monitoring protocols and procedures for conducting monitoring before, during, and after the Project. Most of the post-restoration baseline monitoring and data collection occurred between October 2012 and February 2013. When applicable, post-restoration baseline data are compared to pre-restoration data.

Comprehensive Monitoring Report Goals

This Comprehensive Monitoring Report describes methods and provides data accumulated since the last series of reports, including: pre-restoration monitoring surveys, during-construction surveys, and the first series of initial post-restoration baseline monitoring and surveys. The goal of this document is to report the during-construction and post-restoration conditions of the Malibu Lagoon Restoration and Enhancement Project using hydrologic, chemical, and biological data.

Detailed methods and sampling dates/times are included in each subsection of the report. There are two primary components of the report, hydrologic and biologic; the hydrology component includes both physical monitoring parameters and water and sediment quality. Hydrologic chapters that are included in this report are as follows: California Rapid Assessment Method surveys, physical channel cross sections and vertical elevation profiles, automated water quality sondes, vertical water quality station profiles, and grab samples collected before and after treatment during construction. Biological chapters included in this report are as follows: fish, birds, mammals, herpetofauna, submerged vegetation and algae, vegetation cover, and photo point surveys. Future reports will also contain sediment and benthic invertebrate surveys conducted as described in the monitoring plans.

This document was assembled using various studies and work products that were developed over the course of the Malibu Lagoon restoration planning effort as well as the addition of new, pre-, during-, and post-restoration data. Summary details on the restoration, monitoring protocols, and prior results are compiled from the following documents. They are listed in chronological order, and *italicized* documents are new inclusions for this report:

Moffatt &Nichol. June 17, 2005. Final Malibu Lagoon Restoration and Enhancement Plan, Heal the Bay.

2nd Nature. July 29, 2005. Malibu Lagoon Restoration and Enhancement Plan, Project Monitoring Plan, State Coastal Conservancy.

2nd Nature. February 6, 2006. Quality Assurance Project Plan, Malibu Lagoon Restoration Monitoring, Department of Parks and Recreation.

2nd Nature. July 2008 (revised May 2010). Malibu Lagoon Restoration Monitoring Plan (MLRMP) Baseline Conditions Report.

Santa Monica Bay Restoration Foundation. March, 2012. Malibu Lagoon Restoration and Enhancement Hydrologic and Biological Project Monitoring Plan.

ICF International. May 2012. Malibu Lagoon Plant Communities Restoration, Monitoring, and Reporting Plan.

Dagit, Rosi. January 2013. RCD of the Santa Monica Mountains. Malibu Lagoon Restoration Fish Relocation Report.

Cooper, Dan. February 28, 2013. Cooper Ecological Monitoring, Inc. Malibu Lagoon Avian Monitoring Report (Final), Summer 2012.

Cooper, Dan. February 28, 2013. Cooper Ecological Monitoring, Inc. Pre and During Construction Avian Nesting Surveys May 2012.

Cooper, Dan. February 15, 2013. Cooper Ecological Monitoring, Inc. Avian Usage of Post-Restoration Malibu Lagoon.

King, Jamie. March 6, 2013. California State Parks, Angeles District and Santa Monica Bay Restoration Commission. Malibu Lagoon Restoration Project Wildlife Avoidance, Salvage, and Relocation Efforts.

Hydrologic Monitoring

The monitoring project will include semi-annual physical condition and water and sediment quality assessments, once during tidally dominated conditions (spring) and once during closed conditions (early fall), as well as annual biological sampling for multiple parameters during the spring and fall. The monitoring will occur for at least five years following the completion of the Lagoon restoration plan as documented in the 2012 Malibu Lagoon Restoration and Enhancement Plan, Hydrologic and Biological Project Monitoring Plan (Monitoring Plan).

Water quality and physical monitoring of Malibu Lagoon post-restoration seek to evaluate the specific habitat improvements made to the lagoon as a result of increased water circulation, increased tidal flushing, and increased storage capacity. Monitoring will allow comparison between the pre- and post-restoration water quality and habitat conditions. The key to restoration of Malibu Lagoon will be observable improvements in the chemical conditions that facilitate biological stability by the reestablishment and persistence of species diversity and native organisms well beyond the first five years following construction.

The objectives of the physical and water quality monitoring of the Malibu Creek Lagoon are to:

- Assess the habitat and water quality improvements towards the goals of restoration.
- Document changes in the water quality of the lagoon environment over time following restoration.
- Provide timely identification of any problems with the physical or chemical development of the lagoon.

Specific water quality and physical parameters that are assessed in this report include: channel cross-section and elevation transects, automated water quality sampling at three locations using permanent data sondes, vertical water quality profiles at set stations within the Lagoon, and constituent monitoring during the restoration and construction. Additionally, Level-2 (broad-scale, rapid assessment monitoring) California Rapid Assessment Method (CRAM) surveys were conducted initially pre- and post-restoration to assess the overall condition of the site; they will be conducted annually ongoing as part of future monitoring reports. Further water quality and hydrological monitoring will be documented in subsequent surveys and reports, including additional sediment and water quality constituent monitoring.

California Rapid Assessment Method

Introduction

The following description of the summary and objectives of California Rapid Assessment Method (CRAM) surveys are directly cited from the CRAM User Manual (CWMW 2012):

> “The overall goal of CRAM is to provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and the performance of related policies, programs and projects throughout California...
>
> In essence, CRAM enables two or more trained practitioners working together in the field for one half day or less to assess the overall health of a wetland by choosing the best-fit set of narrative descriptions of observable conditions ranging from the worst commonly observed to the best achievable for the type of wetland being assessed. Metrics are organized into four main attributes: (landscape context and buffer, hydrology, physical structure, and biotic structure) for each of six major types of wetlands recognized by CRAM (riverine wetlands, lacustrine wetlands, depressional wetlands, slope wetlands, playas, and estuarine wetlands).”

Methods

Two surveys were completed of the wetland habitats: one immediately pre-restoration, and one immediately post-restoration (Figures 1 and 2). CRAM data were collected using the estuarine CRAM method during low tide on 1 June 2012 and 14 February 2013. Detailed field methods followed protocols described in the User Manual (CWMW 2012) and the Estuarine CRAM Field Book (CWMW 2012). The estuarine module was used to be comparable with pre-restoration data collected on 1 June 2012 although Malibu Lagoon is most accurately classified as a ‘bar built estuary’. At the time of both surveys, the bar built estuary module had not undergone a final quality control check and was not publically available. Once the module is publically released, data will be cross-walked and translated for the bar built estuary module.

Figure 2 displays the Assessment Area (AA) and buffer lines for the post-restoration CRAM survey. The AA is approximately one hectare of wetland habitats, following guidelines described in the User Manual. The location of the AA is approximately the same as the pre-restoration survey in June 2011 (results of both surveys are presented below).

Figure 1. Landscape photo of a portion of the post-restoration CRAM AA for Malibu Lagoon, February 2013.

Figure 2. Post-restoration CRAM Assessment Area (blue polygon) at Malibu Lagoon. Green lines indicate elevation contours from the grading plan and red lines indicate radiating (potential) buffer lines.

Results

The results of both the pre- and post-restoration estuarine CRAM assessment surveys are shown in Table 1. These data will be cross-walked using the detailed data sheets and notes with the bar built estuarine CRAM once that module is released to the public. While the overall CRAM score (i.e. 50 pre-restoration to 57 post-restoration) and most of the attribute averages are higher post-restoration, the biotic structure attribute is lower post-restoration (from 61 to 39). This difference can be attributed to the initial lack of defined vegetation structure immediately post-restoration (Figure 1). The biotic structure attribute is hypothesized to increase as the duration of time post-restoration also increases and the vegetation community has time to grow, develop, and become more complex. CRAM surveys will continue annually throughout the duration of the monitoring program.

Table 1. CRAM data from AA pre- and post-restoration using the Estuarine CRAM Module. Attribute values were rounded to the nearest whole number.

Attribute	Pre-restoration	Post-restoration
Attribute 1: Buffer and Landscape Context	38	46
Attribute 2: Hydrology Attribute	50	67
Attribute 3: Physical Structure Attribute	50	75
Attribute 4: Biotic Structure Attribute	61	39
Overall AA Score	**50**	**57**

Physical Monitoring – Channel Cross-Sections

Introduction

Many of the biological and chemical processes that occur in wetlands are driven by the physical and hydrologic characteristics of the site (Nordby and Zedler 1991, Williams and Zedler 1999, Zedler 2001). Physical surveys of hydrology, topography, and tidal inundation regimes (Zedler 2001, PWA 2006) can be used to assess temporal changes to a site, including erosion and sedimentation over time. The goal of the cross-section surveys for this report is to provide a set of baseline information regarding channel widths, depths, and cross-sections immediately post-restoration that is repeatable in future surveys to assess sediment movement over time.

Methods

Five permanent and repeatable cross-section locations will be monitored semi-annually for five years post-restoration. Horizontal and vertical locations of cross-section end-points were fixed by monuments. Estimates of sediment volume scour or deposition will be made from data, and cross-sections will be used with water budget data to calculate channel volumes through cross-sectional area. Cross-section monitoring will be performed at the end of the rainy season during open conditions (April) and again prior to the wet season (September).

The five permanent transects (1-5) were surveyed once as part of an initial post-restoration baseline assessment on 14 February 2013 (Figures 3 and 4) and then a second set of quality assurance and quality control surveys (QA/QC) (transects 1, 2, and 5) were conducted on 19 February 2013.

Figure 3. Cross channel elevation surveys at Malibu Lagoon, February 2013.

Figure 4. Cross-channel transect locations (Note: Google earth image is from August 2012 during construction. A current geo-rectified aerial was not available at the time of publication).

Results

Results were calculated for all five post-restoration cross-section transects (Figures 5-9). Cross-sections began between eight and twelve feet in elevation on the near shore channel banks and ended at approximately the same elevation on the foreshore. Transect lengths ranged between 104 and 232 ft (Figures 5-9). The QA/QC measurements matched the original data by an average elevation difference of 0.04 inches, which shows that the precision of the measurements was very high. All elevation data were surveyed using the North American Vertical Datum of 1988 (NAVD 88). These data will serve as the immediate post-restoration baseline database to which all subsequent channel cross-section surveys will be compared.

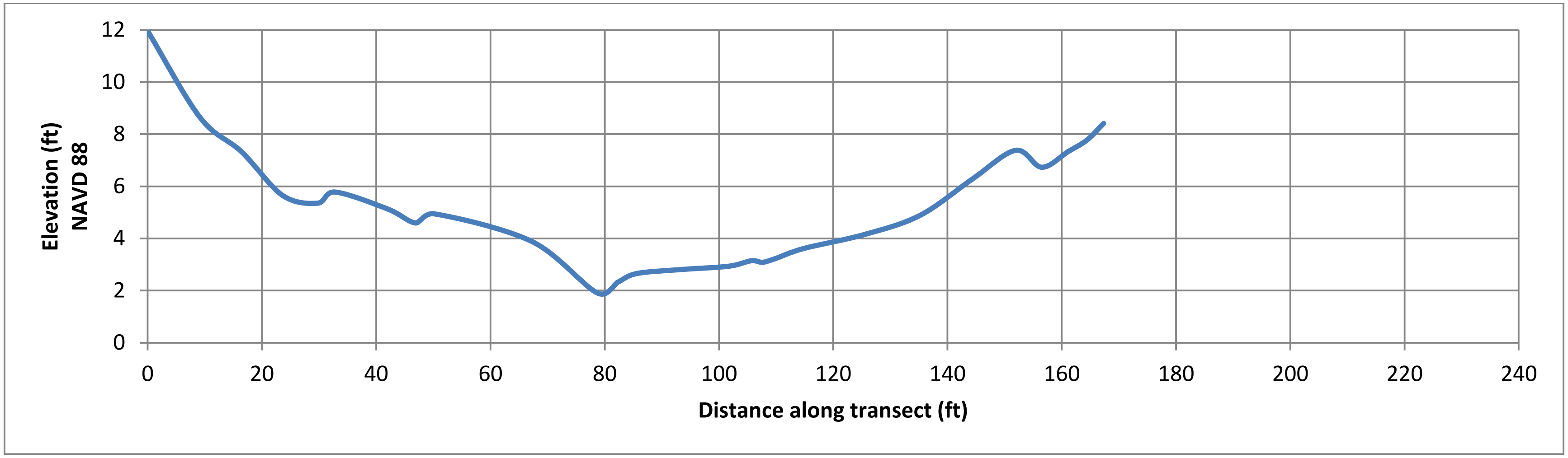

Figure 5. Channel Cross-section Transect 1.

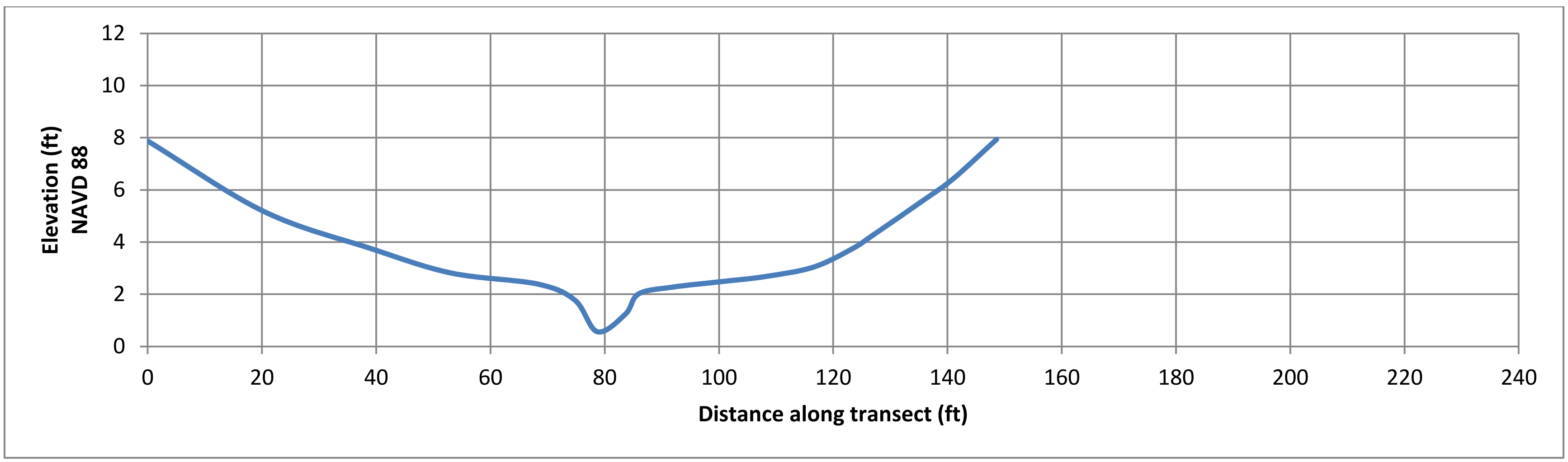

Figure 6. Channel Cross-section Transect 2.

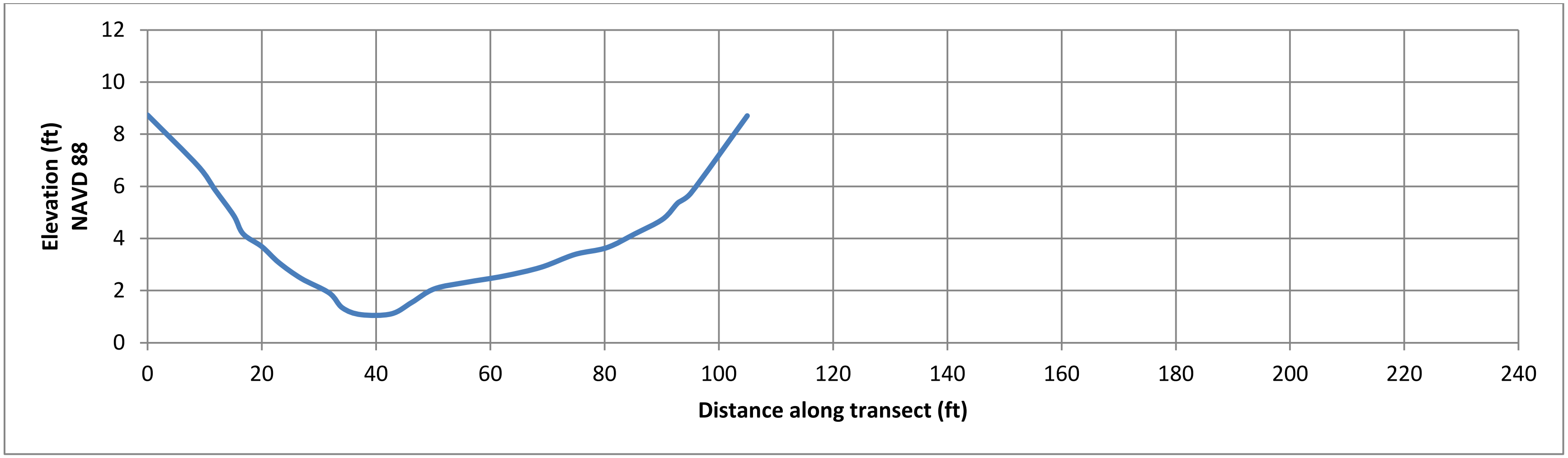

Figure 7. Channel Cross-section Transect 3.

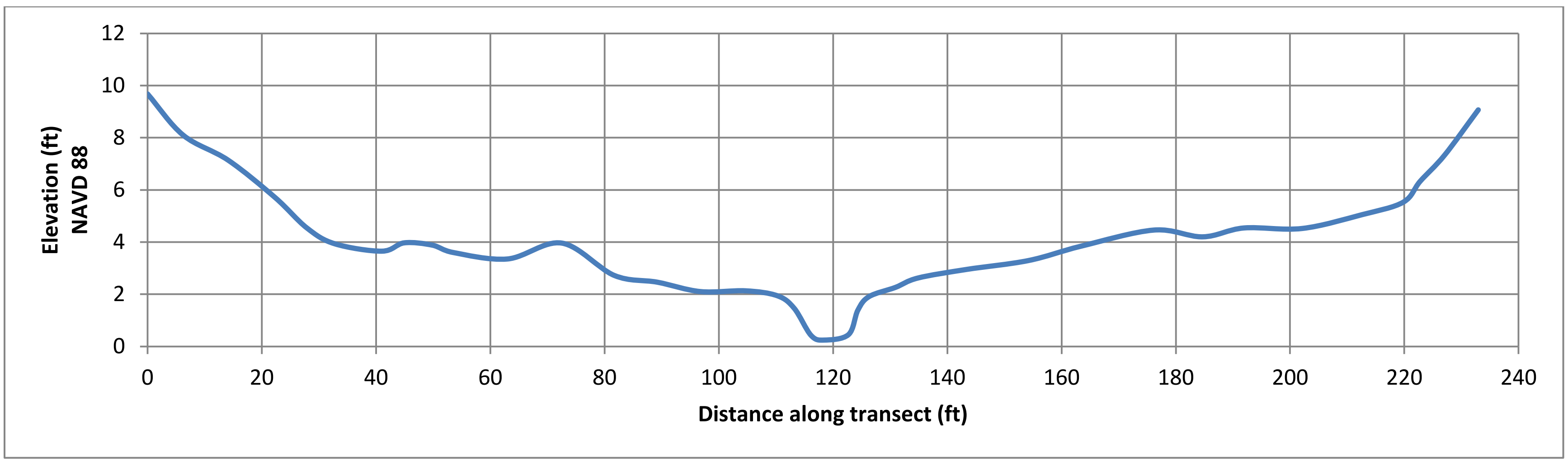

Figure 8. Channel Cross-section Transect 4.

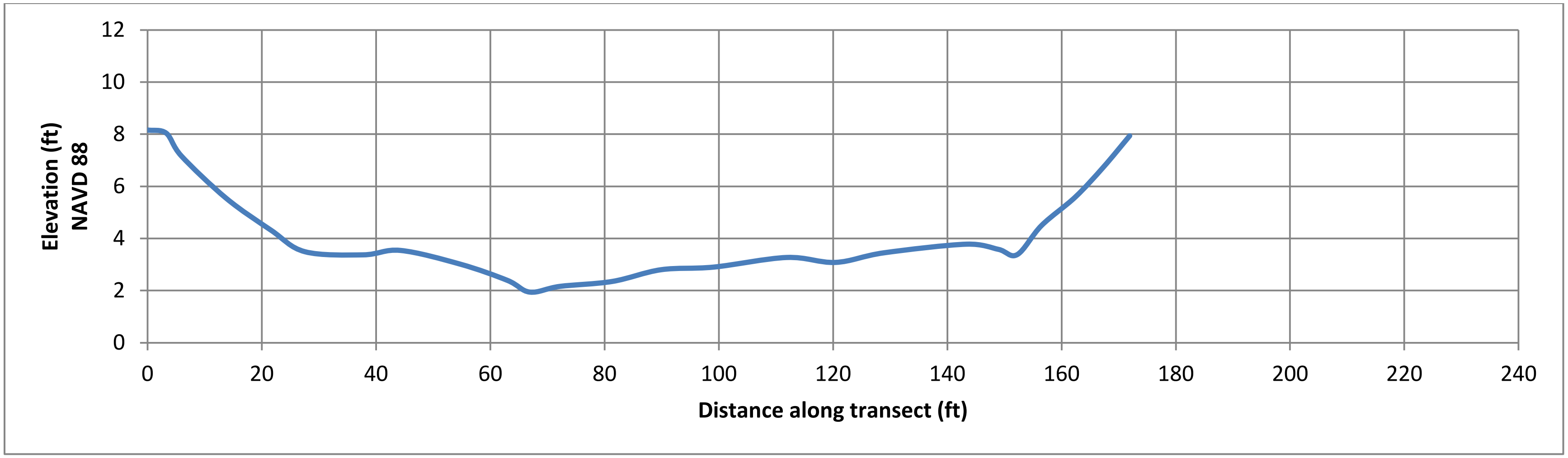

Figure 9. Channel Cross-section Transect 5.

Water Quality – Automated Water Quality Monitoring

Introduction

Water quality probes are used to measure water parameters in continuous monitoring mode by collecting data at user-defined intervals and storing those data until download. Water quality multi-probes can be deployed continuously at monitoring stations to characterize parameters over multiple tidal cycles, during open and closed conditions, through freshwater-input events, or over longer periods of time.

Methods

Three Yellow Springs Instruments (YSI) 600XLM or equivalent multi-parameter data loggers were deployed in the Lagoon on 15 March, 2013 approximately 0.5 ft above the bottom sediments to monitor water depth, dissolved oxygen (mg/L), temperature, salinity, conductivity, pH, and oxygen reduction potential (ORP) on 30-minute intervals. The instruments come with detailed user manuals that will be maintained with the field equipment at all times. In-depth description of the specifications and operation manual of this instrument can be found at www.ysi.com.

Data were collected between September 2006 and June 2012 at three permanent stations prior to the restoration. One station was located within the main Lagoon (ML1) and two in the western Lagoon's back channels (ML2 and ML6). Data were downloaded, and the sondes were calibrated, cleaned, and redeployed approximately once monthly. YSI calibration instructions (www.ysi.com) were followed for each calibration and each probe. Data output from the sondes were exported into a spreadsheet and QA/QC procedures were performed by removing data from the analyses, including: data from probes not meeting full calibration or operating standards, data that were acquired when the sonde was not submerged, data that had unusual outliers, and data that were collected when the battery readings were low. Malfunctioning probes and sondes were sent back to the manufacturer for maintenance.

Permanent housing for post-restoration monitoring was built for three water quality sondes at Water Quality Stations 2, 5, and 8 (Figures 10-12). They were installed on 15 March, 2013 and those data will be included in subsequent monitoring reports.

Figure 10. Surveying in the thalweg for the location of a YSI sonde station, post-restoration, February 2013.

Figure 11. Deploying a YSI sonde at one of the stations, post-restoration, 15 March 2013.

Figure 12. Map of water quality vertical profile and SAV/algae survey stations. Water quality stations 2, 5, and 8 are also the locations of the three permanently-deployed YSI data sondes. Note that each SAV/algae station is comprised of three cross-channel transects approximately 10 meters apart (individual transects not identified on map).

Results

Graphs displaying data from pre-construction monitoring at stations ML1, ML2, and ML6 are presented in Figures 13-15. Figures 13a, 14a, and 15a illustrate the relationship between water salinity (ppt) and water depth (NAVD 88 ft). During closed conditions across the mouth of the main Lagoon, salinity levels lower as freshwater inputs from Malibu Creek raise the water elevations. Figures 13b, 14b, and 15b illustrate the relationship between temperature (^{o}C) and dissolved oxygen (mg/L). In general, as temperature increases in a closed lagoon scenario, levels of dissolved oxygen decrease as the primary producer communities (algae) consume the available oxygen. Figures 13c, 14c, and 15c illustrate the relationship between pH and oxidation reduction potential (ORP).

Data which did not meet the QA/QC standards were removed from the analyses. An example includes the removal of ML2 temperature data from Figure 14 due to probe malfunction. Additionally, large data gaps are present when individual probes or sondes are pulled from the field and sent to the manufacturer for maintenance. Examples include the ML6 data from the first half of 2007 (Figure 15) and ML2 data from September 2010 through January 2011 (Figure 14).

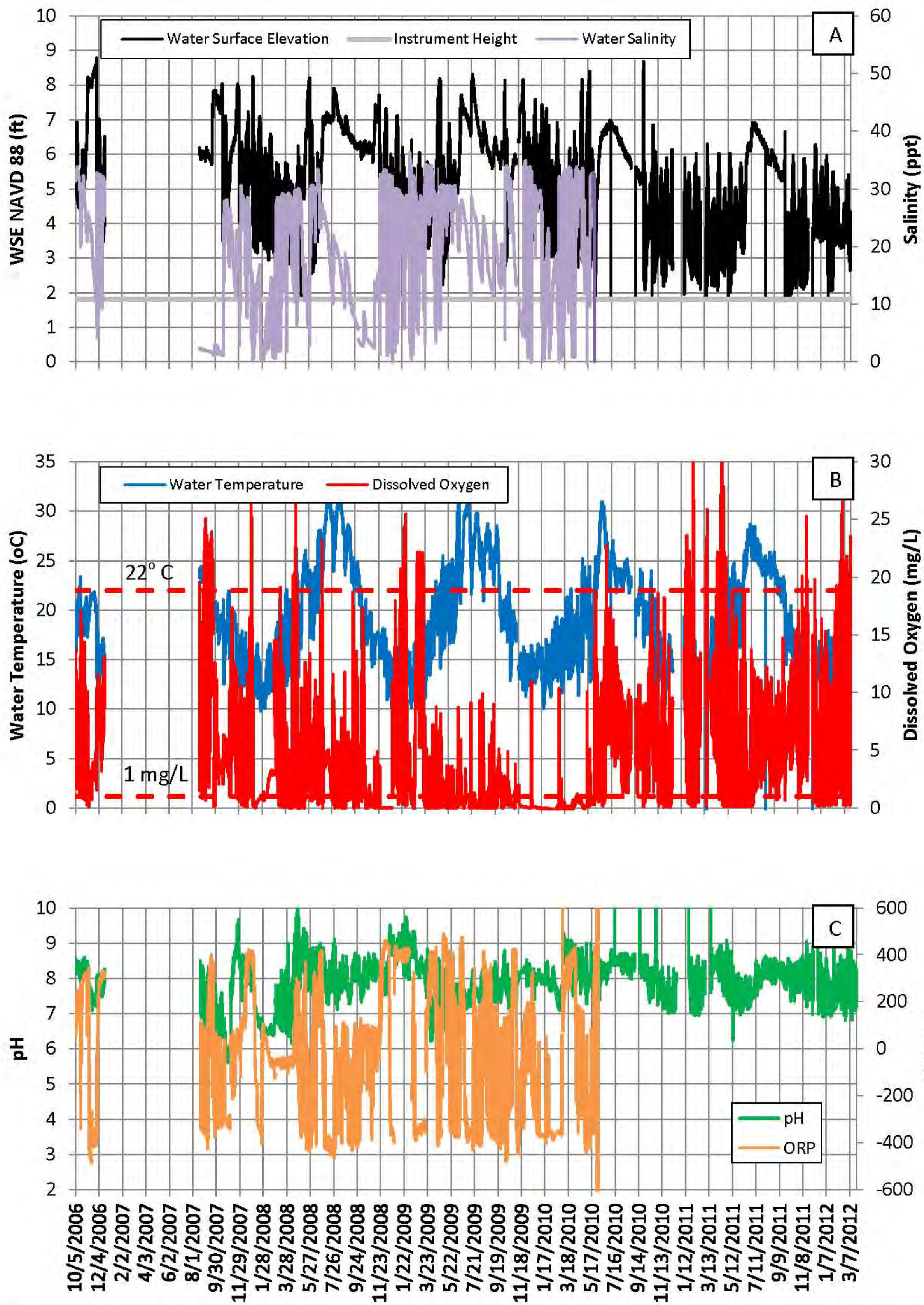

Figure 13A, B, and C. Graphs illustrating continuous water quality parameters from station ML1 (2006 to 2012).

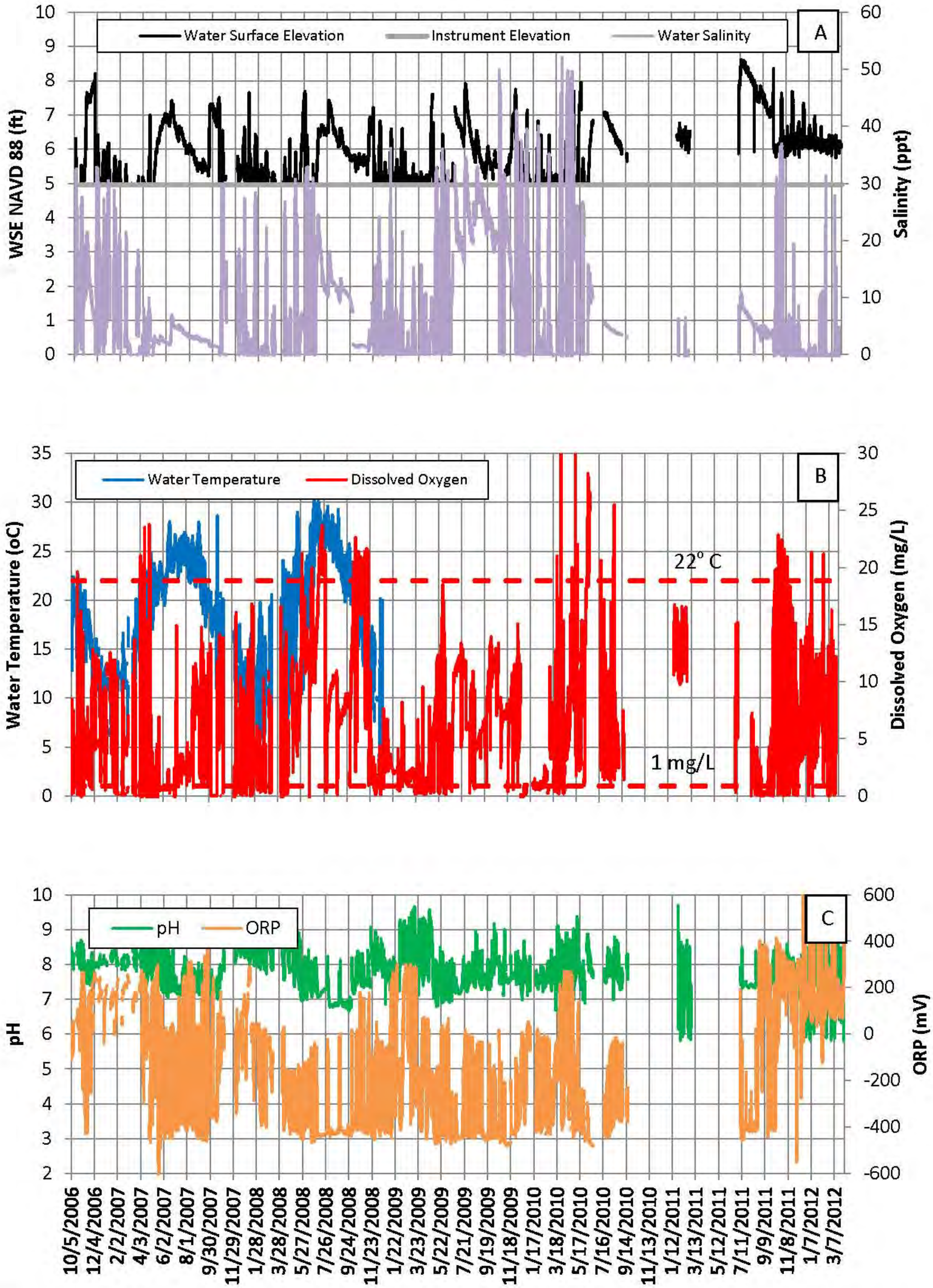

Figure 14A, B, and C. Graphs illustrating continuous water quality parameters from station ML2 (2006 to 2012).

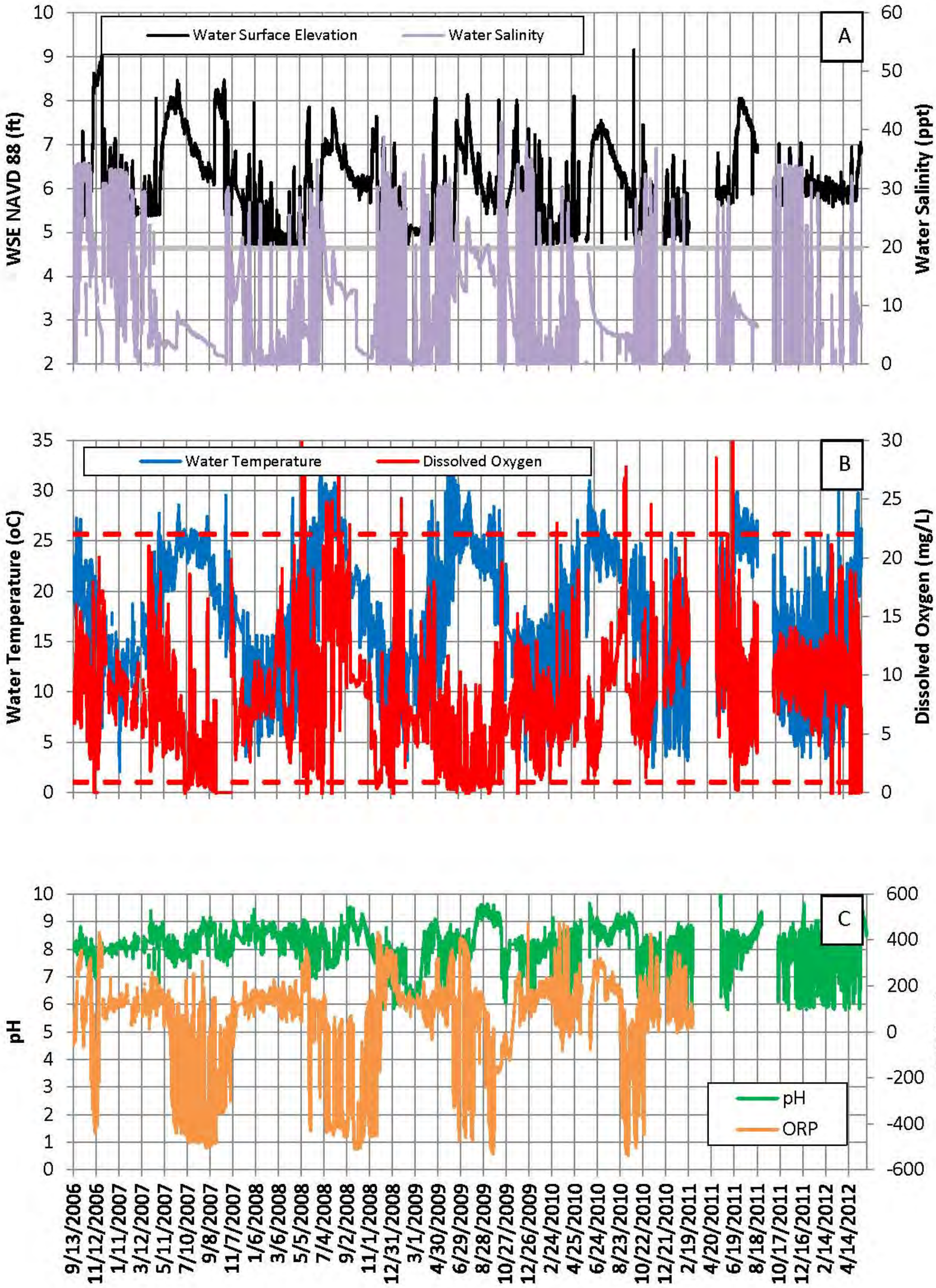

Figure 15A, B, and C. Graphs illustrating continuous water quality parameters from station ML6 (2006 to 2012).

Water Quality – Vertical Profiles

Methods

Semi-annual (April/May and September/October vertical profile sampling (at 0.5 foot intervals) of ancillary water quality parameters (DO, temperature, conductivity, salinity and pH) will be performed at eight stations at high tide using a YSI 600 XLM hand-held water quality instrument or equivalent. The vertical profiles will allow the expansion of the spatial representation of the continuous data loggers in addition to providing a QA/QC method to ground truth the continuous datasets. In-depth description of the specifications and operation manual of this instrument can be found at www.ysi.com.

Baseline immediate post-restoration vertical water quality profiles were conducted during a high neap tide on 14 February 2013 at all eight water quality stations (Figures 16 and 17).

Vertical Profile Field Collection Protocols:

1. Before beginning, all probes were calibrated according to the instrument's manual.
2. Probes were lowered underwater and allowed to equilibrate to surrounding water.
3. At each station, total water depth was measured. The total water column was divided into at least five depth intervals (including surface and bottom depths). At each depth, water temperature, dissolved oxygen (mg/L), conductivity, and pH were measured.
4. All water quality parameters were recorded for each depth interval.

Figure 16. Water quality vertical profile monitoring at Malibu Lagoon, February 2013.

Figure 17. Map of water quality vertical profile stations, SAV/algae sampling stations, and permanent sonde stations (2, 5, and 8).

Results

The immediate post-restoration vertical water quality profiles showed consistently high dissolved oxygen at all stations; all readings were over 12 mg/L at all depths (Figure 18; Table 2), greatly exceeding the <1mg/L threshold. Average salinity, water temperature, and pH were all consistent with water quality parameter goals of the restoration project (Table 3).

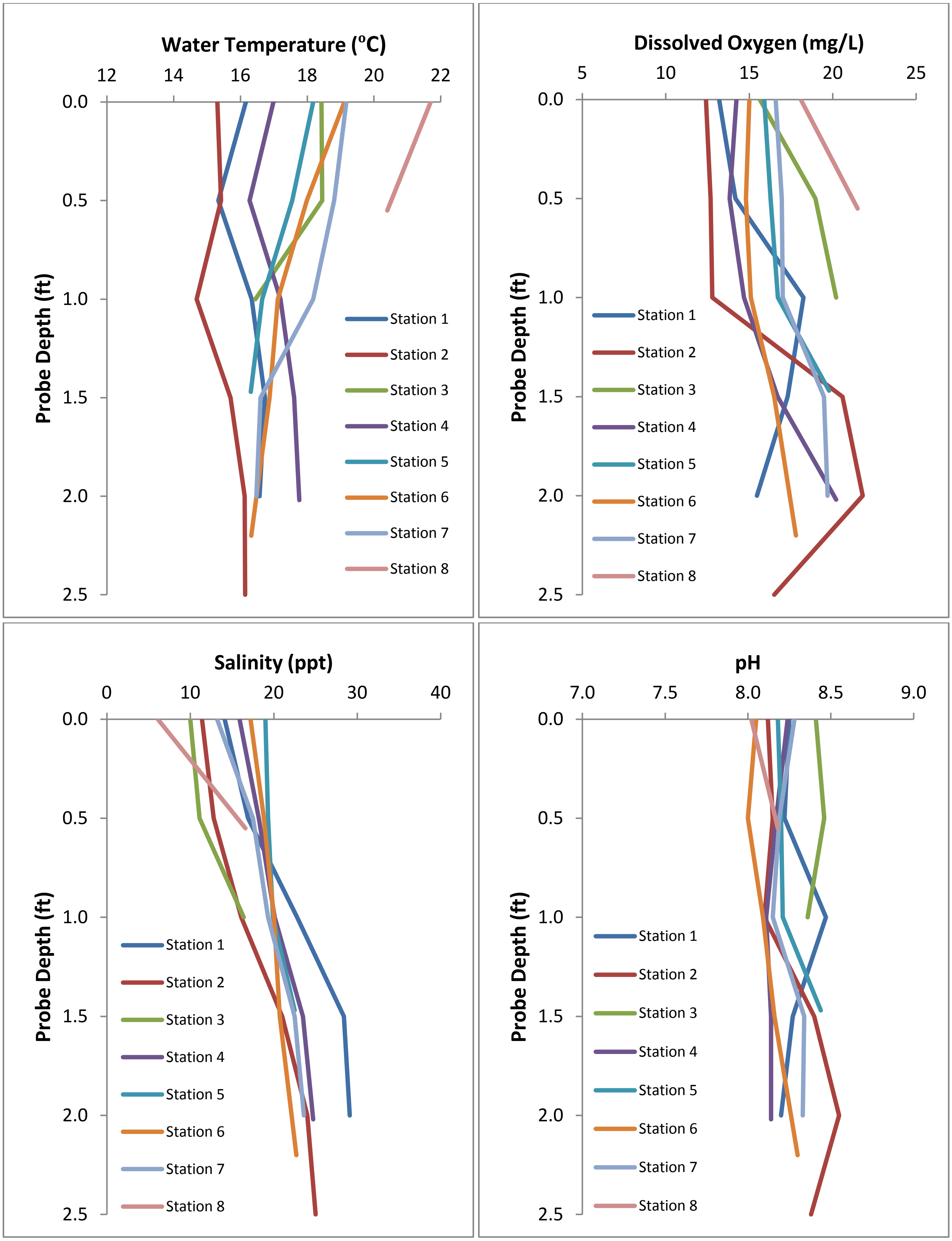

Figure 18. Vertical water quality profiles for four parameters: water temperature, dissolved oxygen, salinity, and pH across eight permanent water quality stations throughout the Lagoon.

Table 2. Maximum and minimum values for each parameter measured.

Parameter	Minimum	Maximum
Temperature (°C)	14.7	21.7
Dissolved Oxygen (mg/L)	12.4	21.8
Salinity (ppt)	6.1	29.1
pH	8.0	8.6

Table 3. Average parameter values and standard error (SE) by station.

Station	Average Temperature (°C)	SE Temp	Average Salinity (ppt)	SE Salinity	Average Dissolved Oxygen (mg/L)	SE Dissolved Oxygen	Average pH	SE pH
1	16.23	0.24	22.26	3.00	15.68	0.94	8.28	0.05
2	15.57	0.23	18.38	2.36	16.13	1.72	8.28	0.08
3	17.78	0.66	12.50	1.98	18.26	1.36	8.41	0.03
4	17.17	0.26	20.48	1.63	15.93	1.18	8.16	0.02
5	17.17	0.43	20.18	0.80	17.17	0.89	8.26	0.06
6	17.48	0.49	19.88	0.92	15.84	0.57	8.12	0.05
7	17.85	0.56	19.22	1.86	17.94	0.68	8.26	0.04
8	21.05	0.65	11.35	5.25	19.79	1.71	8.10	0.08

Summary and Discussion

Qualitative visual changes have occurred in the tidal inundation and circulation patterns seen in the restoration area immediately post-restoration. These improvements in circulation are also indicated by the presence of high dissolved oxygen content throughout the site, and especially in the back channels which were severely impacted by extremely low dissolved oxygen and anoxic conditions.

Water Quality – Surface and Bottom Water Constituent Sampling

Introduction

Water quality measurements may be used as indicators of both human health concerns and the overall chemical and physical conditions of a site. Reduced wetland water quality suggests poor circulation, lack of tidal flushing, or increased sediment transport in wetlands (Zedler 2001). Evaluating the water quality in the Lagoon by monitoring constituents of concern is vital to understanding the system as a whole. Constituents of concern can be defined as specific chemicals or pollutants that are identified for evaluation in a site assessment process as potential stressors.

Improvements to water quality and circulation were several of the driving factors for the restoration of the Malibu Lagoon. As such, detailed and extensive water quality sampling was conducted throughout the restoration process (i.e. during-construction methods and results) and will be collected in the future to assess post-restoration water quality improvements (i.e. post-construction monitoring methods and results). The principal goal of the constituent sampling was to determine if there were any exceedances of the water quality objectives during construction.

Methods

During-construction Monitoring Methods

Implementation of the Malibu Lagoon Restoration and Enhancement Project began on 4 June, 2012. In order to facilitate construction and to protect the main river mouth estuary during construction, a temporary dike approximately 10 feet tall and 50 feet wide was built to isolate the construction area from the main lagoon (Figure 19). In order to construct the project it was decided that water from the western channels would be removed to enable reconfiguring and grading the new channels in a dry condition. To accomplish the dewatering activities a large electric pump capable of pumping 600 gallons per minute (GPM) was installed in the western channels to direct water into the treatment plant. The contractor also constructed a series of temporary berms to isolate different sections of the construction area and to create areas for water storage that could be used to slowly feed the treatment plant. A series of large gas powered pumps capable of delivering up to 1100 GPM were used to pump water from the wetted area of the western channels within the construction zone into storage areas. The 600 GPM electric pump then slowly transported water to the treatment plant for filtration and disinfection. This technique of temporary storage and slowly feeding the treatment plant enabled Ford E.C. (the general contractor) to treat and discharge far less water (Figure 19). Pure Effect was the sub contractor used to operate and test the treatment plant. Water quality objectives were outlined in the project NPDES permit (Appendix A and Table 4).

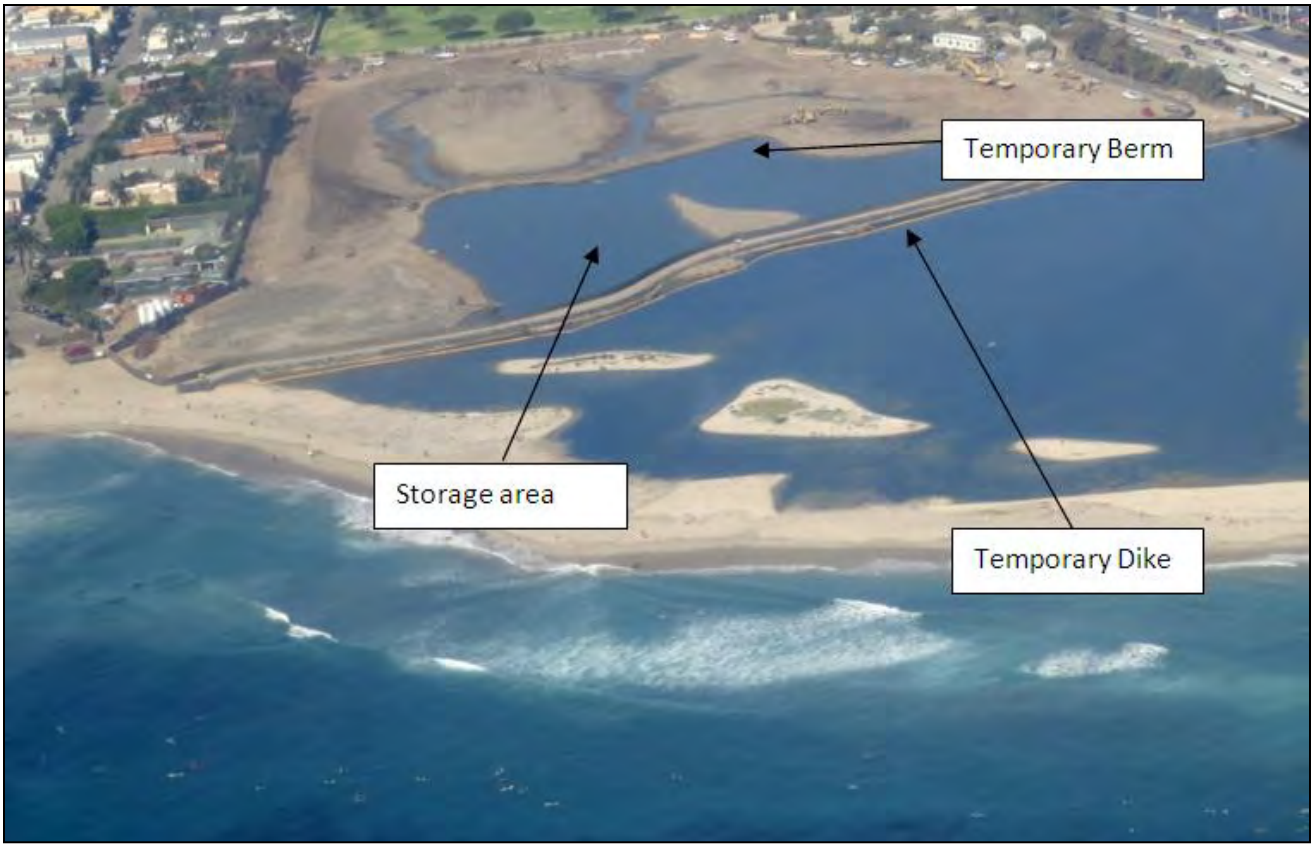

Figure 19. Map indicating the water storage area and temporary dike.

The treatment plant was constructed in July to filter and disinfect water from the construction area in the western lagoon before discharging treated water into the ocean (Figure 20). The treatment system was comprised of the following components:

- Two, 21,000 gallon over and under flow-through filters (Baker tanks) allowed settling of Total Suspended Solids, turbidity, and settleable solids. Polymer M and Chlorine were also injected at this point in the treatment process for a minimum of 30 minutes of contact reaction time. Polymer M was used to coagulate metals for removal by filtration and also helped remove turbidity.
- Following the Baker tanks, water was pumped through Dual Pod sand filters to further remove turbidity, settleable solids, and suspended solids. They also removed bio-matter from the chlorine and coagulation process.
- The next stage in the treatment train was a series of bag filters, 10 micron and 6 micron respectively, to further remove total suspended solids, settleable solids, turbidity, bacteria, and copper.
- The water was then passed through a 20,000 lb. resin bead media filtration (ion exchange) to remove sulfides, copper, Biological Oxygen Demand (BOD) and Oil and Grease (O&G).
- Water was then filtered through two 20,000 lb. granular activated carbon filter tanks to remove O&G, phenols, and residual Chlorine.

- The treatment system was also outfitted with a 5,000 gallon sand filter backwash tank that was plumbed to pump all water back into the Baker tanks. A flow meter displays the total accumulated flow on a daily basis.

The treatment plant was designed with two discharge ports: one at the ocean and a second located in the temporary storage area within the Lagoon (Figure 21). The Lagoon discharge point was installed so that the system could be thoroughly tested and proved before commencing discharges to the ocean. The Lagoon discharge port also would have allowed water to be placed back into the Lagoon in the event that the treatment system malfunctioned.

Water Quality Monitoring

To protect public health and the health of aquatic species, discharges were closely monitored whenever the treatment plant was in operation. Prior to any ocean discharges the plant had to operate successfully for 48 consecutive hours. Water quality monitoring consisted of field measurements five days per week (or whenever the treatment plant was operational) for pH, turbidity, salinity, water temperature, dissolved oxygen, and residual chlorine from both influent (prior to treatment) and effluent (following treatment). Field measurements were conducted independently by State Parks and the Santa Monica Bay Restoration Foundation. In addition to the daily field measurements, Pure Effect, the treatment plant operators, were required to collect samples and have them analyzed by a State Certified Laboratory.

Figure 20. Aerial photo depicting water treatment plant.

Field measurements were conducted using the following equipment: total residual chlorine was tested using the Hach Colorimeter 2. Salinity, pH, dissolved oxygen, and water temperature were tested using a YSI model 63 multi-meter. Turbidity was measured using the LaMotte 2020WE turbidimeter. All meters are EPA compliant. All meters were calibrated daily before testing began, as per the manufacturer's instructions. Calibration logs are part of the field sheets used to record data collected in the field (Appendix B).

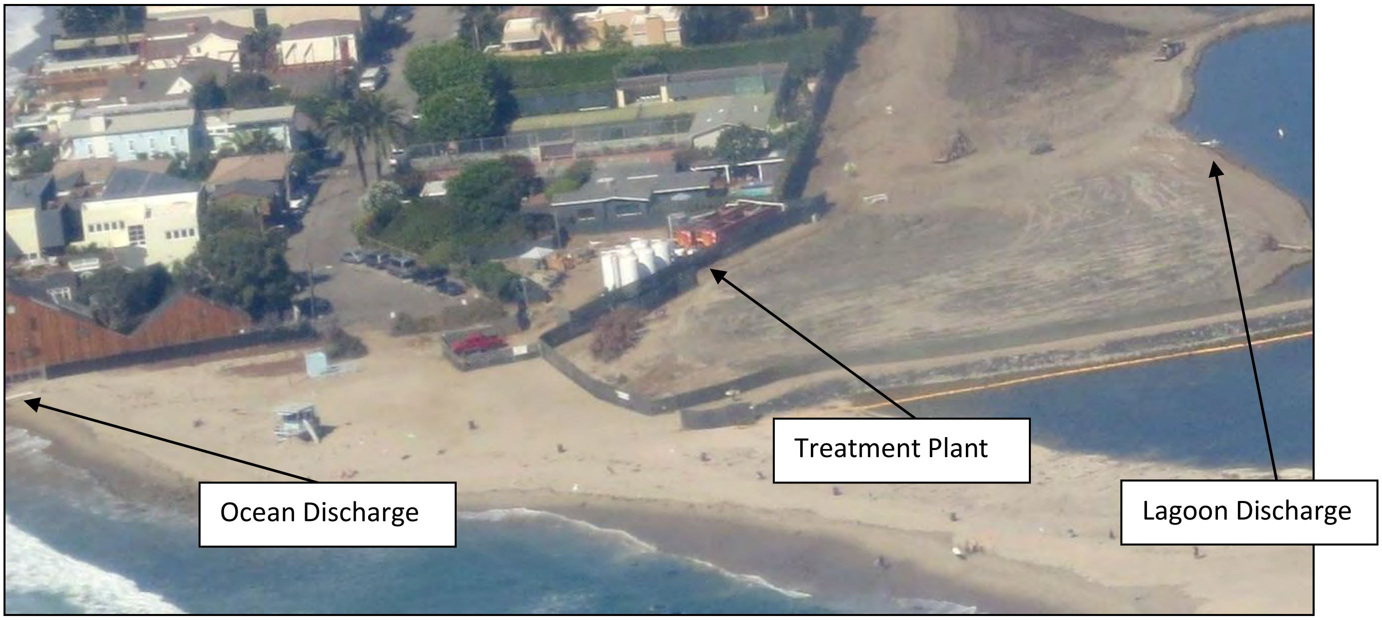

Figure 21. Location of treatment plant and discharge ports.

Pre-Ocean Discharge 48-hour Testing

The following monitoring was required prior to ocean discharges to ensure that the treatment plant was operating as designed and was capable of meeting all water quality objectives outlined in the project NPDES permit (Appendix A and Table 4). Field testing included twice-daily testing for the following parameters: pH, turbidity, salinity, water temperature, dissolved oxygen, and residual chlorine from both influent and effluent (Figure 22). Laboratory testing included twice-daily testing of total suspended solids, turbidity, total residual chlorine, copper, fecal coliform bacteria (*Escherichia coli*), total coliform bacteria, and enterococcus bacteria from both the influent and effluent streams during the 48-hour testing period. Biological oxygen demand (BOD), Oil and Gas (O&G), sulfide, and phenols were tested from both the influent and effluent one time during the 48-hour testing period. The plant successfully passed the 48-hour testing on 16 and 17 July, 2012. The treatment plant met all water quality objectives outlined in the NPDES permit (Appendix A and Table 4) over this 48-hour period and was allowed to commence ocean discharge.

Figure 22. Water quality monitoring of the influent adjacent to the inflow pipe.

Ocean Discharge Monitoring

Ocean discharge began on 23 July, 2012 and was ceased at 1:00 pm on 19 October, 2012. The following water quality monitoring was required at the specified frequency (Table 4) during the 89-day period. Field measurements included daily influent and effluent monitoring of pH, turbidity, salinity, water temperature, dissolved oxygen, and residual chlorine. Laboratory Testing included one-time sampling of acute toxicity from influent and effluent. Continuous monitoring of discharge flow occurred. Total suspended solids were sampled four times per week for the first week and monthly thereafter in both influent and effluent. Bacteria (total coliform, *E. coli* and enterococcus) were sampled four times per week for the first month and three times per week thereafter from influent and effluent. BOD, O&G, sulfide, and phenol were sampled and analyzed monthly from the treatment plant effluent. Copper was monitored weekly for the first month and monthly thereafter from influent and effluent.

Table 4. Voluntary monitoring program and frequency

Constituent	Daily Max	Monthly Average	Units	Frequency: Prior to Startup	Frequency: Week 1	Frequency: Week 2-4	Frequency: After Week 4
flow	----	----	----	cont	cont	cont	cont
TSS	150	50	mg/L	daily	4x/wk	monthly	monthly
*turbidity	150	50	NTU	daily	daily	daily	weekly
BOD 20 degrees celsius	30	20	mg/L	1x during startup	monthly	monthly	monthly
O&G	15	10	mg/L	1x during startup	monthly	monthly	monthly
sulfide	1	N/A	mg/L	1x during startup	monthly	monthly	monthly
phenol	1	N/A	mg/L	1x during startup	monthly	monthly	monthly
*residual chlorine	0.1	N/A	mg/L	daily	daily	daily	daily
copper	5.8	2.9	ug/L	daily	weekly	weekly	monthly
acute toxicity	----	90% survival	----	1x during startup	Up to monthly if < 90% survival	----	----
basic chemistry							
*pH	N/A	N/A	pH	daily	daily	daily	daily
*salinity	N/A	N/A	ppt	daily	daily	daily	daily
*temperature	N/A	N/A	Celsius	daily	daily	daily	daily
*dissolved oxygen	N/A	N/A	mg/L	daily	daily	weekly	monthly
Fecal coliforms (E. coli)	400	200 log mean	mpn per 100 ml	daily	4x/wk	4x/wk	3x/wk
Total coliforms	10,000	1000 log mean	mpn per 100 ml	daily	4x/wk	4x/wk	3x/wk
Enterococcus	104	35 log mean	mpn per 100 ml	daily	4x/wk	4x/wk	3x/wk

* Samples taken daily using a meter in the field.

Post-construction Monitoring Methods

Semi-annual surface water and bottom water samples will be collected at the eight vertical profile stations in spring and early fall, as described in the Monitoring Plan. Surface samples were not collected as part of the immediate post-restoration water quality assessment as described in the Monitoring Plan.

Results

During-construction Monitoring Results

There were no exceedances of any water quality objectives while the treatment plant was operational and discharging to the ocean between 23 July and 19 October, 2012. The treatment plant handled over 73 million gallons of water during the 89-day period when it was operating and discharging to the ocean. The treatment plant proved very effective at reducing turbidity, total suspended solids, settleable solids, copper, total residual chlorine and bacteria. The treated effluent was also tested for acute toxicity which was well within the limits set by the NPDES permit (Appendix A and Table 4). Field measurement monitoring data are available in Appendix B, including field instrument calibration logs. All laboratory data processed by Associated Laboratories, chain of custody sheets, and Quality Assurance procedures are contained in Appendix C. Note that due to the size of Appendix C (797 pages), it is included as a separate document and is not attached to this report.

Post-construction Monitoring Results

Semi-annual surface water and bottom water samples were not collected during the initial post-restoration baseline assessment monitoring. They will be collected at the eight vertical profile stations in spring and early fall, as described in the Monitoring Plan. Post-construction monitoring results for the other water quality parameters are detailed in the appropriate sections.

Summary and Discussion

The lack of any exceedances for any of the water quality monitoring objectives speaks to the success of the hydrological planning as well as the treatment plant. Water coming in from the Lagoon was much cleaner and less turbid at the discharge point, showing the success of the filtration systems in place throughout the restoration. Additional water quality monitoring over the upcoming years will highlight the effects of the restoration efforts on water quality at the Lagoon.

Biological Monitoring

The key to the biological aspects of the Malibu Lagoon restoration will be observable improvements in the establishment and persistence of species diversity and native organisms well beyond the first five years following construction. Biological monitoring components will be monitored in the Lagoon to document any changes in the biological indicators as a result of restoration activities. The monitoring will include annual biological sampling for multiple parameters during the spring and fall and will occur for at least five years following the completion of the Lagoon restoration plan as documented in the 2012 Malibu Lagoon Restoration and Enhancement Plan, Hydrologic and Biological Project Monitoring Plan.

The objectives of the biological monitoring of the Malibu Creek Lagoon are to:

- Assess the habitat and vegetation improvements towards the goals of restoration.
- Document the fish and bird communities' use of the site.
- Provide timely identification of any problems with the biological development of the lagoon.

Specific biological parameters that are assessed in this report include: SAV/algae, fish, and avifauna surveys were completed for this report and are detailed below and in attached appendices. Further biological monitoring will be documented in subsequent surveys and reports, including vegetation transects and photo point surveys.

Benthic Invertebrates

Benthic invertebrate community sampling was not conducted during the initial post-restoration baseline assessment monitoring. Benthic invertebrate surveys will be performed at eight stations annually during the fall of each year post-restoration, as described in the Monitoring Plan.

Fish Community Surveys

Introduction

The RCDSMM has been monitoring the fish community diversity and abundance in Malibu Lagoon following the initial restoration in 1984. At that time, 27 native fish species were observed in the lagoon (Manion and Dillingham 1989). In a small sampling conducted in June 2005, we documented only five native fish species (tidewater goby, CA killifish, topsmelt, long jawed mud sucker, opaleye) plus carp and mosquitofish (Dagit and Swift 2005). Spot sampling between 2005 and 2012 continued to document the low numbers of native species and the increasing abundance of invasive exotic fishes.

Tidewater gobies formerly inhabited most of the coastal lagoons throughout California, including Malibu Lagoon, but were extirpated by the 1970's. In 1991, the RCDSMM worked with CDPR to reintroduce 52 individuals captured in the Ventura River (Manion 1993). From those founding individuals, thousands of these federally listed endangered fishes re-populated Malibu Lagoon by 2005. They prefer the sandier areas near and upstream of the Pacific Coast Highway bridge, but have been observed throughout the entire lagoon, including the back channels.

A pre-construction survey of the fish population was conducted in June 2005 (Dagit and Swift 2005). At that time, a total of five native fish species were documented (Table 5), although it was known that additional species (such as the federally endangered southern steelhead trout) were potentially present. The implementation of the restoration plan was delayed from the intended start date of 2009 to 2012. Spot surveys were conducted in 2008, 2010 and 2012 indicating that a similar suite of species was still present. Due to the extremely deep muck and anoxic conditions throughout the lagoon, pre-construction surveys were not conducted prior to the start of work in June 2012.

Table 5. Summary of Species Observed in Malibu Lagoon, 20 June 2005 (Dagit and Swift 2005).

Species	**TOTAL Captured**	% of Total
Atherinops sp. **Topsmelt**	244	29.00
Cyprinus carpio **Carp**	1	0.10
Eucyclogobius newberryi **Tidewater Goby**	473	57.00
Fundulus parvipinnis **CA killifish**	46	5.50
Gambusia affinis **Mosquitofish**	65	7.75
Gillichthys mirabilis **Long-jawed mudsucker**	1	0.10
Girella nigricans **Opaleye**	1	0.10
SHRIMP	5	0.60
TOTAL	**836**	

Lagoon Condition

The ocean connection to the lagoon closed on 14 May 2012 and remained closed until it breached on 10 June 2012. The breach followed a week of extremely high tides which overwashed the sand berm daily from 4-10 June 2012. Prior to the breach, the lagoon water level was perched at the top of the sand berm, with the depths of the western back channels ranging from 30-90 cm deep. Water was between 3-10 cm deep in some of the vegetated areas between the back channels. The breach occurred approximately mid-way between the eastern and western ends of Surfrider Beach, in an area referred to locally as Second Point.

Tidewater Goby Relocation Plan

A Tidewater Goby Relocation Plan (Appendix D) was prepared in accordance with the requirements of the USFWS Biological Opinion (August 26, 2009). It was submitted on 29 May 2012, reviewed and approved by:

Chris Dellith, USFWS
Dr. Camm Swift, Senior Fisheries Biologist, Emeritus
Suzanne Goode, Senior Environmental Scientist, CDPR
Rod Tuttle, Construction Supervisor, CDPR
Mark Abramson, Project Manager, SMBRF

In accordance with permit requirements, the RCDSMM submitted the qualifications and received approval for the following staff that coordinated and conducted the relocation activities and monitored the construction impacts on native fishes:

Responsible Biologists:

Rosi Dagit, Senior Conservation Biologist, RCDSMM
Doug Rischebieter, Environmental Scientist, CDPR
Rosemary Thompson, Senior Consultant, CARDNO ENTRIX

Jenna Krug, Conservation Biologist, RCDSMM and Steven Williams, Conservation Biologist, RCDSMM assisted in supervising the field assistants throughout the project.

Field Assistants were trained by the responsible biologists and complied with the approved protocol for fish capture, handling and relocation. Field Assistants included: RCDSMM staff, CDPR staff, SMBRF staff, CA Science Center staff, CDFW staff, CA Conservation Corps staff, and Topanga Creek Stream Team selected volunteers.

All volunteers and construction personnel were required to participate in a Safety Training and Tidewater Goby Avoidance Training session prior to working on the site. Appendix E contains a copy of the materials covered.

Incidental Take Procedure

A "lethal take" limit of no more than five tidewater gobies was set by the Biological Opinion (BO)(USFWS 2009). Should any gobies be killed or injured during any of the restoration activities, all work would stop and the RCDSMM Biologists would immediately notify the contractor to cease work and notify Mark Abramson of SMBRF and Suzanne Goode of CDPR to reinitiate consultation with Chris Dellith at USFW. No additional work within the wetted lagoon could take place until authorized by USFWS.

No lethal take occurred.

Methods

RCDSMM, CDPR, and SMBRF relocated and monitored fish during the restoration of Malibu Lagoon in 2012-2013 in compliance with the Reasonable and Prudent Measures identified by the USFWS Biological Opinion (CON 1-8-08-F-4, August 26, 2009). Malibu Lagoon lies within the LA-1 designated critical habitat for the tidewater goby. Implementation of the fish sampling efforts required possession of a valid California scientific collectors permit issued by the California Department of Fish and Wildlife and a California State Parks Department special use permit. In addition, given the reasonable expectation of capturing the federally-listed tidewater goby, a federal Endangered Species Act section 10(a) permit issued by the United States Department of Fish and Wildlife was required to conduct fish sampling in the lagoon. RCDSMM biologists hold all the necessary permits for handling endangered tidewater gobies and southern steelhead trout.

The fish relocation and monitoring work occurred in four phases: (1) pre-restoration relocation of fish, (2) construction monitoring, (2a) removal of the dike and turbidity curtain, and (3) post-construction monitoring. For the first three phases, seines, blocking nets, dip and hand nets, and silt fencing were used to relocate fish to the main Lagoon.

Documenting site conditions

Prior to the start of activities each day, the Responsible Biologist walked the project site to: a) photograph conditions; b) look for any stranded or dead fish; c) identify work priorities for the day; and d) discuss work sequence with the contractor and CDPR/SMBRF contract managers. The following water quality data were recorded by the RCDSMM team at a variety of locations to characterize the site conditions at the start of work each day: air temperature, wind speed and direction, water temperature, salinity, dissolved oxygen, pH, and conductivity. Photos of the work area were taken at the start and end of each work day to document changes in the site conditions as work proceeded (Appendix F).

Photos were also taken to document species captured and handled, especially those whose identification was not immediately taxonomically identifiable. These photographs were then forwarded to Dr. Camm Swift for his review and identification.

Daily Progress Notes

Using the EPA Monitoring Protocol, daily field notes were recorded documenting time of activities, description of the work, conversations about issues of concern, etc. The work progressed in several stages. Initially, the focus was on avoiding stepping into the muck and removing as many fish as possible from the work area. Finding few native fishes, we continued seining in the more traditional manner, using fish exclusion fences and blocking nets to completely clear each area. Pumps were used to draw down water levels slowly allowing fish to be removed and not be stranded.

Capture Methods

In accordance with “Appendix F Tidewater Goby Survey Protocol” (USFWS 2005), a variety of methods were employed in order to successfully capture all the fish in the work area in an efficient manner that caused minimal mortality of native fishes and no mortality of tidewater gobies.

1. Blocking nets and temporary barriers (fish exclusion fences constructed of silt fencing and sandbags) were used to isolate sections of the channels at low tide when water levels were lowest. These devices were installed as needed to create more manageable channel reaches that could be safely fished.

2. Seine nets of various sizes were used. A serious concern was the deep level of anoxic muck, especially in the back channels. Stepping into the wetted area resulted in sinking in above the knees and the suction prevented movement. This also caused release of hydrogen sulfides trapped in the sediments, which can be lethal to fish under certain conditions. Our strategy was to have sufficient people on hand so that each person could step into one spot in a coordinated order, and then pass the seine net from hand to hand, rather than have the nets pulled across the bottom by one pair of fishers. This technique allowed us to herd the fish into areas adjacent to the banks or fish exclusion fences, where another team of fishers was waiting to scoop them up with long handled dip nets. Submerged aquatic vegetation in the nets and along the banks was also carefully inspected to make sure that no fish were entrapped.

   Once we determined that no endangered species were present, and we were getting fewer than five native fish per seine pull, then we reverted to a coordinated seining where fishers walked the net forward as is more commonly done.

3. Once captured, either by the seine or dip net, the fish were immediately placed into buckets of cool, clean water aerated by battery-operated bubblers. The number of fish per bucket depended on size of the fish, native vs. non-native species, and the relocation destination. All native fishes were placed into buckets that were immediately carried to a safe location near the PCH bridge for release into the main lagoon. All goby species (arrow and tidewater) were released immediately upon identification. Fish spent no more than 15 minutes in a bucket between capture and release.

Identification of all fish captured was done in-situ, with photographs taken of any individuals that were not conclusively identifiable. Larval fish were examined under a microscope on one day, but due to time contraints and the overwhelming majority of non-native larval fish, we released all fish that were not conclusively Gambusia safely into the main lagoon outside the work area.

4. The data team documented number of each species, sizes classes, and reproductive status when possible (see datasheet in Appendix D). Non-native fishes (primarily *Gambusia*) were sacrificed and placed in coolers filled with ice. Because they were so small (majority under 2 cm Total Length) the local wildlife centers were not interested in using them as food, so they were disposed of properly.

5. Each area seined by the team was completely fished out. Water levels were lowered by pumps protected by netting, and fishers observed to be sure that all fish were removed from the channel before moving to the next segment.

PHASE 1: Fish Relocation Methods

The critical concerns identified by the USFWS Biological Opinion included the following:

- trampling fish
- crushing fish during dewatering by impingement against the pump screens
- desiccation or suffocation resulting from stranding in a dewatered area
- entanglement in seine nets
- exposure to high temperatures or low dissolved oxygen during handling and relocation

Construction methodology was therefore designed to avoid these impacts to the maximum extent feasible. As the turbidity curtain was installed along the margin of the main lagoon body and the temporary dike was constructed in lifts, the fish relocation team swept the work area prior to construction activities to ensure that no fish remained in the area or were impacted during low tide. Temporary fish exclusion fences were constructed using 3 foot tall silt fencing and were secured to the substrate with gravel bags. This sectioned off portions of the channels so that we could completely seine each reach and prevent fish from returning to a previously cleared portion of the channel.

On Monday, 11 June 2013 the fish relocation team started clearing the channels and the work area for installation of the dike using a variety of seine nets, dip nets and pool scoops with extension handles. The team moved from area to area in accordance with the needs of the construction equipment. The team used a variety of strategies to ensure that sediment disturbance was minimized to avoid stirring up mucky black clouds that obstructed the view of the fish and temporarily released hydrogen sulfide into the water. These included staging people on each side of the channel in a line to pass the seine nets hand-to-hand and thus avoid excessive walking through the muck; using long handled nets from the bank; and, after the majority of native fish were removed, regular seining. The muck levels were significant, with field assistants sinking up to their thighs in many locations.

On the morning of Monday, 11 June 2012, the contractors, CDPR, SMBRF and RCDSMM staff conducted a thorough walk-through of the entire site, the perimeter of the main lagoon and along the beach near the breach before the commencement of construction and fish relocation activities. No stranded or dead fish were observed.

The conditions of the work area were influenced by the tidal cycle from 11-15 June 2012 while the dike was completed and the turbidity curtain deployed. High tides during the evenings allowed movement of a few small fishes into the work area when water levels overtopped the fish exclusion fencing prior to the completion of the dike. Figure 23 and 24 show the locations and a photo, respectively, of fish exclusion fences. Photographic documentation of the process is provided in Appendix F.

Figure 23. Map of Malibu Lagoon showing locations of fish exclusion fences, water sampling locations and approximate dike location.

Figure 24. Photo of fish exclusion fence and sandbags.

Fish Exclusion Fences

The dike was first completed across the "A" and "B" channels adjacent to the main Lagoon. There was little water in "B" channel (maximum of 10 cm depth in a small pool under the pedestrian bridge), and by cutting "B" off from connection with the other channels in three locations, we were able to completely remove all fish from this area first. This permitted the pumping of water from the "A" channel into the "B" channel, reducing the water level sufficiently that the fish could be removed efficiently. A small pump was placed under the pedestrian bridge over "A" channel, and screening around both the pump and fish exclusion fencing on either side of the pump prevented impingement of fish at the pump intake. This set-up was used as the pump was moved to each new location.

Lastly, we focused on the "C" channel, which was the most challenging due to extensive, deep muck, wider channels and uneven elevation that concentrated water in inaccessible pools surrounding a tule patch. Again, pumping was used to move water from this channel into the "B" channel, reducing the water depth and width such that seining was effective.

Upon completion of the dike installation and securing of the lagoon face with erosion control fabric, the turbidity curtain was deployed per specifications on 14 June 2012 (Figure 25). But due to tidal fluctuation, the curtain collapsed and folded in on itself that night during low tide. On the morning of 15 June 2012, we found 148 native fish (see results section), including one tidewater goby, trapped in the folds. The tidewater goby was not harmed and was released into the main Lagoon; however, 12 other native fishes were casualties.

Figure 25. Initial deployment of the turbidity curtain on 14 June 2012.

After careful seining and dip netting all the folds to confirm no additional fish were trapped, the curtain was then pulled up and laid directly along the face of the dike and secured along the bottom and top with gravel bags to prevent water from seeping between the dike and the curtain, and preventing the curtain from slipping down the bank (Figure 26). The turbidity curtain remained in this configuration until 26 June 2012, when the sand bar became sufficiently re-established to prevent connectivity. Over the following days, the lagoon water level rose and stabilized. The upper edge of the turbidity curtain was released on 16 July 2012 so that it could float. The bottom of the turbidity curtain remained secured with sandbags to the base of the dike.

Figure 26. Photo of turbidity curtain while the main Lagoon was tidally influenced (open berm condition).

PHASE 2: Construction Monitoring Methods

Between 1 July and 18 October 2012, work was primarily focused within the work area cleared of all fish. CDPR and SMBRF biologists were on site daily and checked the turbidity curtain at the beginning and end of each day to make sure no fish were entrapped. RCDSMM biologists also made several site visits (1-2 times per month) to observe the condition of the turbidity curtain as the berm closed and water levels in the lagoon rose and stabilized.

On 10 July 2012, the team did a thorough check of the water that had seeped between the turbidity curtain and the dike. On 16 July 2012, the water level had risen sufficiently to remove the sandbags securing the turbidity curtain to the dike, and to float it according to the installation specifications. With assistance from the contractors' staff, we moved the sandbags off the base of the curtain, ensuring that no fishes were trapped in the bags or crushed by moving them.

At every 100 foot connection, a float was attached to an anchor, which was placed further out into the main lagoon. This configuration kept the turbidity curtain in place, but the bottom chain was resting unevenly along the substrate so that fish could move in and out. The turbidity curtain was pulled out far enough so that even with the wind blowing it toward the dike, there was a minimum of three feet between the top float and the dike. This allowed for sufficient flow so that the water between the turbidity curtain and the dike maintained the same water temperature as that in the main lagoon.

On 13-14 August 2012, excavation was conducted along the bank close to the PCH bridge to achieve the required contour. The area between the dike and the turbidity curtain was carefully visually inspected and tested with a dip net to be sure no tidewater gobies or goby burrows were in the proposed work area. Then the area was seined prior to excavation, and blocking nets used to isolate the disturbed area. By carefully and gently lowering the bucket into the water, there was little rippling and waves.

PHASE 2a: Dike and Turbidity Curtain Removal Methods

Removal of the dike and installation of the large woody debris salvaged from sycamore or London plane trees commenced on 18 October 2012. Placement of the tree on the east bank to provide woody debris structure for enhanced bird roosting and fish habitat required that a large excavator traverse a narrow channel (approximately 100 cm maximum depth), which was part of the main Lagoon, located near the Adamson House and beach. The 2-foot diameter tree trunk included the root ball and some branches.

In order to exclude fish from the path the excavator traveled through the water, a team set blocking nets and then seined in front of the excavator to herd any remaining fish out of the way. We also seined the area into which the tree was being placed to ensure that no fish were inadvertently present.

Similar strategies were employed for installation of the pump basket and pump to equalize the water levels between the main Lagoon and the work area prior to breaching the dike. The pump basket was covered with 1.5 cm hardware cloth as required to prevent impingement of fish.

Beginning on Monday 22 October 2012, the excavators started removing fill from within the water. The pump had worked all weekend to equalize the water level on either side of the dike. We set blocking nets between the area where the dike was being removed and the turbidity curtain and seined to depletion. We set the nets to prevent any fish from being washed into the work area when the dike was finally breached.

Removal of the dike continued daily through Friday, 26 October 2012. Nets were set and moved according to the needs of the equipment. The turbidity curtain remained in place and seine pulls were conducted to make sure no fish were trapped between the remaining dike and the turbidity curtain.

On Monday, 29 October 2012, the process of excluding fish was repeated as the excavator moved rocks through the narrow southeast corner of the main lagoon to more securely anchor the sycamore and London plane trees. We had the opportunity to conduct some spot seines throughout the main lagoon and upstream as far as the Cross Creek Road Bridge. The turbidity curtain sections were disconnected and removed by section on Tuesday 30 October 2012. Observers stood on either side of the curtain as it was pulled through the water by the excavators and folded on shore. Observations from the PCH bridge were made at the end of the day to document turbidity levels related to the removal of the curtain. All turbidity was contained within the work area by the turbidity curtain and was allowed to settle over the weekend before the turbidity curtain was removed.

Final work in the water was completed on Wednesday 31 October 2012 with the removal of a single anchor that had gotten snagged during removal of the curtain.

PHASE 3: Post-Construction Monitoring Methods

Post-construction surveys of the entire Lagoon were conducted on 8 January 2013 (Figure 27) during a falling tide. This date was selected as it provided suitable tides and the lagoon was connected to the ocean. Tide was high at 0546 (6.3 ft) and low at 1305 (-0.8 ft). This permitted surveying as the tide receded during the day.

Figure 27. Team of field scientists conducting beach seines as part of fish community surveys, January 2013.

Two different survey methods were used; blocking nets and seines were used at the permanent stations, and spot survey seines were used for the rest of the main Lagoon.

Permanent Stations

Six fish sampling stations (Table 6) were established within the Malibu Lagoon to characterize fish communities in all aquatic environments represented in the system, based on the requirements of the Malibu Lagoon Restoration and Enhancement Hydrologic and Biological Project Monitoring Plan (SMBRF 2012) as shown in Figure 28. Stations were distributed throughout the restoration area to provide documentation of fish diversity, abundance, distribution, and to replicate as closely as possible the stations used previously in the 2005 pre-construction survey.

Table 6. GPS coordinates of permanent monitoring stations (Decimal degrees).

Station	Latitude	Longitude
1	34.02.032	-118.41.054
2	34.01.983	-118.41.084
3	34.01.958	-118.41.086
4	34.01.947	-118.40.963
5	34.02.000	-118.41.006
6	34.02.049	-118.40.974

Figure 28. Map of the six permanent fish monitoring stations.

At each station, one transect tape was deployed along the shoreline extending 10 meters. Two 10 x 2 m blocking nets were deployed perpendicular to the shore. Blocking nets (3 x 2 m) were then pulled together to form a triangle, subsequently trapping any fish on the interior of the triangle. Two teams with 3 x 1 m seines walked carefully to the apex of the triangle and pulled from the apex towards the shore. Seines were beached at the edge of the water and all contents examined. All fish were transferred immediately into buckets of clean, cold water standing by each net. Algae presence was noted. Fish were identified to species, Fork Length was measured, and they were released outside of the blocked area. Seine pulls continued until three consecutive pulls were empty. The presence of one oriental shrimp in the pull was considered empty.

Substrate was primarily sand and gravel, except at Station 6, located along the west bank of the Lagoon outside of the restoration area where muck up to 30 cm deep was encountered. Additionally, water quality variables were measured at the permanent stations.

Spot Survey Seining in the Main Lagoon

Using 2 x 1 m seines, three teams pulled two parallel seines along the shoreline, beach bank, center Lagoon, above the PCH bridge, and in the ocean inlet (Figure 28). Collection, identification, and release methods were the same as the permanent stations within the restoration area.

Results

PHASE 1: Fish Relocation Results

Water depth in the western channels within the work area ranged from 3-30 cm during Phase 1. Data were collected daily by each seining team and collated by the Responsible Biologist in the daily fish notes. 197 live fish and 12 dead fish were recorded in the turbidity curtain surveys on 15 June 2012 (Table 7).

Table 7. Species and number of individual fish trapped in the turbidity curtain on 15 June 2012.

Species	Number Alive and Released	Number Dead
Tidewater goby (6-7 cm)	1	0
Staghorn sculpin (6 cm)	2	0
Smelt larva (1-2 cm)	111	10
Killifish (1-2 cm)	22	1
Topsmelt adult (16 cm FL)	0	1
Sub-total native fish	**136**	**12**
Gambusia (non-native)	61	----
TOTAL fish trapped	**197**	**12 native fishes, 0 goby**

A total of 477 native fish, representing five native species (tidewater goby, CA killifish, long-jawed mud sucker, topsmelt and staghorn sculpin), were handled throughout Phase 1 (either with seines, nets or by hand) (Table 8). The most abundant organisms found in our nets were juvenile water boatman, followed by mosquitofish. The most abundant native fishes were juvenile CA killifish.

There were a total of eight adult tidewater gobies captured, mostly in the areas closest to the main body of the lagoon. We also caught two larval gobies (<2 cm) in "B" channel that were possibly tidewater gobies. Two of these fish were initially identified as arrow gobies, but following the review and recommendation of Dr. Camm Swift, we considered them all to be tidewater gobies. All of these fish were released alive and well into the main lagoon.

A total of 21 native fish were killed during this work, including juvenile CA killifish and topsmelt (Table 8). This mortality was associated with the turbidity curtain folding when the lagoon was still tidal. Once the berm closed and the lagoon stabilized, the turbidity curtain was secured to the dike, and no additional mortality occurred.

Our documentation of the invertebrates was not consistent over the course of the work, so although the crab numbers are accurate, the numbers of other species are conservative estimates.

Table 8. Summary of individual fish handled in the Malibu Lagoon Restoration Area (11-20 June 2012).

Native Fish Species	**Captured by seine/nets**	**Trapped in turbidity curtain**	**Number released**	**Number dead**
Unidentified goby larva (<5 cm)	2	0	2	0
Tidewater goby adult (6-8 cm)	7	1	8	0
CA killifish juveniles (<5 cm)	289	22	306	5
CA killifish juveniles (5-10 cm)	16	0	16	0
Long-jawed mudsucker (<5 cm)	8	0	8	0
Long-jawed mudsucker (5-10 cm)	11	0	11	0
Topsmelt larva (<5 cm)	2	0	1	1
Topsmelt juvenile (6 cm)	0	1	0	1
Topsmelt adult (16 cm)	0	1	0	1
Unidentified smelt larva (<5 cm)	3	111	101	13
Staghorn sculpin (5-10 cm)	1	2	3	0
TOTAL (N=498 native fish handled)	**339**	**138**	**456**	**21**
Non-Native Fish Species				
Mosquitofish juveniles (<5 cm)	4055	60	0	4115
Mosquitofish gravid females (5-10 cm)	17	1	0	18
TOTAL	4072	61	0	**4133**
Invertebrates				
Hemigrapsus crabs	6	----	----	----
Water boatman juveniles	6,000+	----	----	----
Amphipods	2500+	----	----	----
Isopods	2500+	----	----	----

The species diversity and abundance is similar to that observed in the pre-construction survey conducted in June 2005. At that time, four of the same native fish species were represented. The major difference was the lack of staghorn sculpin and in the increased numbers of mosquitofish observed, as well as the explosion of water boatman.

PHASE 2: Construction Monitoring Results

No tidewater gobies were observed during the PHASE 2 Construction Monitoring. During the 10 July 2012 survey a few mosquitofish, oriental shrimp, and smelt larvae were present. No mortalities were observed. During the 16 July 2012 surveys, the only species observed were schools of larval smelt and gambusia, and a few oriental shrimp.

During the 13-14 August 2012 surveys, Seine hauls captured several hundred larval/post-larval and juvenile topsmelt (25-50 mm), oriental shrimp, *Hemigraspus* crabs and mosquitofish. All of these were released alive into the main Lagoon, outside of the turbidity curtain.

The turbidity curtain worked well and prevented sediment from dispersing into the main lagoon. Spot seines were conducted in the main body of the lagoon adjacent to the beach to examine the fish assemblage and distribution pattern. Very few fish were captured, including primarily topsmelt (~75 mm) and oriental shrimp. Again, no evidence of tidewater gobies was noted.

PHASE 2a: Dike and Turbidity Curtain Removal Results

No tidewater gobies were observed during the PHASE 2a Dike and Turbidity Curtain Removal. Species found included only topsmelt, mosquitofish, and a single longjawed mudsucker. Two juvenile topsmelt (3-5 cm) were killed when impinged on the seine net. All other fish found when the dike was breached (*Gambusia*, CA killifish, oriental shrimp) were released alive into the main lagoon.

On the Monday, 29 October 2012 surveys, Topsmelt and shrimp were the most abundant species observed. On Tuesday, 30 October 2012, No fish were observed trapped in the curtain. Several mosquitofish and shrimp, as well as small schools of smelt larvae, were observed swimming near the curtain as it was removed.

PHASE 3: Post-Construction Monitoring Results

Permanent Stations

Substrate was dominated by sand and gravel. No muck was observed. Due to the lack of vegetation, shelter value and cover were absent, and habitat was of uniform low quality at this time. Table 9 displays the data from the general water quality parameters measured at each station on 8 January 2013. Water quality parameters were not measured along the spot survey locations. Table 10 displays a summary of the total number of individual fish found at all of the permanent survey stations.

Table 9. Water quality measured at permanent monitoring stations 8 January 2013.

Variable	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Max depth (cm)	26	75	74	49	50	76
Avg depth (cm)	14	47	62	27	30	38
Water (^{o}C)	12.8	11.8	12.5	12.4	11.9	14.4
Air (^{o}C)	14	14.5	14.7	16	18.2	19.4
Salinity (ppt)	29	15	13	18	20	11
DO (mg/l)	9.83	9.01	9.72	9.53	9.87	NR
DO (%)	111.3	92.5	97.8	104	103.2	NR
pH	8.36	NR	NR	NR	NR	NR

NOTE: NR = probe failed and recording not completed

Table 10. Summary of species observed at the permanent monitoring stations on 8 January 2013.

Species	Common Name	Number of individuals
Leptocottus armatus	Staghorn sculpin (juv <2cm)	17
Atherinops sp.	Topsmelt (juv <5 cm)	3
Menida audens	Mississippi silversides (non-native) <5 cm	1
Shrimp *sp.*	Oriental Shrimp	37

Note: Dr. Camm Swift has documented the presence of Mississippi silversides since 2005 in Malibu Lagoon. It is unclear how these invasive species arrived, but they have persisted over time in small numbers.

Spot Survey Seining in the Main Lagoon

Substrate was variable in the main Lagoon, from silty muck approximately 30 cm deep, to cobble-boulder substrate along the west and east banks, with sand-dominated substrate along the beach berm. Although the tide was receding, depth was variable and in some locations was too deep to seine. In addition to the habitat diversity provided by the substrate, a variety of algae were observed, including *Ruppia*, *Zostera*, *Phyllospadix*, *Macrocystis* and *Egregia* kelp.

847 fish and 422 invertebrates were captured and released in the main Lagoon surveys of Phase 3 (Table 11). A total of ten juvenile tidewater gobies (Figure 29) were captured in the main Lagoon during the Phase 3: Post Construction Survey. These were difficult to identify in the field due to small size (<2 cm), therefore photos were taken and identification was confirmed by Dr. Camm Swift. All gobies were released safely back into the lagoon.

Table 11. Summary of all species observed in the main Lagoon, 8 January 2013.

Species	Common Name	Number of Individuals
Hypsopsetta guttulata	Diamond turbot (<2 cm)	7
Hypsypops rubicundus	Garibaldi (28 cm FL) (*dropped/eaten by birds*)	1
Menida audens	Mississippi silverside (non-native) (<5 cm)	3
Gambusia affinis	Mosquitofish	32
Engraulis mordax	Northern anchovy (<5 cm)	3
Leptocottus armatus	Staghorn sculpin (<2cm)	781
Eucyclogobius newberryi	Tidewater goby (<5 cm)	10
Atherinops sp	Topsmelt (<5 cm)	10
Fish Sub-total	----	**847**
----	Crab sp. (<5 cm)	9
----	Shrimp sp. (<5 cm)	402
----	Ctenophore sp. (<2 cm)	3
----	Salp sp. (<2 cm)	3
Aplysia californica	Sea hare (5-10 cm)	2
----	Segmented worm <2 cm)	3
Invertebrate Sub-total	----	**422**

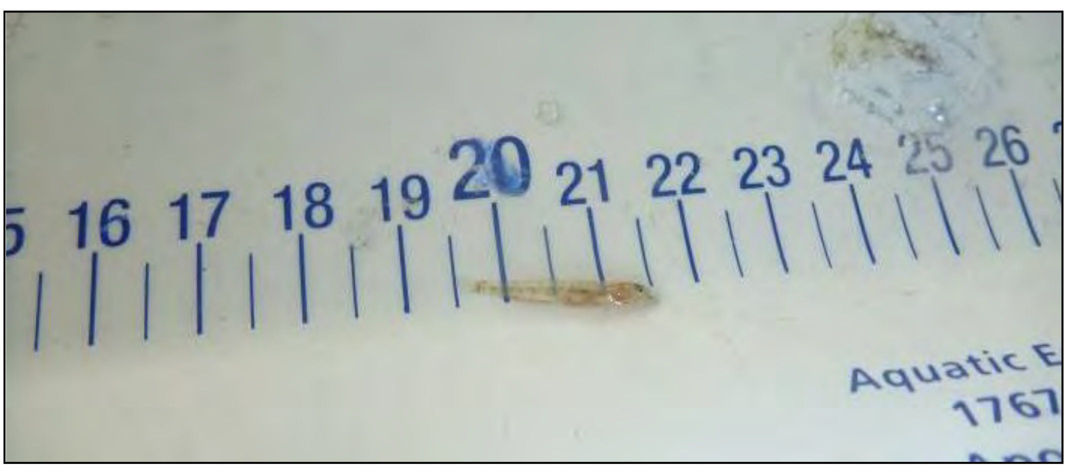

Figure 29. Tidewater goby found in the main Lagoon surveys, photographed on a fish measuring board.

The staghorn sculpin (Figure 30) and diamond turbot individuals were very small juveniles, indicating recent recruitment/spawning during the connected lagoon–ocean condition. The single adult Garibaldi seemed to have been dropped by birds.

Figure 30. Staghorn sculpin individuals found in the main Lagoon surveys, photographed on a fish measuring board.

Summary and Discussion

In accordance with the permit and project goals, no tidewater gobies and few other native fishes were harmed during the construction or initial restoration of Malibu Lagoon. A total of eight adult tidewater gobies were safely relocated from the work area in June 2012. A total of ten juvenile tidewater gobies were captured and released in the main lagoon during the post-construction survey in January 2013. The only observed fish mortalities were associated with the initial deployment of the turbidity curtain when tidal fluctuation caused folding for one night. This situation was rectified immediately and no further mortality of any fish was observed. Coordination between the fish relocation and protection crew with the construction team worked well.

PHASE 1: Fish Relocation

This Phase took place over eight days (11-18 June 2012). The contribution of over 1500 person-hours were necessary to install the fish exclusion fences and capture and relocate all native fish from the work area into the main lagoon.

PHASE 2: Construction Monitoring

Once the work area was devoid of fish, monitoring of the dike and turbidity curtain continued as needed between mid-June and October 2012. No fish were observed in the work area and the turbidity curtain functioned per specifications without impacting any fish.

PHASE 2a: Removal of the Dike and Turbidity Curtain

During the eight days needed for the removal of the dike and turbidity curtain (18-31 October 2012), over 300 person-hours were necessary to provide on-site monitoring for fish safety.

PHASE 3: Post-Construction Monitoring

The Phase 3 Post-Construction Monitoring covering both the permanent stations and the perimeter of the main Lagoon was completed in one day with a team of 12 people. The five native fish species documented in the post construction survey (diamond turbot, northern anchovy, staghorn sculpin, tidewater goby, and topsmelt) reflect the winter, marine influenced conditions, as compared to the five native species (CA killifish, long-jawed mudsucker, opaleye, tidewater goby and topsmelt) observed in the June pre-construction survey of 2005. Tidewater gobies were observed in both the pre- and post construction surveys.

No opaleye or long-jawed mudsuckers were captured in January 2013, although numerous long-jawed mudsuckers were moved from the work area to the main lagoon in June 2012. Oriental shrimp and mosquitofish were observed in both the pre and post-construction surveys. Mississippi silversides were not observed in the 2005 survey, although that is about when Dr. Swift began seeing them in spot seines. Additionally, we did not capture any carp in 2013, compared to the single individual captured in 2005.

Surveys in the restoration area were encouraging. The presence of both staghorn sculpin and topsmelt juveniles indicated recent spawning and sufficient conditions to support rearing, despite the fact that vegetation is not yet re-established. It was also good to see that mosquitofish had not yet re-colonized this portion of the lagoon.

Seining in the main body of the lagoon also documented juvenile staghorn sculpin and topsmelt, but additionally supported very small diamond turbot, northern anchovy and tidewater goby. Presence of these juveniles indicates recent spawning and the potential for recruitment. The single dead adult Garibaldi appeared to have been dropped by birds and was thus not counted as a resident species.

Additional surveys in late spring-summer and fall should provide more information regarding the re-establishment of all fish species throughout the lagoon.

Avian Community Surveys

Introduction

Bird usage of Malibu Lagoon was assessed during and immediately following a major restoration project that began in mid-2012 and is currently (as of February 2013) ongoing.

Construction Permit Conditions

In accordance with the Migratory Bird Treaty Act, Fish and Game Code, and project permits, the project site was surveyed regularly for active bird nests before and during construction. The following permit conditions directed the survey effort and associated avoidance and minimization measures.

California Coastal Commission Coastal Development Permit, Special Condition 1(A-D), 5-6

- Within 30 and 3 days prior to start, a survey for sensitive birds, nests, and reproductive behavior within 500' of the project site;
- Surveys to be continued monthly during the bird nesting season;
- Qualified monitor surveys at the start of each day & during major construction;
- All nesting birds to be buffered. Specifically all bird nests within 300’ of the work area (or 500’ for raptors) shall have peak noise levels < 65dB at the nest site;
- Noise reduction measures can be used to keep noise levels within acceptable range;
- Work will be stopped until noise levels within acceptable range; and
- Preparation of a monitoring report.

U.S. Army Corps of Engineers Section 404 Permit, Special Conditions 2-4

- No take of listed species or adverse modification of critical habitat permitted; and
- Notify USFWS within 3 days of finding dead or injured listed species.

California Environmental Quality Act, Mitigation Monitoring and Reporting Program

- No take of listed species or adverse modification of critical habitat permitted;
- Monitor by FWS approved biologist during any disturbance within suitable/occupied habitat for the following species: CA brown pelican, western snowy plover, Heermann's gull, elegant tern, and CA least tern; and
- Schedule construction to avoid disturbing western snowy plover, California least tern.

In addition, USFWS Critical habitat for the western snowy plover was established and published in the Federal Register on 19 June, 2012, subsequent to the start of the project (Figure 31). The mapping of critical habitat included portions of the Southeast corner of the project area, and Surfrider Beach. The boundary of the newly established critical habitat was demarcated by the biological monitors, the area was cordoned off and work was halted in this area until consultation with and approval by the USFWS and the Army Corps of Engineers occurred. Approval to proceed was received on 19 July 2012.

Figure 31. Revised critical habitat for western snowy plover as provided by USFWS on 19 July 2012 (red outline).

Avoidance, Disturbance Minimization, and Exclusion Measures

Nesting Birds

To prevent birds from nesting underneath bridges that were not already occupied at the start of the project, quarter-inch bird netting was stapled underneath two of the unoccupied bridges (Bridge "D" and "B"). Within 24-hours of all ground-disturbing or noise-inducing activities, project biologists surveyed for nesting birds. Known nests were checked for changes in status of nest progression (egg/chick number). Monitors minimized time at nests and used maximum cover and greatest distance feasible to conduct surveys. Paths to nests were alternated to avoid attracting predators to nest sites.

During all noise-creating construction activities, noise levels were monitored using the (Extech 407736 IEC 651 ANSI S.1.4 Type 2) sound level meter near all active nests to ensure the 65 dB threshold required by the project permits was not exceeded. Active nests were also monitored simultaneous to loud construction to ensure nesting birds were not being disturbed by project activities (e.g. leaving nest, changing flight patterns to and from nests).

In the event nesting bird disturbance was suspected, construction activities were required to immediately stop until direction from the lead biologist for altering the work effort could be given. Measures implemented included equipment relocation, change in equipment type or utilization, or provision of visual and/or noise buffering. Key measures employed successfully during this project included:

- Use of premade fence stands rather than pounding in fence posts, to avoid excessive noise levels;
- Use of the quietest equipment feasible near active nests (e.g., using the smallest excavator on site);
- Temporarily deactivating or muffling back-up alarms on machinery when working near nests;
- Surrounding stationary noise sources (land-based pumps, generators) with sandbags or sinking them into pits (submersible pumps) to attenuate noise levels;
- Positioning excavators to work with “quiet side” (side without exhaust vents) towards nest, or avoiding use of loud “opposable thumb” mechanism attached to the bucket on certain machinery;
- Hanging plywood sheets from bridges to buffer nests located under them from visual and noise disturbance;
- Postponing dewatering to minimize potential disturbance to bird nests located in bulrush stands (e.g., American coot, pied-billed grebe, and great-tailed grackle); and
- Having monitors stop work when birds or their young came within range of construction equipment (duckling “herding” occurred periodically throughout the project).
- Work was not allowed to continue in the flagged buffer zones around nests until the chicks had fledged, or the nest was determined to have been abandoned. We determined nest abandonment via the following measures:
- No adult presence for several days on nest, or eggs found floating in water (eggs cannot usually survive the natural daily temperature changes without being brooded); or
- Egg(s) present two weeks longer that average published gestation period for species with no adults present.

Suspected abandonment was always confirmed by three days of direct observation (often through binoculars at a distance) for half an hour at sunrise and sunset.

These measures only applied to actively nesting birds; that is, those tending a nest that is mostly complete, or with eggs or young still in the nest. Once young birds had fledged (i.e., left the nest), or if mobile young were encountered without a nest nearby, they were no longer provided with flagged buffers and other special protection, since most were very mobile quickly, and moved to other areas of the site (and, in the case of waterfowl, into the main body of the lagoon unaffected by construction) within hours of fledging. Care was taken however to ensure that less mobile birds such as ducklings or sick birds were not adversely affected by project activities.

Special Status Birds

The sandy areas of the project site (beach and southeastern corner) can be used by the listed western snowy plover and California least tern, in addition to other special-status species. Therefore monitoring by a permitted project biologist was required prior to and during any equipment activity in or near these areas (Figure 32).

Figure 32. Monitoring for western snowy plover and other special-status species in advance of equipment moving through designated critical habitat areas (photograph by Noa Rishe 2012).

Activities monitored included installation, maintenance, and removal of the dewatering plant outfall pipe; excavator access across Surfrider beach to install submerged trees for fish habitat in the eastern lagoon by the Adamson House boathouse; and invasive weed removal near the Malibu Colony neighborhood. DPR Environmental Scientist Jamie King monitored all activities. Equipment was stopped to allow any western snowy plover that were hunkered down in low-lying spots in the beach to move through the area undisturbed.

Methods

Preconstruction Quarterly Survey Methods (2005-2006)

From late 2005 through mid 2006, Cooper Ecological Monitoring, Inc. conducted quarterly bird surveys of the entire site, which involved two visits (morning and late afternoon) on two consecutive or near-consecutive days during October 2005, January 2006, April 2006 and July 2006. The purpose of this survey design was to capture the seasonal, tidal, and temporal variation of avifaunal usage of the Malibu Lagoon. Different bird communities will use a site depending on lagoon water levels and what habitat types are exposed (i.e. mudflats). Alternatively, other species, particularly gulls, will come in to roost in the late afternoon and overnight, regardless of tide or water level.

Preconstruction Nesting Survey Methods

Cooper Ecological Monitoring, Inc., performed four initial preconstruction surveys of bird activity within the restoration area from 2 May 2012 to 28 May 2012, and provided memoranda describing the bird species found on site and highlighting areas where evidence of nesting behavior (such as territorial displays and nesting-associated calls) had been detected. The dates of the preconstruction surveys and summary memoranda (2012) were:

- 2 May (08:00 – 10:30 AM)
- 8 May (12:30 – 1:30 PM)
- 11 May (11:15 AM – 12:45 PM); summary memo dated 11 May 2012
- 28 May (10:00 AM – 11:50 AM); summary memo dated 28 May 2012

Construction Nesting Survey Methods

Beginning May 30, 2013, CDPR biologist Noa Rishe, with support from State Park staff Nick Chang and John Luker and Santa Monica Bay Restoration Foundation Staff Elena Tuttle and Ivan Medel, began general bird surveys at least three times a week for nesting activity and special-status bird species. Cooper accompanied Rishe for four hours on 12 June (10:00 AM – 2:00 PM) and for just over an hour on 29 June 2012 (1:30 PM – 2: 40 PM) to ensure continuity of the work (Cooper 2012c, 2012d). All bird survey and monitoring work during construction was supervised by the approved lead biologists Daniel S. Cooper, Mark Abramson (Santa Monica Bay Restoration Foundation, “SMBRF”) and Jamie King (California Department of Parks and Recreation “DPR”).

All areas of the site were surveyed using both walking and kayaking “transects of convenience” (areas where vegetation allowed for passage). Birds seen courting, displaying, or carrying food and/or nesting material were followed from a distance using binoculars to identify potential nesting sites. In these cases, the immediate area was carefully searched until the presence or absence of an active nest was determined. When potential nests were located in trees, and no activity was observed after 20-30 minutes of observation, a smartphone with camera was attached to a PVC pole and used to definitively confirm whether the nest was active or not. This setup was also used to better view nests in inaccessible locations, such as under bridges.

Once active nest sites were found, they were immediately flagged with yellow caution tape to create a minimum 50’-radius buffer around them. The species and number of eggs present were confirmed during this and subsequent visits, and nests with eggs were checked discreetly almost daily to identify an estimated date for the laying of the first and last egg in each nest, and to confirm fledge dates. This way, an estimated date for the completion of each nest could be accurately determined. Fledging was confirmed by seeing young birds out of the nest in the vicinity of the nest (for precocial birds such as waterfowl), or by observation of nest features (copious droppings on the edges of the nest).

Figure 33. Avifauna roosting and feeding in the Malibu Lagoon.

Post-Construction Survey Methods

The Project site was surveyed on two dates by Cooper Ecological Monitoring, Inc.:

- 11 Feb. 2013 (7:48 AM – 09:25 AM) (high tide, 45 ^{o}F)
- 12 Feb. 2013 (3:48 AM – 4:45 PM) (low tide, 58 ^{o}F)

During the 2013 visits, surveys were conducted by slowly walking the perimeter of the lagoon to the beach (just inside the perimeter construction fence). The surveyor also walked east along the edge of the main Lagoon, scanning north across the site. All species observed using the site were recorded. Those species only observed flying over were excluded, which included dozens of gulls. Birds flying offshore or using the inshore marine waters were also excluded. Individuals were noted as using one of three main areas: "W", or the western portion of the estuary, including the vicinity of the parking lot; "L", the main body of the lagoon unaffected by construction; and "B", the sandy beach away from the main Lagoon (Figure 34).

During the February 2013 survey, a berm along the western edge of the lagoon separated portions of the lagoon during low tides. This area supports a variety of bird species as roosting habitat. Most of the birds using this berm were also using the main Lagoon during the February 2013 quarterly survey, and were therefore recorded as using the "L" section of the site. Waterbirds now move freely between all areas of the (expanded) lagoon (sections W and L), which now have similar vegetation structures due to the ongoing habitat restoration (Figure 34).

Figure 34. Oblique aerial photograph of Malibu Lagoon (post-restoration), taken 29 January 2013 (courtesy Lighthawk and SMBRF).

Ebird Data

For additional recent bird records, we queried Ebird, a new, geo-referenced global online database of bird sightings (www.ebird.org) for observations from Malibu Lagoon (entered as "Malibu Lagoon" and "Malibu Lagoon State Beach", among other names). Ebird was not available in this current form during the prior surveys in 2006, but now adds considerably to our understanding of current bird distribution, particularly in such well-worked sites as Malibu Lagoon. It should be noted that Ebird is a citizen monitoring program, and the data have not be quality control checked by ornithologists.

Results

A total of 56 bird species were observed during preconstruction and early construction surveys (D.S. Cooper, unpublished data; Appendices G and H).

Pre-construction Quarterly Survey Results (2005-2006)

The results of these surveys were incorporated into an annotated checklist for the site and a report on the breeding birds of Malibu Lagoon (Cooper 2006). These quarterly surveys will be repeated from 2013 through 2017. The first of four “year 1” surveys was conducted in February 2013 (see ‘post-construction survey results’). See Appendix I for a complete list of observations from January 2006 and February 2013.

Pre-construction Nesting Survey Results

The four pre-construction surveys, which began on 2 May 2012, revealed the presence of a small number of active nests, as well as family groups of species that likely bred earlier in the year. Several potential nesting observations were of species that were not confirmed as breeding in the project area, and so were not monitored, including a nest of bushtit (*Psaltriparus minimus*) that was found on 2 May. Cooper (Cooper 2012a) wrote:

> “An active nest was observed being constructed at the edge of the parking lot on 2 May; by 8 May it appeared to be abandoned. On 11 May, what was likely the same pair appeared to be renesting just west of the reserve, with two birds seen carrying nesting material (appeared to be mulefat *Baccharis salicifolia* or willow *Salix* sp. “fluff”) west from the reserve. In addition, up to four family groups of bushtit, likely raised on-site, were observed roaming around the reserve on each visit.”

In addition to the bushtit above, nesting prior to start of pre-construction monitoring (i.e., during March – April 2012) was confirmed or suspected of occurring in the project area for mallard (*Anas platyrhynchos*)[1], common yellowthroat (*Geothlypis trichas*) California towhee (*Melozone crissalis*) song sparrow (*Melospiza melodia*), and brown-headed cowbird (*Molothrus ater*) based on the presence of young-of-the-year observed on several pre-construction surveys (D.S. Cooper, 2012a, 2012b, 2012c and 2012d).

A mallard female with approximately 5 ducklings was observed on 11 May, a mallard brood of “very young ducklings” was present on 28 May, and two separate broods (15 and 3 ducklings) were observed on 12 June. A female common yellowthroat was observed feeding a young cowbird by Bridge “D” (see Figure 3) on 28 May, and on 12 June, two yellowthroat juveniles (out of the nest) were being fed by parents also near Bridge “D” on 12 June. A California towhee was observed carrying food near Bridge “D” with fledgling nearby on 28 May.

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[1] The mallards present at Malibu Lagoon in 2012 appear to be a mix of wild birds and domesticated individuals, a situation noted locally as early as the 1970s (Kiff and Nakamura 1979). Some appear to be paired with “wild” female mallards, so it was impossible to determine which nests were “valid” mallards and which were domestic ducks. Therefore, all nests were treated as being of wild birds and were protected as such.

Song sparrow family groups or juveniles/fledglings[2] were observed scattered around the site on 2 May, 11 May (2 broods), and 12 June (1-3 broods). (all observations D.S. Cooper, unpublished data). In addition, a few species were noted with young during the construction surveys, but no physical nests were found in the project site then, nor during pre-construction surveys in May.

Therefore, either they nested prior to start of construction and were only "discovered" later, or they nested outside the project area (e.g., upstream along Malibu Creek) and were therefore missed during monitoring. A female gadwall (*Anas strepera*) with four ducklings was observed (by DSC) just downstream of Bridge "A" on 12 June, suggesting that successful fledging may have occurred around the start of construction (scattered pairs were observed before and during the construction project, but this was the only solid indication of nesting). Also on 12 June, a juvenile northern mockingbird (*Mimus polyglottos*) was observed near a pair of adult mockingbirds in a clump of quailbush (*Atriplex lentiformis*) just south of Bridge "D", suggesting that successful nesting occurred here prior to the start of construction. See Appendix H for detail on an inactive mockingbird nest found in the same area.

Of interest, an apparently active nest of great blue heron (*Ardea herodias*) was found just off the southern boundary of the site on 12 June:

> "An individual (great blue heron) was observed flying into the crown of a tall cypress (*Cupressus* sp.) within Malibu Colony, after which the distinctive guttural sounds of young herons were heard from the same area, indicating an adult feeding nestlings. A second adult flew in from the north during this observation, and landed in a tidal channel near the nest. While this nest was not detected on previous visits, it is very well hidden, apparently within the actual crown of a tree that is itself blocked from view by a larger eucalyptus tree. Active construction has been going on directly under the nest (house construction) since the first breeding season survey for this project (early May), so presumably the birds are not disturbed by the noise/activity, which is typical for the species in our area." (Cooper 2012c)

Incidentally, this nest was apparently active in 2011 as well (Cooper 2011).

Finally, a pair of northern rough-winged swallow (*Stelgidopteryx serripennis*) was observed bringing nesting material to a presumed nesting site under the Pacific Coast Highway on 2 May; however, neither it nor young was observed in subsequent visits.

Additional species suspected of initiating nesting during pre-construction surveys are discussed below ("Construction surveys") if nesting was confirmed, or are listed in Appendix G if no indication of actual nesting was found.

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[2] While "fledgling" implies a dependent bird just out of the nest and "juvenile" a somewhat older bird, no attempt to age these birds was made in the field; for some species, the presence of either at a site can imply local nesting, while for others (e.g. American crow *Corvus brachyrhynchos*), juveniles often follow parents far from the nest site and continue begging for weeks after fledging.

Construction Nesting Survey Results

Twenty-one nests from seven (or eight; see below) species were found and monitored during construction, as summarized in Figure 35 and Table 12, with detail provided in Appendix H. Most, if not all, nests were judged to represent separate pairs (i.e., double clutching was not confirmed during the survey period). As outlined in "Methods" above, each nest was afforded the fullest protection feasible during the construction project, and ultimately, the majority of nests found fledged young successfully (57% of nests and 60% of all eggs). Those that failed were likely lost to flooding, predation, or abandonment due to unrelated (to the construction) causes.

Of the 21 nests monitored, the most numerous were American coot (five nests) and "mallard/gadwall" (eight nests; males not seen, so identification uncertain). The other species recorded as nesting at the lagoon during the construction period were black phoebe (three nests), pied-billed grebe (two nests), and single nests of northern mockingbird and song sparrow.

Mallard/gadwall tended to nest among marsh jaumea (*Jaumea carnosa*) and on mats of pickleweed (*Salicornia pacifica*) at the base of shrubs (particularly quailbush, *Atriplex lentiformis*), while coot and great-tailed grackle built nests amid reed beds (*Scirpus*[3] spp.). Three black phoebe nests were placed under the existing footbridges onsite. Both pied-billed grebe nests were found in wetland areas, on floating mats of algae and vegetation. One nest each was observed for the northern mockingbird and song sparrow, both in shrubs.

Twelve of the 21 nests (57%) fledged at least one young and 61 of the 102 (60%) survived to fledging. American coot had the lowest success rate (20%). For most birds, nesting success is so variable, and so dependent on local effects (weather, predator community, etc.) that comparing success found in other studies is not particularly helpful, especially with data from just one season and few nests for each species from a relatively small (12-acre) area.

[3] The taxonomy of bulrushes (*Scirpus*) has recently been revised; what had been several species in the genus *Scirpus* have now been split into multiple genera. To avoid confusion with other types of plants, these are referred to herein as "*Scirpus* sp.", known by the common names of bulrush (which we use) and tule. These dominated the reed beds at the site during our study, although a small number of cattail (*Typha* spp.) patches were also present.

Figure 35. Overview of nest locations. Primary study area shown within the red dashed line.

Table 12. Summary of confirmed nesting activity at Malibu Lagoon during construction (June-September) in 2012, by species[4]. Details and photos are included in Appendix H.

Species	**Nests**	**% Success**	**Comments**
Mallard/gadwall (*Anas platyrhynchos* or *A. strepera*)[5]	8 nests: K,L,M,N,O,Q,S,T Eggs: 62 Fledged: 38	Nests: 5/8 (63%) Fledged young: 38/62 (61%)	Includes presumed hybrids with domesticated, "mallard-like ducks".
Pied-billed grebe (*Podilymbus podiceps*)	2 nests: G,I Eggs: 10 Fledged: 10	Nests: 2/2 (100%) Fledged young: 10/10 (100%)	
American coot (*Fulica americana*)	5 nests: A,C,H,J,U Eggs: 27 Fledged: 3	Nests: 1/5 (20%) Fledged young: 3/27 (11%)	Lagoon mouth breach appears to be a cause for low success; species also appears sensitive to dewatering as nests less stable, more accessible to predators.
Black phoebe (*Sayornis nigricans*)	3 nests: B,E,R Eggs: 9 Fledged: 7	Nests: 2/3 (66%) Fledged young: 7/9 (78%)	Least disturbed by adjacent construction; presumably acclimated to loud volumes/frequent human traffic associated with footbridges.
Northern mockingbird (*Mimus polyglottos*)	1 nest: F Eggs: 1 Fledged: 0	Nests: 0/1 (0%) Fledged young: 0/1 (0%)	Old egg; no parents were observed tending nest.
Great-tailed grackle (*Quiscalus mexicanus*)	1 nest: D Eggs: 1 Fledged: 1	Nests: 1/1 (100%) Fledged young: 1/1 (100%)	Although many pairs were observed onsite towards the end of the restoration work, only one nest was found.
Song sparrow (*Melospiza melodia*)	1 nest: P Eggs: 2 Fledged: 2	Nests: 1/1 (100%) Fledged young: 2/2 (100%)	Most nesting apparently occurred prior to start of construction.
TOTAL	Nests: 21 Eggs: 102 Fledged: 61	Nests: 12/21 (57%) Fledged young: 61/102 (60%)	.

[4] Data and information provided by DPR staff.

[5] Females, eggs and young of the gadwall (*Anas strepera*) may look almost identical to mallard, and both species were confirmed as breeding (successfully) at the site. The monitors were made aware of this identification challenge during the construction monitoring, and felt that all the nests identified as mallard were indeed mallard. Cooper observed several mallard broods during May and June 2012, and only a single gadwall brood. However, an estimated 10 pairs of gadwall were observed during Cooper's initial site visit on 2 May 2012, indicating that this was also likely a common species during the project. Either way, both species were afforded identical protection at the site.

Special Status Birds

Special-status birds (i.e., aside from nests) present within the project area during construction were western snowy plover (*Charadrius alexandrinus nivosus*; Federally threatened; California Species of Special Concern) and the California brown pelican (*Pelicanus occidentalis californicus*; State Fully Protected). Plovers were found by mid-summer on Surfrider beach, and tended to congregate to the Southeast of the project limits near the Adamson house. Therefore, they were avoided during construction activities on the beach via direct monitoring before and during any motorized vehicle access in beach areas.

Brown pelicans frequently visited the project area. Four dead and three ailing pelicans were detected within the project area during construction; one of the ailing pelicans was successfully captured by DPR and California Wildlife Center staff for rehabilitation. Domoic acid poisoning/starvation were suspected to be the cause of pelican mortality. USFWS was notified regarding these events, and direction was given to deposit viable specimens at local museums. The Western Foundation of Vertebrate Zoology accepted one of the pelican specimens for educational and research purposes.

Elegant tern colonies are on California Department Fish and Wildlife list of species tracked by the California Natural Diversity Database. Heermann's gull currently has no special status. Both species had mitigation measures outlined for them within the EIR/EIS for the project. Both were observed commonly through the project period mainly roosting with other gulls and terns in main body of Malibu Lagoon and on the adjacent beach. Neither nests locally, and therefore were not found to have been impacted in any way by the construction project. The California least tern was not observed during the construction project nor in pre-construction surveys, and it is not known to nest at the site (Cooper 2006).

Post-Construction Survey Results

In total, 70 bird species were recorded during the January 2006 visits. By comparison, 53 species were noted in February 2013, with 45 species recorded both years. While the lack of replication precludes us from saying whether this difference is significant or not, the fact that the total number dropped by roughly 25% suggests that fewer species were using the site this past winter (2012-13) than during the winter of 2005-06. It should be noted that only the wetland vegetation had been planted at the time of the survey (i.e. no upland vegetation) and the wetland habitats had not had the opportunity to develop the vegetative structure and cover, and was largely barren dirt (Figure 36), replacing a more complex mix of landscaped scrub and reed beds dominated by bulrush (*Scirpus spp*.) (Figure 37). The aggregate number of individual birds over both days (combined) of each survey was much higher in February 2013 (3,933) than January 2006 (1,811), owing to the large numbers of gulls roosting on the beach in 2013. Excluding gulls, the number of individual birds using the site was remarkably similar: 1,386 in 2006 and 1,304 in 2013.

Figure 36. Malibu Lagoon on 12 February 2013, looking southeast, showing newly-planted vegetation on slopes. Waterfowl visible in the channel include Northern Shoveler, American Wigeon, Mallard and American Coot (photo credit: D. Cooper).

Figure 37. Photo of habitat in May 2006 (brood of Mallards visible in foreground) (photo credit: D. Cooper).

Among the species recorded in 2006, but not in 2013, are several that are associated with scrub and riparian woodland habitat (including non-native/ornamental landscaping), such as Downy Woodpecker (*Picoides pubescens*), Anna's Hummingbird (*Calypte anna*), House Wren (*Troglodytes aedon*), Northern Mockingbird (*Mimus polyglottus*), Oak Titmouse (*Baeolophus inornatus*), Orange-crowned Warbler (*Oreothlypis celata*), Spotted Towhee (*Pipilo maculatus*) and White-crowned Sparrow (*Zonotrichia leucophrys*). This result is expected as these habitat types were intentionally reduced onsite to expand the rarer wetland habitat. Nonetheless, small numbers (generally 1 or 2 individuals) of several scrubland bird species were still making use of the site, and were detected in small fragments of riparian and coastal scrub located adjacent to PCH and in the "rain-garden" within the parking lot created in 2008 during an early phase of the restoration.

Scrub species observed in February 2013, included Allen's Hummingbird (*Selasphorus sasin*), Bewick's Wren (*Thryomanes bewickii*), Bushtit (*Psatriparus minimus*), Common Yellowthroat (*Geothlypis trichas*), California Towhee (*Melozone crissalis*), Song Sparrow (*Melospiza melodia*) and Lesser Goldfinch (*Spinus psaltria*). These latter species may be thought of as poised to recolonize the upland portions of the site as the vegetation grows in, and all but Downy Woodpecker and Oak Titmouse from the prior list should become regular visitors again, based on their continued abundance in the Malibu area and preference for coastal scrub habitat.

Waterfowl showed mixed results; some species were recorded in 2013 but not in 2006, including American Wigeon (*Anas americana*) and Northern Pintail (*Anas acuta*). Waterfowl recorded in 2006, but not in 2013, included Cinnamon Teal (*Anas cyanoptera*) and Lesser Scaup (*Aythya affinis*); however, both of these species, while annual, occur in very low numbers at the site (often fewer than five individuals in winter; www.ebird.org). Their absence may be attributed to chance, rather than habitat change at the site.

Shorebirds trends are even more difficult to analyze using the limited amount of quarterly bird data and high variation on available habitat at any given time (e.g. changes in water levels, due to tides and the open or closed status of the lagoon, affect the area of sandy beach available). However, the three shorebird species found in January 2006, and not in February 2013, are all typical of fresh and brackish water, often with emergent vegetation (Greater Yellowlegs *Tringa melanoleuca*, Long-billed Dowitcher *Limnodromus scolopaceus* and Wilson's Snipe *Gallinago delicata*). This suggests that the temporary reduction of freshwater marsh habitat may have rendered the site temporarily unsuitable for these species. During the February 2013 visit, few shorebirds were observed using the new habitat in the western portion of the site (five Killdeer *Charadrius vociferus*, five Least Sandpipers *Calidris minutilla*, and a Spotted Sandpiper *Actitis macularis* were observed over two survey days). However, with only three months' worth of tidal flow over this portion of the site, all during cold winter months, it is likely that the invertebrate community needed by these shorebirds has simply not developed yet, and that increased shorebird activity will occur later in the spring.

Still, many shorebird species were observed using the site in both 2006 and 2013, such as several dozen Black-bellied Plover (*Pluvialis squatarola*), and a roosting flock of Western Snowy Plover (*Charadrius* *alexandrinus nivosus*) on the beach/sandspit. Other species showed more variability; for example, up to 59 Willet (*Tringa semipalmata*) were recorded in 2006 (11 January 2006), while just one was found in 2013, yet the species remains very common on local beaches (D.S. Cooper, personal observation) and is expected to use the site in large numbers at least seasonally. This variability could be caused by differences in the weather, survey timing, or natural variation in bird behavior on any given day. Without data from additional quarterly surveys, generalizations about usage of shorebirds and other species based on past quarterly surveys should be avoided.

Ebird Data

To provide more observations through a greater sample size, we queried Ebird for data to augment to field surveys conducted as part of this project. Using ebird, one can readily compare observations made prior to the start of construction in mid-2012 with those made during construction. However, as important caveats, Ebird continues to grow in popularity such that the number of checklists submitted to the database was relatively low prior to around 2010; and the data do not distinguish between the various sections of the site, so birds from the western portion of Malibu Lagoon (i.e., the restoration project site) are lumped in with those observed using the main Lagoon, or even with those on the beach. Evaluating 2011 (prior to restoration) and 2012 (during, and subsequent to restoration), distinct and informative patterns may still be detected. Counts of waterfowl (including ducks and duck-like species such as the American Coot *Fulica americana*) appear to have changed little from 2011 to 2012. See below for graphs of two common species, Gadwall (*Anas strepera*; Figure 38) and Northern Shoveler (*Anas clypeata*; Figure 39).

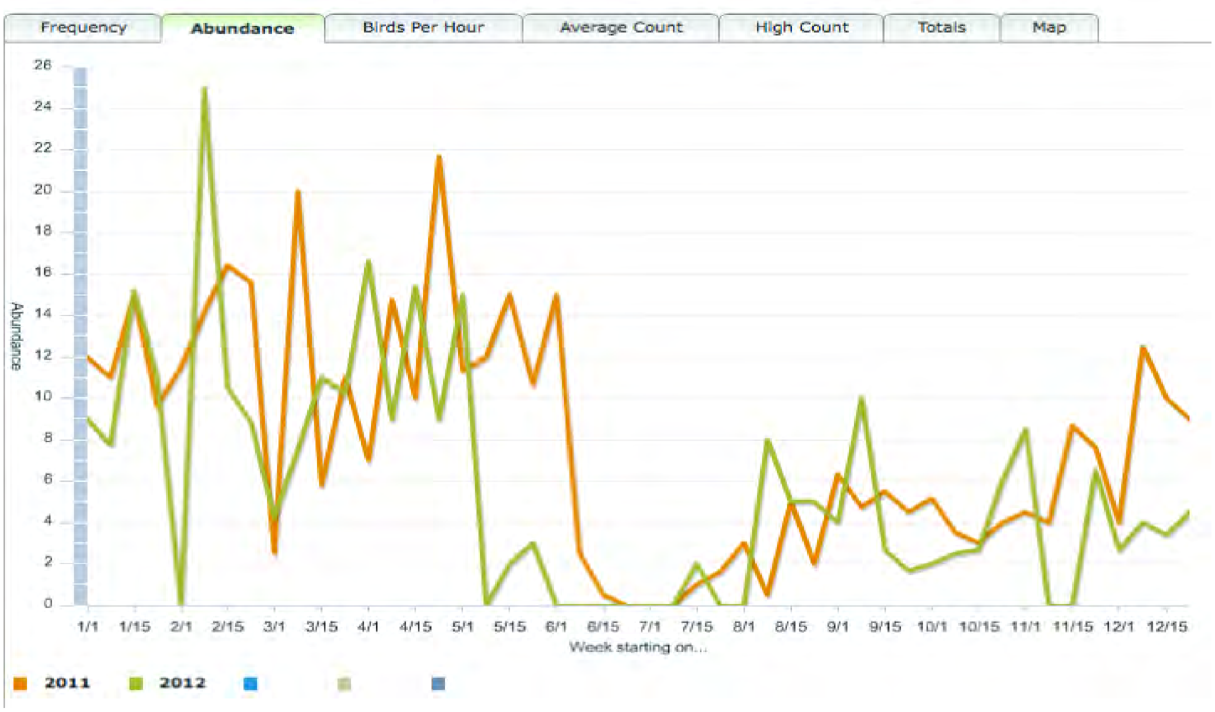


Figure 38. Abundance of Gadwall at Malibu Lagoon, 2011 (orange) and 2012 (green).

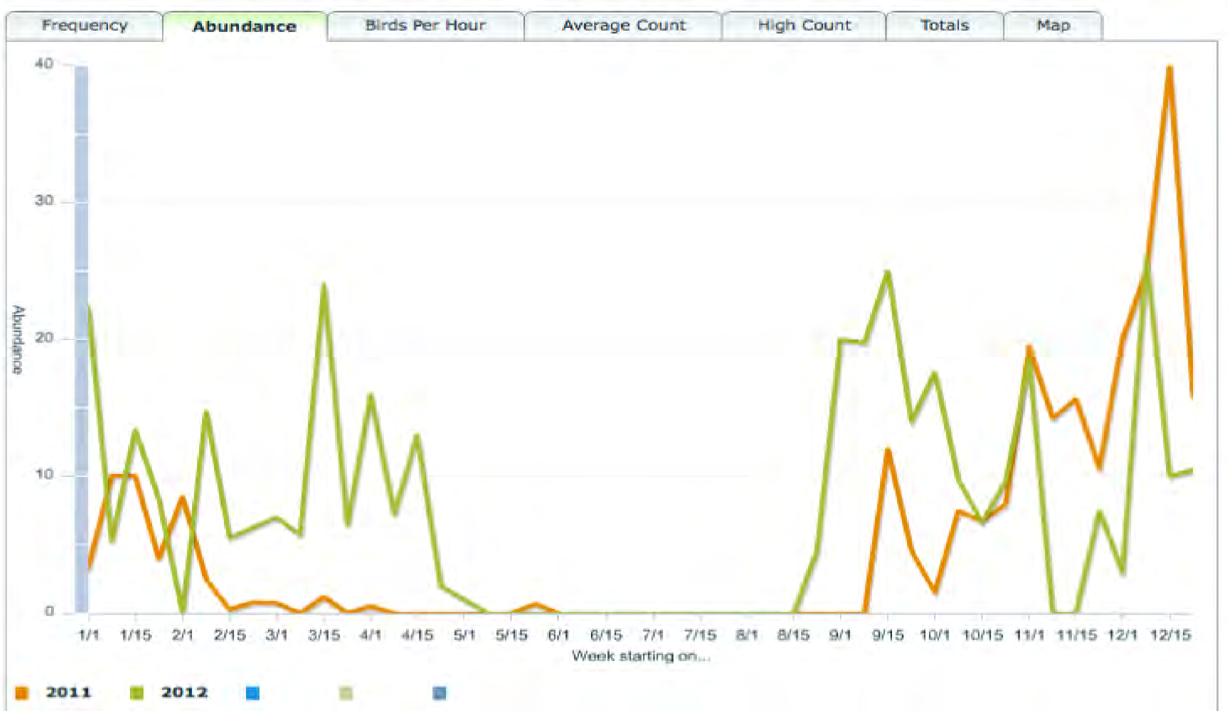


Figure 39. Abundance of Northern Shoveler at Malibu Lagoon, 2011 (orange) and 2012 (green).

Shorebirds also appear to have changed little from 2011 through 2012. Malibu Lagoon has not been consistently productive for shorebirds at least in recent decades, generally supporting just a few dozen individuals during most of the year[6]. Counts of the more common species (Least Sandpiper and Willet) were not dramatically different in late 2012 versus 2011 (Figures 40 and 41). Obviously, more years of data should clarify these trends.

[6] See Cooper (2006, Appendix I). Historical counts provided by Chuck Almdale, Santa Monica Bay Audubon Society, and the field notes of Kimball L. Garrett, Los Angeles Co. Museum of Natural History.

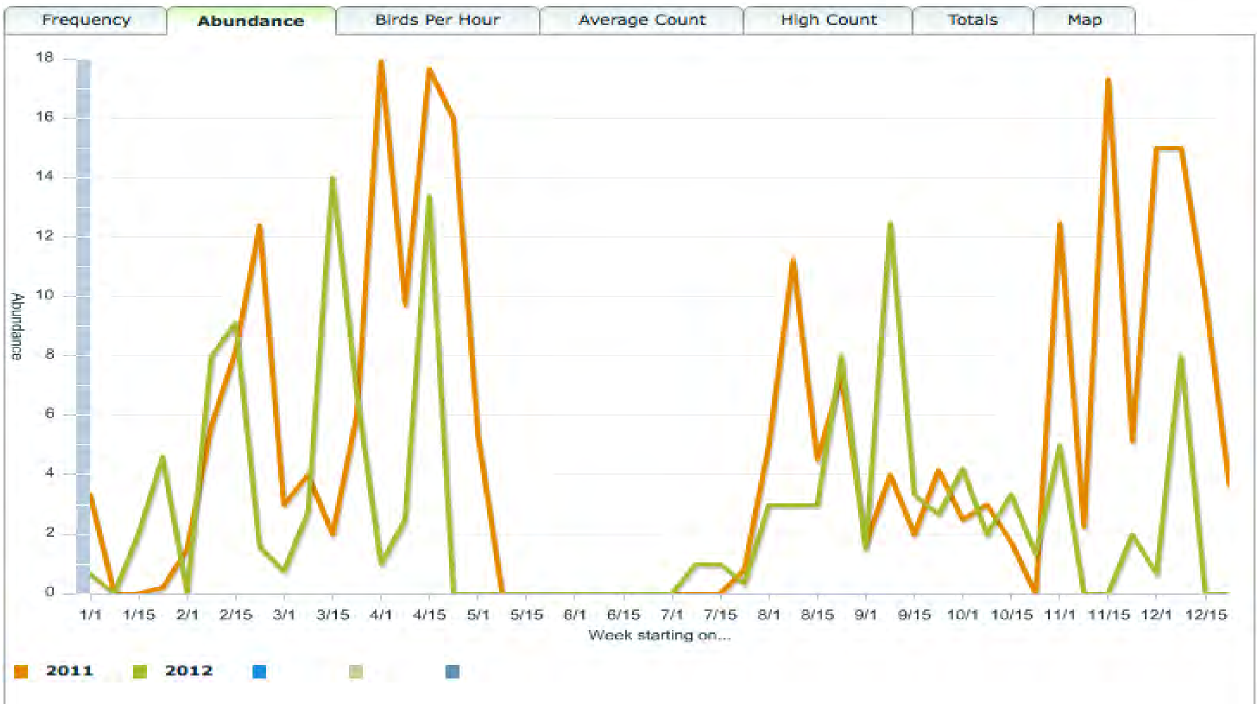


Figure 40. Abundance of Least Sandpiper at Malibu Lagoon, 2011 (orange) and 2012 (green).

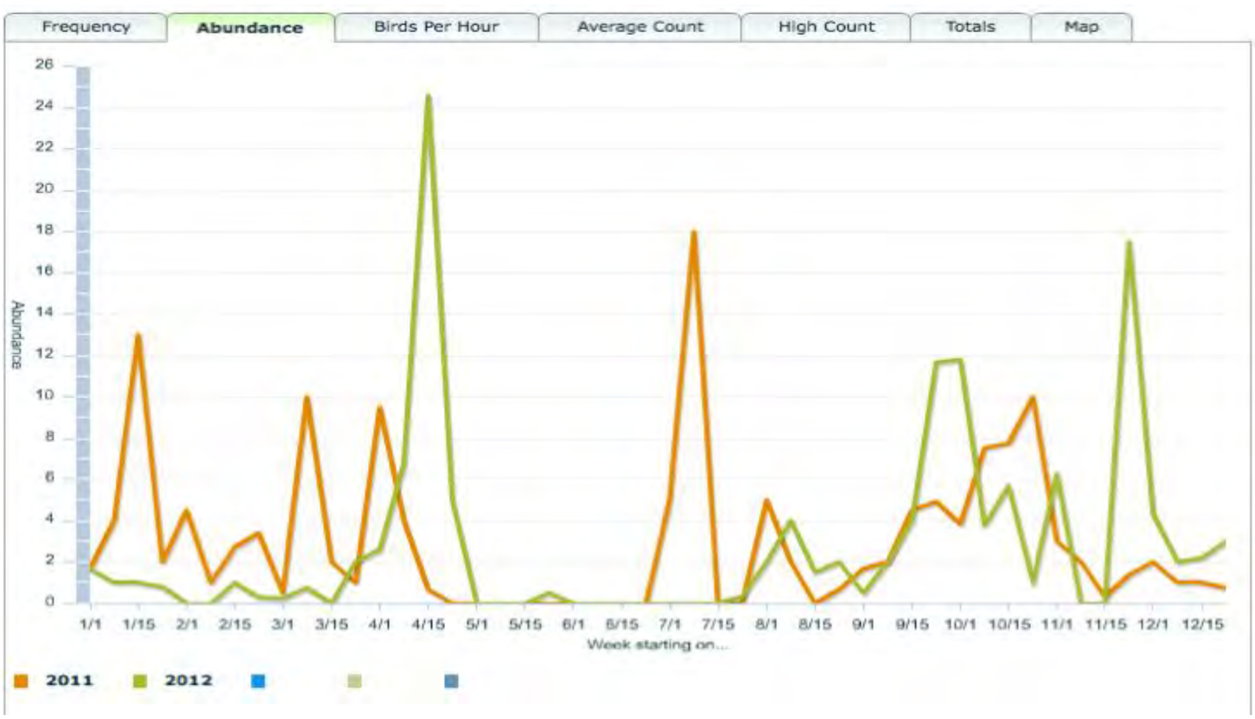


Figure 41. Abundance of Willet at Malibu Lagoon, 2011 (orange) and 2012 (green).

Scrub-dwelling birds have undoubtedly temporarily declined at the site owing to the temporary reduction of available habitat. This was intentional, as a goal of the project was to reduce landscaped/introduced scrub vegetation in wetland areas and replace it with more regionally-rare wetland habitats that were historically present. Species like Song Sparrow and Common Yellowthroat were found in smaller numbers by 2013, as their preferred habitat has been reduced. Figures 42 and 43 show counts of these two species from 2011 and 2012. However, both would be expected to at least partially recover their pre-construction numbers as the more limited coastal sage scrub habitats mature. It is expected that these birds will seek refuge in the ample coastal scrub and riparian habitats upstream, where they remain common (D.S. Cooper, personal observation).

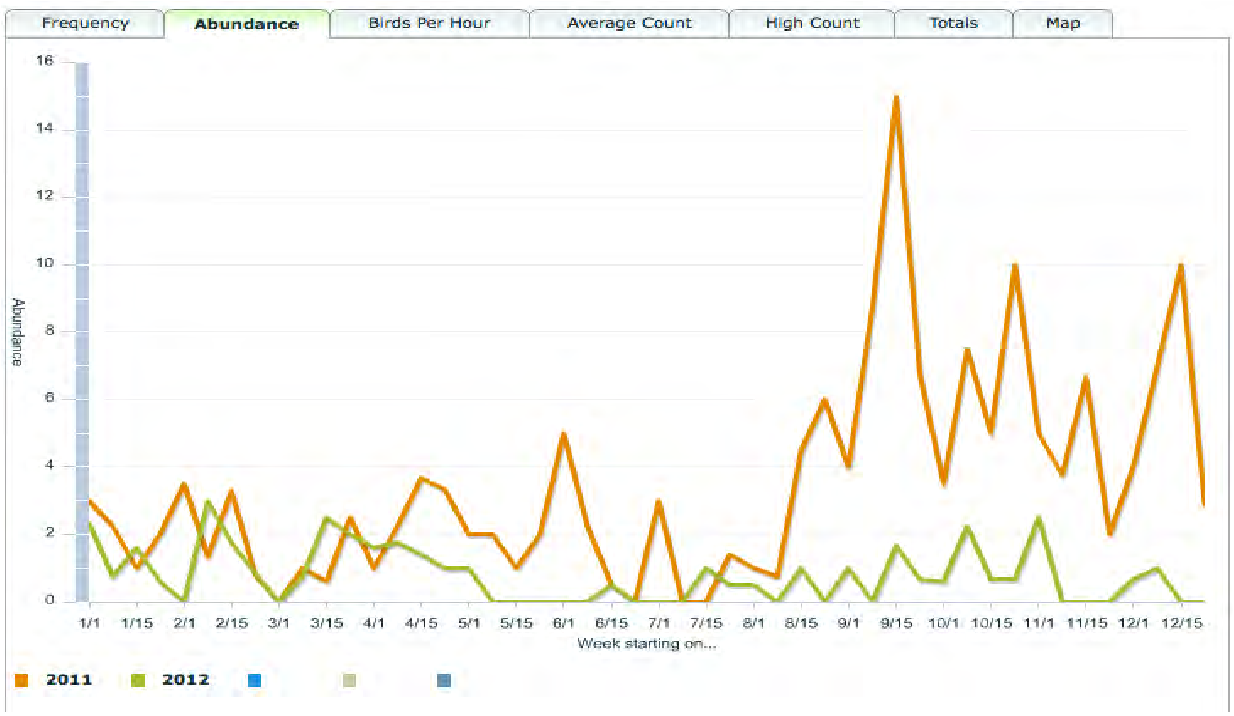


Figure 42. Abundance of Common Yellowthroat at Malibu Lagoon, 2011 (orange) and 2012 (green).

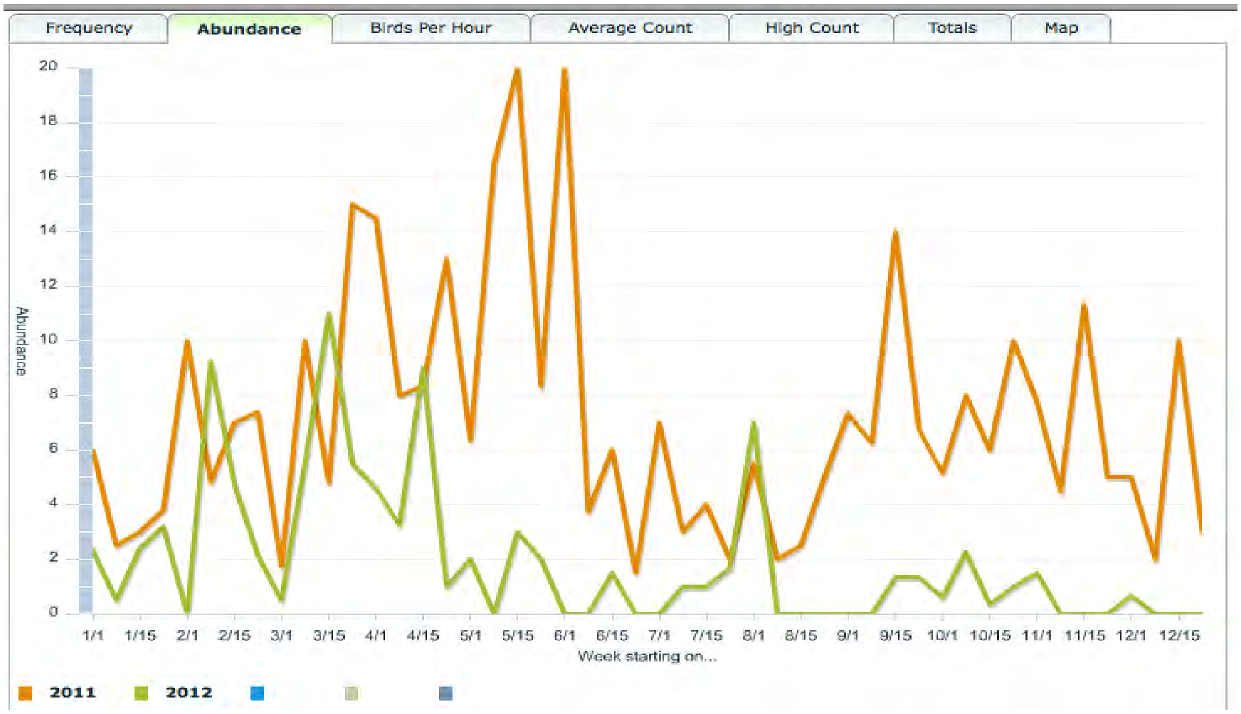


Figure 43. Abundance of Song Sparrow at Malibu Lagoon, 2011 (orange) and 2012 (green).

A key goal of the restoration project was to increase the diversity and variety of native vegetation to benefit multiple wildlife species. As a result, there was a net reduction in the coverage of bulrush beds within the site; hence, the numbers of birds that prefer bulrushes or similar vegetation (such as Red-winged Blackbird, *Agelaius phoeniceus*) would be expected to be less abundant onsite. Indeed, Red-winged Blackbird (Figure 44) and similar freshwater marsh species were rarely encountered during the second half of 2012. As with scrubland species, it is anticipated that these species will utilize appropriate habitats directly adjacent to the site until onsite vegetation matures and increases in size and coverage, which will be monitored through ongoing quarterly surveys.

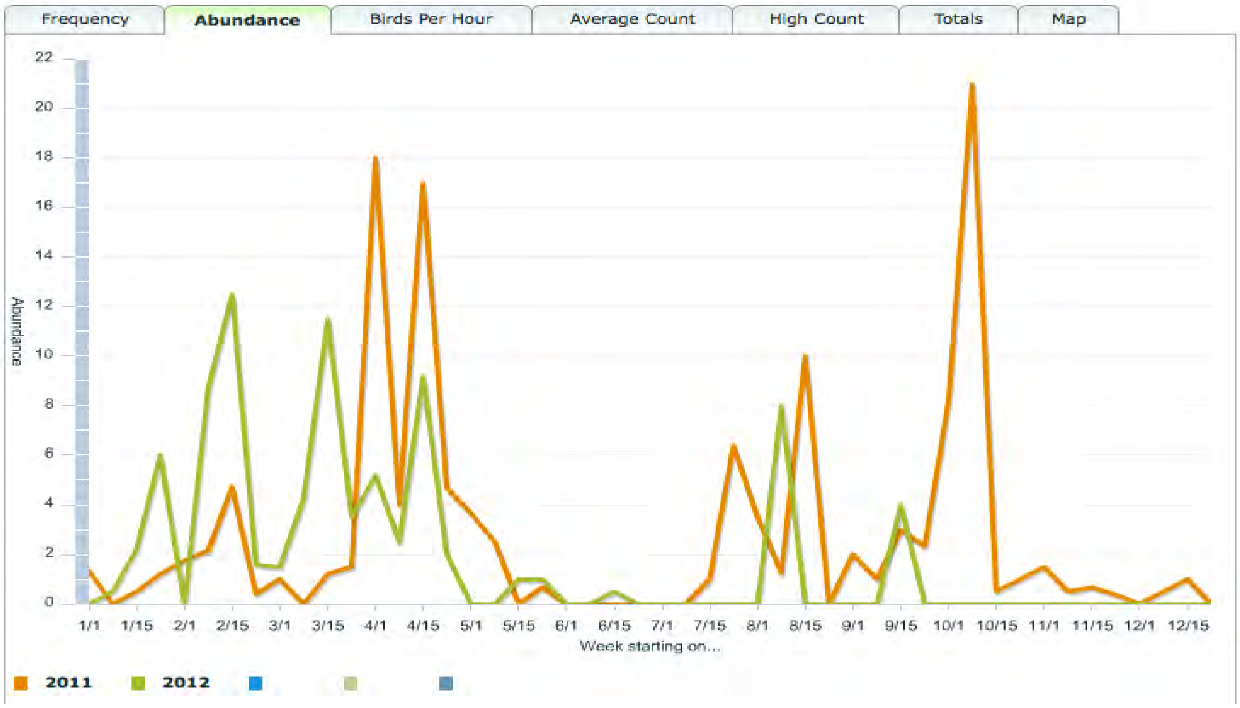


Figure 44. Abundance of Red-winged Blackbird at Malibu Lagoon, 2011 (orange) and 2012 (green).

Special-status bird species

Several special-status bird species[7] were detected during quarterly surveys in February 2013. Up to 16 Brown Pelican (*Pelicanus occidentalis californicus*; California Fully-protected) individuals were recorded roosting in the main lagoon and adjacent beach/sandspit. Up to 50 roosting Western Snowy Plover (Federally Threatened, State Species of Concern) were observed on the sandspit (40 on 11 Feb. 2013, 50 on 12 Feb. 2013). As for bird species of local conservation concern in Los Angeles County[8], the Virginia Rail (*Rallus limicola*) was observed in January 2006 (up to four individuals in the western portion on 11 Jan. 2006), but was not found in 2013. As discussed previously, this is not unexpected as this species requires dense reed beds, which were reduced temporarily as part of the restoration.

Summary and Discussion

A total of 53 bird species were recorded on the first quarterly survey of Malibu Lagoon, post-restoration (February 2013). While this number was around 25% lower than that recorded during the initial pre-restoration survey (January 2006), it reflects the early stage of the planted vegetation over most of the restoration site, which is just under three months old. The aggregate number of individual birds detected in 2013 was very similar to that in 2006 (just over 1,300 for both years) when one excludes A diverse community of waterbirds (waterfowl, shorebirds, waders) was found to be using the entire lagoon site in February 2013, but only a handful of shorebirds and waders were detected in the newly-

7 *Calif. Dept. Fish & Wildlife, The Resources Agency. Special Animals (898 taxa), January 2011.*

8 Los Angeles County Sensitive Bird Species Working Group. 2009. Los Angeles County's Sensitive Bird Species. Western Tanager 75(3):1-11.

created western tidal channels. Scrubland and freshwater marsh bird species were predictably reduced, but are expected to re-colonize once the planted vegetation grows in. Clearer trends should emerge with additional quarterly surveys, particularly as the habitat grows in and the invertebrate fauna becomes re-established.

Mammalian and Herpetofauna Monitoring and Relocation

Introduction

In accordance with the California Environmental Quality Act, project permits, and the State Park's mission to protect onsite natural resources, wildlife salvage and relocation efforts were conducted both prior to and during construction at the Malibu Lagoon Restoration project site (Project). This chapter summarizes efforts to protect herpetofauna, invertebrate, and terrestrial mammalian taxa both before and throughout Project construction, and the resulting data of wildlife salvage and relocation. Specific efforts for protection of birds and fish are discussed in separate chapters.

The mission of California State Department of Parks and Recreation (CDPR) is to provide for the health, inspiration, and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation. As such, protection of not only special-status biological resources (plants, animals, habitats, and regulatory area protected at the local, state or federal level), but ecosystems as a whole, is at the heart of resource protection activities within CDPR. A key goal of this project was therefore to salvage and relocate not only the special-status species encountered, but other vertebrate wildlife present within the coastal habitats onsite.

Project permit conditions that directed the wildlife salvage and relocation efforts included:

California Coastal Commission (CCC) Coastal Development Permit, Special Conditions 1-2:

- Survey for sensitive species within 500 feet of site within three days of construction. Relocate or buffer sensitive species found.
- Monitor present during all construction, grading, excavation, vegetation removal, hauling, maintenance, etc. to avoid impacts to special-status species.
- Initiate a salvage and relocation program prior to any excavation/maintenance activities for special-status species to move out of harm's way, or as appropriate, implement a resource avoidance program to avoid adverse impacts to sensitive species.

U.S. Army Corps of Engineers Section 404 Permit, Special Conditions 2 and USFWS Biological Opinion Measure 4.1:

- Approved biologist will conduct an environmental training session for all project personnel prior to any project activities and as needed as new personnel are brought on the job. Includes listed species.

Methods

All salvage and relocation was completed under the authorization provided by CCC, and the following Department of Fish and Wildlife collection permits authorizing onsite monitoring and resource work:

a. Seth Riley: SC-5636
b. Jamie King SC-7163
c. Rosi Dagit: SC-0604

Training and oversight for staff conducting salvage activities was led by CDPR staff Environmental Scientist, Jamie King, and Senior Environmental Scientist, Suzanne Goode, and Santa Monica Bay Restoration Foundation (SMBRF) Senior Watershed Advisor, Mark Abramson. A team of qualified partners and scientists provided guidance on the mammal trapping and relocation efforts, and included National Park Service Biologists, Joanne Moriarty, Cathy Schwemm, Tim Coonan, Katy Delaney, and Seth Riley, Resource Conservation District Scientist, Rosi Dagit, and Santa Monica Bay Restoration Foundation Biologist, Karina Johnston.

Multiple staff and volunteers were involved with the trapping efforts under the supervision of the lead biologists and included:

- CDPR: Noa Rishe, Nick Chang, Lily Templeton, David Altamonte, David Iniguez, Ranger and Maintenance Staff.
- RCDSMM: Jaynie Shulman, Jenna Kruger, Steve Williams, and Delmar Lathers.
- SMBRF: Elena Tuttle, Ivan Medel, and Charlie Piechowski.

Pre-construction Phase

Environmental Training

All construction crew and monitoring staff received environmental training regarding the special-status species that could be encountered onsite, as well as the proposed trapping and relocation efforts. Appendix J contains a summary of the training conducted.

Small Mammal/Carnivore Trapping

Live traps are commonly used for mammal sampling (Sealander and James 1958, Nichols and Pollock 1983, Slade et al. 1993, Whittaker et al. 1998, Cypher 2001). Two hundred Sherman live traps (24 x 9 x 8 cm) and 16 small carnivore traps were deployed on the evenings of 7-9 June 2012 within two hours of sunset. Due to vandalism and trap theft, a total of 556 trap nights occurred over this time period. Traps were deployed in transects across all habitats throughout the site that were not submerged or in danger of tidal inundation during the trapping period. These included remnant dune, woodland, scrub, high marsh, and ruderal habitats. Figure 45 displays the transect alignments.

Figure 45. Map including the location of transect lines.

Prior to placement in the field, traps were “cured” outside in scrub habitat for at least two weeks to acclimate to local conditions and smells. Gloves were used to handle traps at all times. Small mammal trap sites were chosen to cover all available microhabitats with an emphasis on known woodrat nests, active burrows, and along the edges of shrubs. Small carnivore traps were placed near the bridges as weasels and other large mammal sign had been documented in these areas. All trap locations were flagged and numbered to ensure collection of all deployed traps. Approximately one tablespoon of Four-way sweet horse feed and a cottonball (for warmth) was placed in the back of each Sherman live trap, while raw meat, cat food and/or fish oil were used in the small carnivore traps. A light trail of feed led from the mouth of the trap into the back. Natural material in the area was used to ensure there was no gap between the lip of the trap and the ground and many traps were often covered with natural debris to camouflage them.

Traps were checked within two hours of sunrise, and those with animals present were collected and processed. Captured animals were identified to species, transferred temporarily to buckets with vegetative cover, and released at one of three locations out of harm’s way and within appropriate habitat. The release areas were all on CDPR land located near the Adamson House, Serra Retreat community, and on the project site in habitat areas not planned for disturbance. Care was taken to spread the release of animals both temporally and spatially at each site, and to provide each animal appropriate cover and adjacent habitats to enable it to adapt to the new surroundings. Animals were not released when predators (e.g. red-tailed hawks) were observed in the area.

Herpetofauna Capture

Herpetofauna (amphibians and reptiles) were captured throughout the site June 4-10, 2012 when they were most active and likely to be visible. Several methods were used: grass noose, net, or by hand. Captured animals were handled and relocated using the same locations and methods outlined above. Hands were wetted before handling any frogs.

During this same time period, an effort was made to confirm the presence of the California legless lizard (*Anniella pulchra*). All appropriate habitat areas were searched, including dunes, shrubs, and upland areas. Additional survey protocols were taken in these habitats, including raking, sieving and sifting sand, and track searches. No sign or individuals of this species were found.

Construction Phase

Prior to vegetation removal activities, the monitoring team worked with the contractor to schedule the order of activities to shift wildlife towards the northeast area of the project site, so that wildlife could move offsite to large adjacent open space areas associated with Malibu Creek State Park. A corridor of vegetation was left as long as possible (several months) to facilitate wildlife movement towards this area. Care was taken to deter animals from traveling towards the beach and neighborhood areas to the south and parking lot area to the northwest as the areas had high human activity and provided limited cover and habitat values. Silt fence was also deployed strategically to facilitate animal movement in a northeast direction.

Prior to removal of any shrubs or trees, areas were surveyed for the presence of woodrat or other mammal nests or locally sensitive monarch butterflies. Potentially active nests were flagged and buffered with flagging for construction avoidance until traps had been deployed to capture and relocate any woodrats present. Work avoided individual monarch butterflies when encountered onsite. Sherman live traps were strategically set prior to the removal of wetland vegetation that had been left intact awaiting the completion of bird nesting. The goal was to trap and relocate any remaining small mammals.

During all vegetation removal or trimming activities, a trained and qualified biological monitor surveyed the area ahead of construction equipment to flush wildlife out of harm's way, and when feasible, capture and relocate offsite. When an animal was observed near equipment, the monitor signaled the equipment operator to pause work, and the animal was captured for relocation offsite. Figure 46 illustrates site photos of the monitoring, salvage, and relocation effort for herpetofauna and mammalian taxa.

Figure 46. Site photographs of herpetofauna and mammal pre-construction and construction surveys.

DPR monitor Nick Chang flagging woodrat nest for avoidance until they could be trapped for animal relocation (6/7/12).

DPR environmental scientist Jamie King baiting traps for animal relocation before grubbing activities (6/7/12).

DPR ranger Christy Ferrero assisting with animal relocation before grubbing activities under scientist supervision (6/7/12).

Setting carnivore traps for animal relocation prior to construction (6/7/12).

DPR ranger Carlos Matamoros setting and flagging Sherman live traps.

South coast marsh voles (CA Species of Concern) relocated prior to project construction offsite in appropriate habitat. This was the most abundant species encountered onsite.

Volunteer biologists Jack Topel SMBRC and Rosi Dagit RCD identifying and releasing small mammals offsite. (6/8/12).

Woodrat before release. Plastic bags with ventilation were used to enable identification while minimizing handling.

Gates were installed at the NE corner of the project site 6/12/11 to allow wildlife to relocate out and upstream of the construction area (6/13/12).

Project area delineated with construction fencing to ensure public safety and delineate work area. Silt fence facilitates animal movement towards adjacent upstream areas and not towards adjacent development (6/14/12).

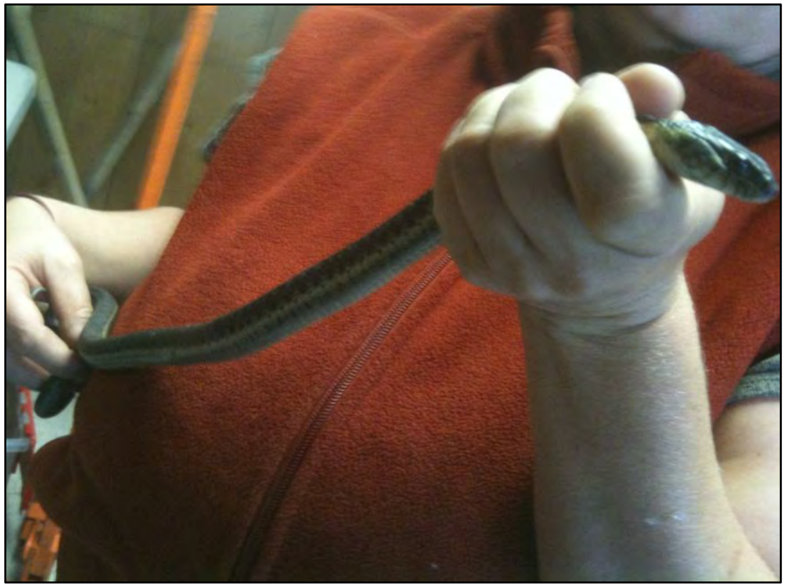
DPR monitors David Altamonte and Noa Rishe capturing and relocating wildlife ahead of equipment (6/13/12).

A few Pacific tree frogs were found during construction in wetland habitats.

Many western fence lizards were relocated both before and during construction. This was the most abundant reptile captured onsite.

Several ornate shrews (California Species of Concern) were captured during construction. Invertebrates were provided and the shrews were immediately relocated.

Side-blotched lizards were found less frequently than western fence lizards.



One two-striped garter snake (California Species of Concern) was found under straw wattles onsite near the parking lot and relocated. This was the only snake observed onsite.

Alligator lizards were abundant onsite.

CA ground squirrel relocated offsite.

Young western harvest mouse was rescued by SMBRC staff Elena Tuttle and Karina Johnston to the CA Wildlife Center until it was old enough to be rereleased.

DPR staff John Luker transporting an injured mammal to the wildlife Center.

Mummified raccoon carcass found at the start of the project In the rain garden vegetation. Cause of death was unknown but was prior to the onset of the project based on the carcass condition.

Results

406 individuals of 20 species of wildlife (Table 13), including four California Species of Special Concern (SSC) were encountered prior to and during project construction onsite.

Table 13. Species list of relocated wildlife and nativity or conservation status. Special-status species are bold and non-native species are marked with an asterisk.

- Alligator lizard (*Elgaria multicarinata*)
- Black rat *(Rattus rattus)**
- California ground squirrel (*Otospermophilus beecheyii*)
- Deer (*Odocoileus hemionus*)
- Domestic cat *(Felis catus)**
- Dusky-footed woodrat (*Neotoma fuscipes*)
- House mouse *(Mus musculus)**
- Long-tailed weasel (*Mustela frenata*)
- **Monarch butterfly (*Danaus plexippus, locally sensitive)***
- Norway rat *(Rattus norvegicus)**
- **Ornate shrew (*Sorex ornatus salicornicus (?), SSC*).** No dead specimens were available to confirm identification, this subspecies is assumed.
- Pacific tree frog (*Pseudacris regilla*)
- Raccoon (*Procyon lotor*)
- Side-blotched lizard (*Uta stansburiana*)
- **South coast marsh vole (*Microtus californicus stephensi*, SSC)**
- Striped skunk (*Mephitis mephitis*)
- **Two-striped garter snake *(*Thamnophis hammondii*,* SSC)**
- Virginia opossum *(Didelphis virginiana)**
- Western fence lizard (*Sceloporus occidentalis*)
- Western harvest mouse (*Reithrodontomys megalotis*)

Of the 556 pre-restoration trapping nights, 99 individuals were captured (Table 14), representing an 18% capture rate. Of the 406 individuals encountered during the Project, 387 (95%) were avoided, flushed, or captured and relocated offsite out of harm's way. This high survival rate is due to extensive monitoring, salvage, and relocation efforts implemented before and during construction activities.

126 of the 406 animals (31%) encountered were special-status (one two-striped garter snake, four ornate shrews, and 120 south coast marsh voles, and at least one monarch butterfly; Table 14).
Of the 387 animals avoided, flushed, or moved out of harm's way, 121 (31%) were special-status species (one two-striped garter snake, four ornate shrews, and 115 south coast marsh voles, and at least one monarch butterfly). 121 of 126 (96%) of all special status species encountered were avoided or successfully relocated.

Table 14. Daily counts and relocation of each species of herpetofauna and mammals pre-construction and during-construction.

DATE	INVERTS	HERPETOFAUNA				MAMMALS														TOTAL	PROJECT RELATED INJURY/ MORTALITY	COMMENTS
	Monarch butterfly (*Danaus plexippus*)	Pacific tree frog (*Pseudacris regilla*)	Alligator lizard (*Elgaria multicarinata*)	Side blotched lizard (Uta stansburiana)	Two-striped garter snake (*Thamnophis hammondii*)	Western fence lizard (*Sceloporus occidentalis*)	Virginia opossum (*Didelphis virginiana*)	Ornate shrew (*Sorex ornatus*)	Raccoon (*Procyon lotor*)	Striped skunk (*Mephitis mephitis*)	Long-tailed weasel (*Mustela frenata*)	Domestic cat (*Felis catus*)	CA ground squirrel (*Otospermophilus beecheyii*)	South coast marsh vole (*Microtus californicus stephensi*)	Dusky-footed wood rat (Neotoma fuscipes)	Western harvest mouse (*Reithrodontomys megalotis*)	House Mouse (Mus musculus)	Norway rat (*Rattus norvegicus*)	Black rat (Rattus rattus)	Deer (*Odocoileus hemionus*)	**20**		
Preconstruction (June 7-9, 2012; 556 trap nights)																							
			1	*4*		*24*	*5*			*1*	*1+*		*4*	*20*	*11*	*25*	*1*		*1*			*1*	Trap M(x): 1 WHM
Subtotal	0	0	***1***	***4***	0	***24***	***5***	0	1	***1***	***1+***	0	***4***	***20***	***11***	***25***	***1***	***0***	***1***	0	***99***	***1***	Mummified raccoon carcass found onsite during trapping period. Oppossum easily caught in traps
Construction (June 10, 2012-February 22, 2013)																							
6/12/12			1	4		24																	
6/13/12			10			10	1							11									
6/14/12			9			12		1						16		3							
6/15/12			4			13								17		1						3	M(x): 1 vole. 1 injured vole and 1 infant mouse taken to rescue
6/18/12		3	7			5		1						15		12		2				4	M(x): 1 vole, 2 mice. 1 vole to rescue center
6/19/12			4			5								3		1						2	M(x): 1 alligator lizard, 1 fence lizard
6/20/12			6			2							2	4								2	M(x): 1 alligator lizard, 1 vole (floating in water, to LA Co NHM for ID)
6/21/12			2											2									
6/22/12														2	3								
6/25/12			2			2								6			2					2	M(x): 2 voles
6/26/12		2	4			4		1							1								
6/27/12										1				1									Estimated date for skunk capture
7/2/12			2			1								9		15						4	M(x): 2 WHM. WHM 1 baby and 1 adult taken to wildlife rescue

Table 14. Daily counts and relocation of each species of herpetofauna and mammals pre-construction and during-construction.

DATE	INVERTS	HERPETOFAUNA					MAMMALS														TOTAL	PROJECT RELATED INJURY/ MORTALITY	COMMENTS
	Monarch butterfly (*Danaus plexippus*)	Pacific tree frog (*Pseudacris regilla*)	Alligator lizard (*Elgaria multicarinata*)	Side blotched lizard (Uta stansburiana)	Two-striped garter snake (*Thamnophis hammondii*)	Western fence lizard (*Sceloporus occidentalis*)	Virginia opossum (*Didelphis virginiana*)	Ornate shrew (*Sorex ornatus*)	Raccoon (*Procyon lotor*)	Striped skunk (*Mephitis mephitis*)	Long-tailed weasel (*Mustela frenata*)	Domestic cat (*Felis catus*)	CA ground squirrel (*Otospermophilus beecheyii*)	South coast marsh vole (*Microtus californicus stephensi*)	Dusky-footed wood rat (Neotoma fuscipes)	Western harvest mouse (*Reithrodontomys megalotis*)	House Mouse (Mus musculus)	Norway rat (*Rattus norvegicus*)	Black rat (Rattus rattus)	Deer (*Odocoileus hemionus*)	**20**		
7/3/12																1							
7/9/12			1											4		1							
7/11/12														2									
7/16/12			4			2		1						6		2						1	1 vole
8/6/12												1											M(x): 1 cat, throat ripped out (preyed on). Not project related.
8/16/12	1+	2	1											2	1	1							
9/10/12							1																1 old dead opossum near colony fence-thrown over fence by resident/worker. Not project related.
11/28/12					1															1			Young faun along PCH, avoided
Subtotal	***1+***	***7***	***57***	***4***	***1***	***80***	***2***	***4***	***0***	***1***	***0***	***1***	***2***	***100***	***5***	***37***	***2***	***2***	***0***	***1***	***307***	***18***	
TOTAL	***1+***	***7***	***58***	***8***	***1***	***104***	***7***	***4***	***1***	***2***	***1+***	***1***	***6***	***120***	***16***	***62***	***3***	***2***	***1***	***1***	***406***	***19***	

Table Notes:

- At least one weasel was captured as shown by feces found in traps, but the animal(s) are believed to have been released by vandals opposing the project the first night of trapping. Although weasels were spotted several times during construction, including early February 2013, none were recaptured after the first night of trapping.
- M(x)=mortality or casualty
- WHM=western harvest mouse

Summary and Discussion

Vandalism was anticipated during implementation as there was a small, but vocal, opposition to the Project. Although security guards were present onsite, vandals stole 22 small Sherman live traps and four small carnivore traps the first night of trapping. Multiple traps were renumbered and relocated or had animals released out of them, as evidenced by feces within the traps. For this reason, we believe that at least one long-tailed weasel, which had been frequently observed onsite, had been caught, but released.

Pre-construction trapping success was greater than anticipated based on previous trapping efforts onsite. The 18% capture rate was significantly higher than previous trapping efforts onsite (ERA 2005, 1 black rat caught in 300 trap nights) and some relevant literature. It is hypothesized that the number would have been higher without the traps being vandalized, which hindered pre-restoration salvage and relocation efforts. The bait and trapping method was effective for a wide array of species, including the south coast marsh vole, western harvest and house mouse, woodrat, black rat, Norway rat, and opossum.

Ornate shrew were captured by hand when individuals became visible when retreating from equipment or exposed during excavation. Inclusion of an invertebrate-based bait may facilitate capture in other restoration projects or monitoring efforts. Regardless, targeted shrew capture methods would need to be employed to capture shrews prior to future survey efforts.

Rabbits were never captured, although observed several times directly offsite. Presumably, they were flushed offsite in advance of construction.

Salvage in advance of construction equipment was very effective for relocating wildlife out of harm's way and was the primary means of capture for lizards, ornate shrew and a larger number of voles. There were many challenges associated with this method, including that it is very time intensive and has increased risk to personnel working in the vicinity of large equipment and the rough terrain. Increased injury also occurred to wildlife during construction, supporting maximizing trapping efforts in advance of grubbing to minimize animals requiring salvage. Staff skill also varied significantly for this method.

Herpetofauna were found on a continual basis throughout pre-construction and construction activities. Capture was fairly time intensive, as the ability of monitors to capture individuals varied based on monitor speed and skill set. Use of either pitfall arrays or cover boards well in advance of Project construction during future survey work is recommended, to supplement hand capture.

The use of silt fencing and the detailed coordination of construction activities to flush animals offsite to the northeast seemed an effective means of removing animals from the construction areas. Few individuals were encountered on the beach or other areas fenced-off for animal exclusion. The exception was rabbits, several were observed directly observed in all areas of vegetation offsite. Rabbits were not observed being flushed in advance of construction equipment and therefore are not included in Table 14 above.

Signs of potential mammal poisoning by adjacent residents was seen via an opossum carcass that suddenly appeared after lunch on 10 September 2012, soon after the area had been surveyed. An education plan with area neighbors is recommended to provide guidance on the food chain effects of some types of poison use and recommended Best Management Practices. A similar approach should be considered for educating local residents on home rodent trapping and concerns about feral and house cats as they could detrimentally impact sensitive small mammal species, such as the south coast marsh vole or ornate shrew.

Vegetation – SAV/Algal Percent Cover Monitoring

Introduction

Algae and submerged aquatic vegetation surveys provide important information about primary productivity within a system and given trophic structure. Algae abundance and growth can also be useful indicators of eutrophication and tidal flushing (Zedler 2001). Since the Lagoon had significant issues with eutrophication and an excess of algal growth pre-restoration, they are important components to monitor post-restoration.

Methods

Monitoring will be conducted during the fall for a period of five years after construction, at a minimum. For the initial baseline post-restoration surveys, floating, mat, and attached submerged aquatic vegetation (SAV) and macroalgae were monitored at eight stations (Figure 47) on 14 February 2013 during a low tide. Three transects were surveyed using a line-intercept method at each station. Transects were averaged by station using the length of each transect to determine total percent cover (± standard error).

Figure 47. Transect deployed in the main Lagoon for SAV/algae monitoring, February 2013.

Results

Results were analyzed both as individual transects and as an average of the three transects per station (± standard error) (Table 15). Total transect lengths varied by station, from the largest at 50m (Stations 1, 2, and 3) to the smallest at 8m (Station 8). The category 'wrack' is an amalgamation of several types of unattached or floating kelp species, including those in the genera *Macrocystis, Phyllospadix, Egregia,* and *Eisenia.* The *Cladophora* cover is a small attached 'turf-like' green alga. All stations had a total algal cover of 5.1% or less, and two stations (5 and 6) had zero algal cover (Table 15). With the exceptions of Stations 3 and 8, stations were dominated by wrack as the overall proportion of total algal cover.

Table 15. Table of post-restoration baseline monitoring data for SAV/algal percent cover averaged by station and type of algae. Total includes both wrack and *Cladophora sp*.

Station	% cover wrack	% cover *Cladophora*	Total algal % cover	Proportion of total as wrack
1A	2.3%	0.0%	2.3%	1.00
1B	2.5%	0.0%	2.5%	1.00
1C	4.0%	0.1%	4.1%	0.97
Station 1 (avg ± SE)	**2.9 ± 0.53%**	**0.0 ± 0.05%**	**3.0 ± 0.57%**	**0.98**
2A	1.0%	0.0%	1.0%	1.00
2B	0.1%	0.0%	0.2%	0.75
2C	0.2%	0.0%	0.2%	1.00
Station 2 (avg ± SE)	**0.4 ± 0.28%**	**0.0 ± 0.01%**	**0.5 ± 0.27%**	**0.97**
3A	0.6%	2.0%	2.6%	0.23
3B	0.0%	0.0%	0.0%	----
3C	0.0%	0.0%	0.0%	----
Station 3 (avg ± SE)	**0.2 ± 0.20%**	**0.7 ± 0.67%**	**0.9 ± 0.87%**	**0.23**
4A	2.0%	0.3%	2.3%	0.87
4B	2.0%	0.0%	2.0%	1.00
4C	1.0%	1.0%	2.0%	0.50
Station 4 (avg ± SE)	**1.7 ± 0.33%**	**0.4 ± 0.30%**	**2.1 ± 0.10%**	**0.79**
5A	0.0%	0.0%	0.0%	----
5B	0.0%	0.0%	0.0%	----
5C	0.0%	0.0%	0.0%	----
Station 5 (avg ± SE)	**0.0 ± 0.00%**	**0.0 ± 0.00%**	**0.0 ± 0.00%**	----
6A	0.0%	0.0%	0.0%	----
6B	0.0%	0.0%	0.0%	----
6C	0.0%	0.0%	0.0%	----
Station 6 (avg ± SE)	**0.0 ± 0.00%**	**0.0 ± 0.00%**	**0.0 ± 0.00%**	----
7A	0.3%	0.1%	0.4%	0.70
7B	0.5%	0.1%	0.6%	0.81
7C	0.3%	0.1%	0.4%	0.77
Station 7 (avg ± SE)	**0.4 ± 0.06%**	**0.1 ± 0.00%**	**0.5 ± 0.06%**	**0.77**
8A	0.0%	4.9%	4.9%	0.00
8B	0.3%	8.3%	8.7%	0.04
8C	1.7%	0.0%	1.7%	1.00
Station 8 (avg ± SE)	**0.7 ± 0.52%**	**4.4 ± 2.42%**	**5.1 ± 2.01%**	**0.13**

Summary and Discussion

There was significant and excessive algal growth in the Lagoon pre-restoration; algae cover was one of the key indicators of eutrophication to the system. The surveys and data were difficult to collect due to the massive amounts of organic muck causing an inability to deploy transects.

These data collected as part of the initial post-restoration baseline surveys will be used to evaluate the growth and prevalence of algae throughout the upcoming years of monitoring. Initial cover of algae is present, but in low quantities and is primarily dominated by wrack (unattached or floating kelp). Further analyses in subsequent reports will track the algae growth over time to evaluate the success of the new circulation and inundation patterns in the Malibu Lagoon.

Vegetation – Plant Cover Transect Monitoring

Methods

Data for absolute percent cover of native/nonnative species was collected along three randomly placed 50-meter transects (Figure 48 and 49) using the line-intercept method on 15 March 2013. These baseline data were the first set of post-restoration vegetation surveys.

Each transect location was recorded with a submeter global positioning system (GPS) unit and photographed at each end. Species data were collected to an accuracy of 0.01 m along each 50-meter transect. Absolute percent cover was calculated based upon the total distance for each species within all transects combined for a site-wide (transect-based) total (e.g. 15 m of native vegetation cover out of 150 total meters from all transects would be a 10% native vegetation cover). Data are displayed as a bar graph.

Figure 48. Map of vegetation transect locations and start/end points.

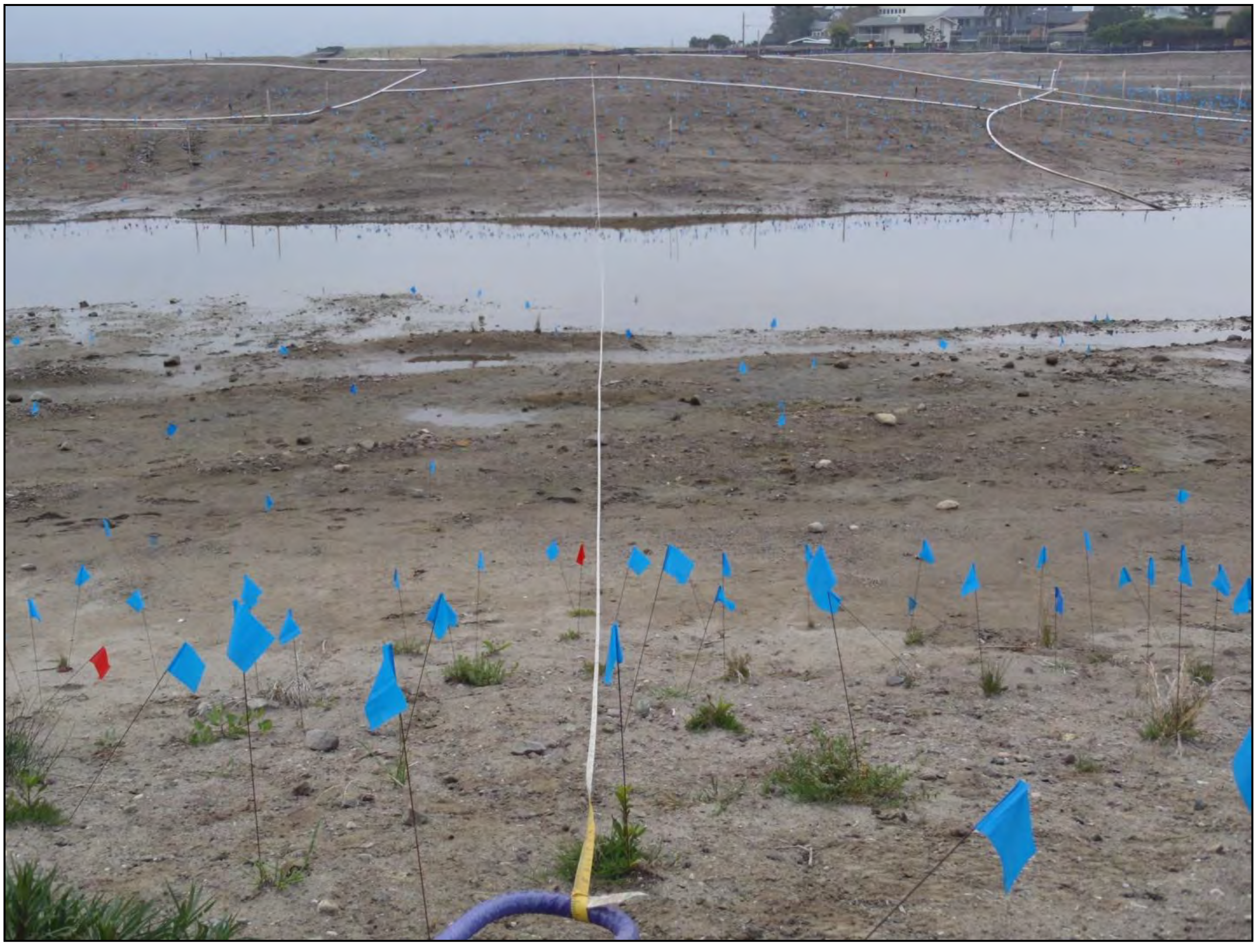


Figure 49. Example photo of vegetation transect start point.

Results

Absolute vegetation cover was assessed for all three transects combined by adding the total distances for each species and dividing by 150 m (length of all transects combined). Species were divided into native, non-native, or wrack and added together. The total absolute cover of vegetation was 3.36%, with bare ground or mudflat accounting for the rest (96.64%). Native cover accounted for 1.1% of the total absolute cover, non-native cover for 0.2%, and wrack for 2.1% (Figure 50).

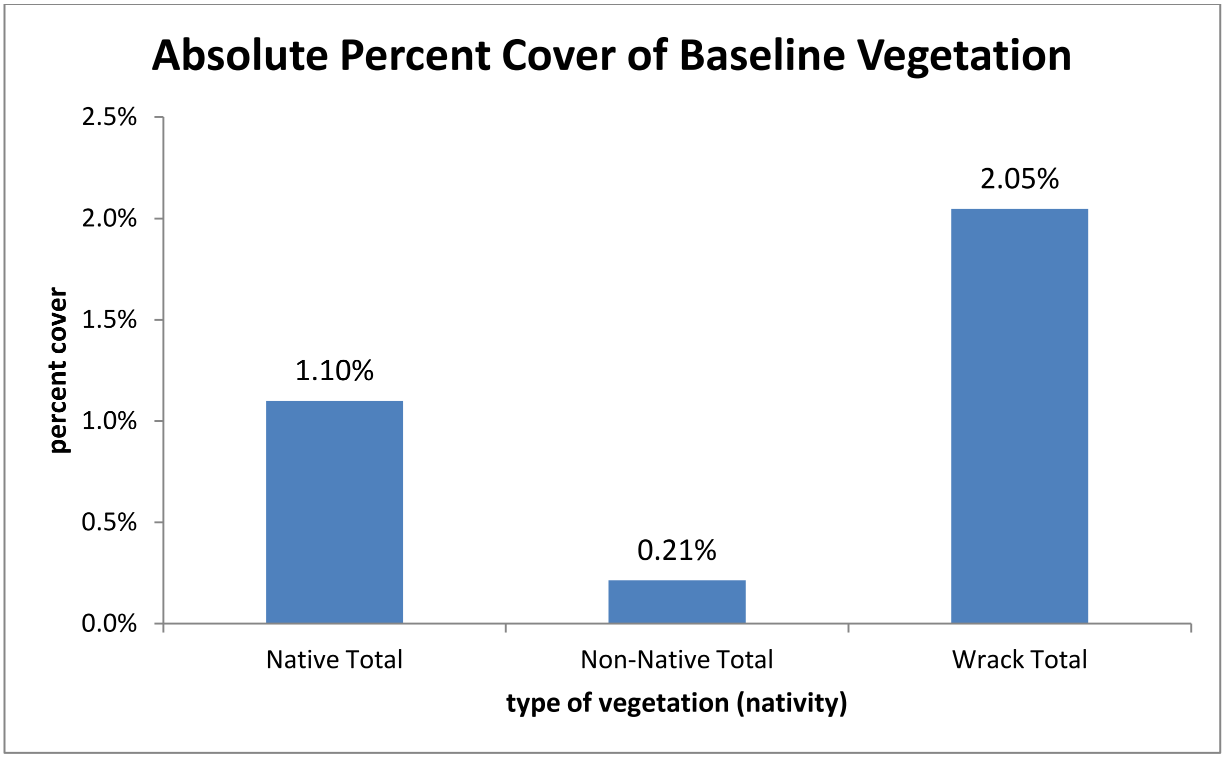


Figure 50. Graph displaying the absolute cover of vegetation in the initial post-restoration baseline surveys.

Summary and Discussion

The vegetation cover as assessed by these three transects overall is very low. However, this is as expected, since the immediate post-restoration vegetation cover will take time to develop and become more complex (similarly to the biotic CRAM metric). The number and species richness of vegetation planted throughout the Lagoon is variable based on habitat, but has over 68,000 individual plants of 70+ species in total throughout the site, in addition to the areas that received hydroseeding.

Vegetation cover will continue to grow and develop over time, as mature plants have a chance to form and develop. Weeding will also continue throughout the site to remove non-native sprouts. As the photos throughout this document show, the number of individual plants is high, though they are all quite small at this time, therefore accounting for far less absolute cover than adult plants.

Vegetation – Photo-Point Monitoring

Methods

The primary purpose of this sampling method is to capture broad changes in the landscape and vegetation communities over seasons or years. This method collects georeferenced photos for use in site management (e.g. invasive species tracking) and long-term data collection. Three permanent, photo-monitoring locations (Table 16 and Figure 51) were established to visually document the establishment of vegetation following restoration. Photos were taken at low tide and the stations were located using GPS. The baseline photo point survey was conducted immediately post-restoration on 15 March 2013 at approximately 9am during a low tide. The approximate bearing is relative to the center of the photo. Bearing ranges are included on the datasheets. Photos were taken using a Cannon EOS Rebel T3I on a tripod at a height of 1.5 m.

Table 16. GPS coordinates, bearings, and time of photographs.

Station	GPS Coordinate (decimal degrees)	Approximate Bearing	Time	Number of Photos
Photo Point 1	34.03373°, -118.68470°	155°	09:05 AM	1
Photo Point 2	34.03233°, -118.68439°	300°, 75°	09:22 AM	2
Photo Point 3	34.03223°, -118.68285°	220°, 100°	09:38 AM	2

Figure 51. Map of photo point locations and bearing.

Results

A total of five photos were taken at three locations to assess a range of habitat types across the restoration area. Figures 52-56 display the photos from the five locations immediately post-restoration on 15 March 2013.

Figure 52. Photograph of Photo Point 1, bearing 155º on 15 March, 2013.

Figure 53. Photograph of Photo Point 2, bearing 300º on 15 March, 2013.

Figure 54. Photograph of Photo Point 2, bearing 75º on 15 March, 2013.

Figure 55. Photograph of Photo Point 3, bearing 220º on 15 March, 2013.

Figure 56. Photograph of Photo Point 3, bearing 100º on 15 March, 2013.

Report Summary

The Malibu Lagoon Restoration and Enhancement project was deemed substantially complete on 15 March, 2013. It is already evident through several of the post-restoration monitoring components that lowering the lagoon elevation, creating a wider single channel directed more towards the incoming tide, and removing the pinch points have already increased circulation both in an open and closed lagoon condition. Several important components of the restoration that can be highlighted as immediately successful, including: the high levels of dissolved oxygen, good circulations patterns, elevation transect targets, and bird use of the site. The bird use of the site has never stopped, even throughout the construction period, and it is hypothesized that it will continue to improve as the vegetation develops over the next several years. Fish are also already starting to recolonize the main Lagoon.

SMBRF and State Parks will continue to closely monitor the hydrology and biological resources on site for the next five years. It is expected that further improvements for the biological residents of the restored Malibu Lagoon will continue to be seen.

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Photo: Malibu Lagoon Restoration at sunrise (I. Medel; January 2013).