Santa Monica Beach Restoration Pilot Project

Implementation and Monitoring Plan

October 2016

Prepared for:
California Coastal Commission
City of Santa Monica
California Department of Parks and Recreation

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Timing of Operations: Project operations will begin in November 2016 in accordance with Coastal Development Permit No. 5-16-0632 and extend for a period of five years. A possible permit extension will be considered at the end of the five year period.

Prepared by: The Bay Foundation

Prepared for:
California Coastal Commission
City of Santa Monica
California Department of Parks and Recreation

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Suggested Citation:
Johnston, K.K. and M. Grubbs. 2016. Santa Monica Beach Restoration Pilot Project Implementation and Monitoring Plan. Plan prepared by The Bay Foundation for the California Coastal Commission, City of Santa Monica, and California Department of Parks and Recreation. 22 pages.

Acknowledgements
We would like to thank the US Environmental Protection Agency and the Annenberg Metabolic Studio for funding this pilot project, and our partners: the City of Santa Monica and the California Department of Parks and Recreation. Their support will allow us to explore soft-scape protection measures to combat climate change, while bringing back an important coastal habitat to the Los Angeles region.

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Introduction

Background

Over 17 million visitors frequent the beaches of Santa Monica every year. Beaches are broadly recognized and highly valued as cultural and economic resources for coastal regions (Dugan et al. 2015). However their value as ecosystems is often less appreciated. Southern California beach systems and associated wildlife are highly impacted by threats, including native species extirpation and extinction, erosion, non-natural sediment and sand transport through mechanical means, pollution, and loss of natural morphology due to daily vegetation and top soil removal through grooming and other regular maintenance (Dugan et al. 2003). However, these systems also offer essentially the last line of defense in terms of natural "softscape" protection. As a vital part of our coastline, beaches and dunes support and protect our homes, roads, and infrastructure, providing a natural buffer from sea level rise (SLR) as well as from tidal and wave action from the ocean. Beach habitats and dunes are critical in managing sand transport to create resilient beach morphologies, which naturally adapt to climate change impacts. By restoring natural processes to impacted beach systems, we will improve their ecological and utilitarian functions, and serve as a model for similar projects statewide.

Since the 1960s, beaches in the Los Angeles area have been subjected to the continuous removal of natural features as they begin to develop. Mechanical maintenance of beaches has significant impacts on the physical and biological processes of natural beach and dune ecosystems (Dugan et al. 2003, Dugan and Hubbard 2009, Hubbard et al. 2013). Over much of the state, and in many parts of the country, beaches are not frequently groomed, but are instead allowed to develop natural features, such as low dunes away from active recreation areas. These features not only support native, and in many cases, rare and endemic species of plants and animals, they also provide a cost-effective buffer to storm surges and other regular, predictable threats, including SLR and increased erosion.

In addition to providing habitat for avifauna, including Federally-designated "Critical Habitat" (USFWS) for the threatened western snowy plover (*Charadrius nivosus alexandrius*), coastal strand habitats have a varied native vegetation community, including species such as red sand verbena (*Abronia maritima*), dune evening-primrose (*Camissoniopsis cheiranthifolia*), and beach saltbush (*Atriplex leucophylla*), and provide a vital habitat for invertebrate species. Thus, the current condition of groomed and flattened sand with vegetation removed provides almost no habitat value and removes all of the ecosystem services (Dugan et al. 2003, Hubbard et al. 2013, Gilburn 2012). Without vegetation, erosion is more frequent and there is nothing to trap wind-driven aeolian transport of sand (Nordstrom et al. 2011).

Future, restored conditions would include no mechanized 'flattening' of the sand and removal of vegetation. After seeding and planting vegetation, sandy coastal strand habitats and plant hummocks would develop, which would then support higher levels of the ecological community (e.g. invertebrates, birds). Recent scientific literature highlights the need for ecosystem-level, rather than species-level, beach restoration planning to achieve the greatest ecological benefits (e.g. Schlacher et al. 2008).

Project Goals

This pilot project aims to restore approximately three acres of sandy coastal habitats located on the beaches of Santa Monica by utilizing existing sediments to transform a portion of the current beach into a sustainable coastal strand and foredune habitat complex resilient to sea level rise. As an alternative to traditional hardscaping options, this project will evaluate a living, restored shoreline with a diverse wildlife community as an alternate approach to combat climate change.

Another project goal is to bring back a diverse, endemic-rich, coastal plant and wildlife community which has been almost completely extirpated from the Los Angeles region. Returning broad ecosystem functions will create increased protection for coastal infrastructure and residences from sea level rise and erosion while providing a vital refuge for invertebrates, birds, and rare coastal vegetation species.

This demonstration site will also serve as a model for the region, showing that heavy recreational use of beaches and meaningful habitat restoration are not incompatible goals. It will provide not only a scientific basis to develop guidelines and protocols but an integrated, locally-based program for increasing the usefulness of natural environments in a developed area. It will evaluate “soft” low-cost natural shore protection from sea-level rise and storms while providing public benefits and enhancing natural resource values.

Additional benefits of healthy beach ecosystems include, but are not limited to:

- Enhancing a developed coastline
- Critical habitat for rare coastal strand vegetation and invertebrate species
- Habitat for birds, possibly including the threatened western snowy plover
- Food web support
- Familiarizing residents, especially children, with a healthy, natural landscape
- Promoting tourism based on environmental values through unique aesthetic and bird watching opportunities
- Educational opportunities including native plants and healthy beach management practices
- Understanding of a ‘soft-scape’ climate change protection project
- Natural shoreline protection through buffering and absorption of wave energy
- Sea water filtration
- Detrital processing and nutrient recycling

All of these benefits are expected while having low-to-no impact on existing recreational uses of the beach.

Project Description

The pilot project of approximately three acres aims to return a healthy and beautiful ecosystem to Santa Monica State Beach (Figure 1), which in turn, will address climate change issues for both humans and wildlife. This pilot project will use low-lying sand fencing and native plant seeds to restore approximately two out of three acres of a highly impacted beach system (Figure 2). The third acre is comprised of the dry and wet sand shore-ward of the project area that will remain ungroomed (passive restoration through not raking the sand), and the area immediately adjacent to the perimeter of the sand fence, which will also remain ungroomed.

Design aspects will feature curved, flowing, low-lying fence lines, a path through the restoration area, and an unenclosed perimeter along the water's edge. Many of these design components are incorporated to minimize disturbance, and even enhance your interaction with the beach. The site will allow visitors to continue to recreate as well as enjoy the local native flora and fauna that are now absent along the groomed beaches of the Santa Monica Bay.

Seeded specialized coastal strand and foredune vegetation will grow, develop, and begin trapping sand transported by wind. Wind-driven sand will bump into vegetation, fall, and accrete, naturally increasing the elevation of plant hummocks over time to an estimated height of 1-3 feet. Additional trapping of sand will occur through the deployment of sand fencing (Nordstrom et al. 2011). Because beach dunes accrete sediment transported from the ocean they will continue to grow concurrently with rising sea levels. This dynamic process can continue as long as the vegetation community is robust and healthy. This process has repeatedly been demonstrated in the scientific literature as well as in pilot projects in other California counties, such as the Surfer's Point restoration project in Ventura County.

Project implementation will begin in November 2016, and should require approximately 3-4 weeks, including monitoring. It will be followed by post-restoration monitoring for a time period of no less than five years. For more information, details, artistic renderings, and links to public documents and photographs, please visit the project website: http://www.santamonicabay.org/santa-monica-beach-restoration-pilot/.

This project would not be possible without two additional project partners: City of Santa Monica (land managers) and California Department of Parks and Recreation (land owners). We are grateful for their support and enthusiasm for this pilot project. Additionally, we are also grateful for the many proponents and project supporters for this project, including but not limited to: Audubon Society – Santa Monica Chapter, California Native Plant Society, Loyola Marymount University, University of California, Santa Barbara, Cooper Ecological Monitoring, Inc., Coastal Restoration Consultants, Inc., Congress Member Ted Lieu, Assembly Member Richard Bloom, Senator Fran Pavley, Los Angeles World Airport Dune Preserve, Friends of Ballona Wetlands, US Fish and Wildlife Service, Heal the Bay, University of Southern California – SeaGrant, Santa Monica Bay Restoration Commission, Santa Monica Bay National Estuary Program, US Environmental Protection Agency, Patagonia, Council Member Paul Koretz, Girl Scout Troop 10975, Friends of LAX Dunes, Mia Lehrer and Associates, US Green Building Council – LA, beach managers throughout Southern California…. and local residents!

Figure 1. Photograph of the project site at Santa Monica Beach, Santa Monica, CA.

Figure 2. Map of the Santa Monica Beach Restoration Pilot Project location and general vicinity.

Sampling Design

The project area will be divided into two, roughly 1-acre, treatment plots (T1 and T2; Figure 3). The treatment plots are separated by a curved path, bordered by a symbolic rope fence. The exterior perimeter (except for the ocean-ward side) will be surrounded by a low-lying sand fence (not to exceed 3 feet in height). Each treatment plot will be further subdivided into four quadrants for analysis, though there will be no physical barriers within the treatment plots. This subdivision will allow for an experimental treatment design.

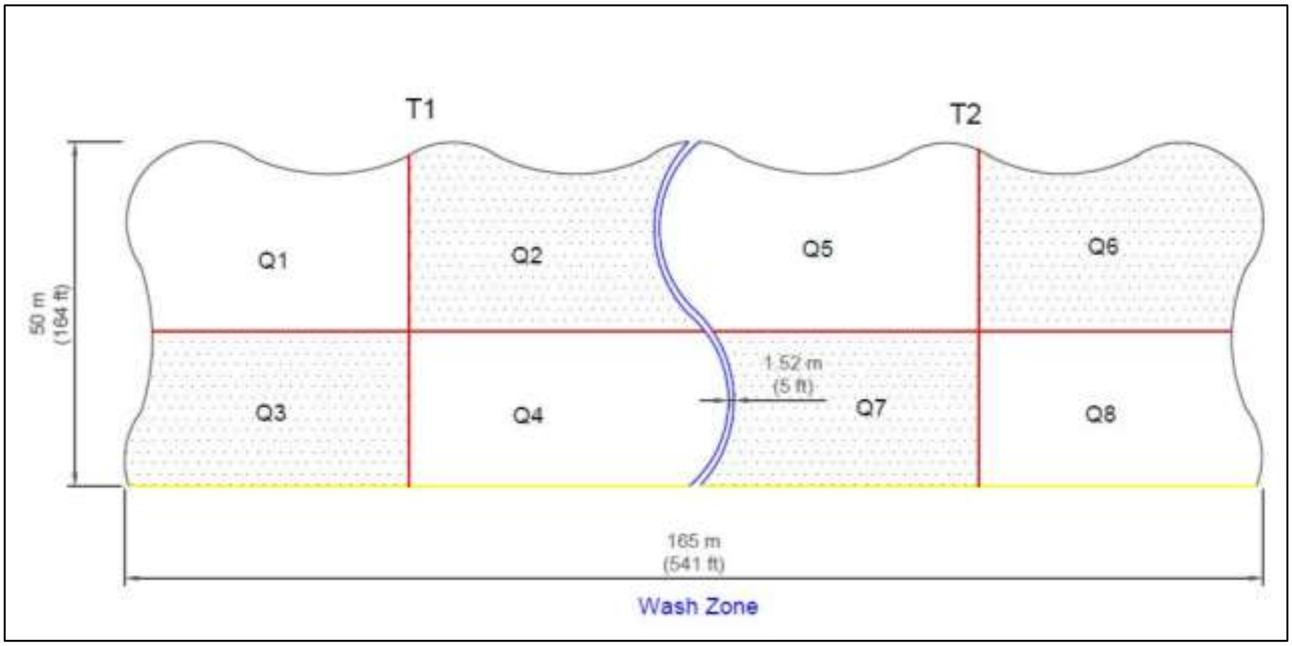

Figure 3. Restoration site graphic design, including two treatment plots (T1 and T2).

Permitting, implementation, and post-restoration maintenance and monitoring will be coordinated and conducted by The Bay Foundation (TBF) and consultants.

Permitting

TBF, in coordination with the City of Santa Monica (City) and California Department of Parks and Recreation (DPR), has obtained the necessary permits to implement the Santa Monica Beach Restoration Pilot Project. Approval from the City at a public City Council meeting in the form of a Memorandum of Understanding (MOU) and restoration site plan stamped and approved by the Planning Department was obtained prior to the submittal of a Coastal Development Permit application to the California Coastal Commission (Commission). Additionally, a CEQA exemption was filed and obtained by the City to implement this project.

In October 2016, the Commission approved permit application No. 5-16-0632 with the following special conditions:

1) An assumption of risk, waiver of liability and indemnity;
2) Limited development authorization period;
3) Dune habitat creation plan;
4) Public access requirements; and
5) Permit compliance.

Permit condition 1 includes a waiver signed by the City and DPR. Regarding permit condition 2, CDP (No. 5-16-0632) authorizes the approved beach restoration project for a period of five years from the date of Commission action. After such time, the authorization for continuation and/or retention of the approved fencing, signage, and active management of the dune habitat shall cease, unless the applicants submit an amendment to this permit, or new CDP application to the Commission, and that amendment or permit is approved, thereby extending the time period for the development. The dune habitat created pursuant to the permit may remain in place. The third permit condition is met by this Implementation and Monitoring Plan. Permit conditions 4 and 5 will be met throughout the duration of the project.

Lastly, coordination and communications are ongoing with federal and state agencies with an interest in this project, beach management, and/or wildlife (e.g. US Fish and Wildlife Service). All annual reports for this project will be made publically available on The Bay Foundation's website: www.santamonicabay.org.

Implementation

Implementation of this project will occur during the winter/rainy season to allow for natural germination and establishment of native seeds during the winter rains. The proposed project is not anticipated to adversely affect the seasonal California grunion run and egg incubation period which ranges from March 1st through August 31st. Best beach management practices that restrict beach grooming (raking) during grunion spawning will continue as before.

Implementation of this project will occur in two phases, detailed below:

1) Installation of fencing, including the perimeter sand fence and symbolic (rope and post) pathway fence, and
2) Native coastal strand and dune vegetation seeding.

Sand Fence Installation

Sand fencing will be installed to facilitate the establishment of dune hummocks. No sand fencing will be installed on the seaward perimeter of the dune area. The sand fencing will be no more than 36 inches (3 feet) in height above the sand, and it will be designed to be removable in the event of significant storm events or emergencies. T-posts will be used to stabilize wood sand fence panels.

A symbolic post and rope fence will be installed through the center of the project site to accommodate an approximately 5 feet wide by 164 feet long sandy trail which will serve to provide public access to the shore. The post and rope fence will be no more than 36 inches (3 feet) in height and designed to be removable in the event of significant storm events or emergencies.

Hand-Seeding of Native Plants

Seed will be sourced from S&S Seeds, who have over 30 years of experience with California native wildland seed and have provided seed for coastal dune, bluff, and wetland habitat restoration projects across all of California. TBF consulted with experts and S&S Seeds to develop a specialized plant pallet and custom seed mix design specific to local coastal strand habitat. Table 1 outlines the four species included in the custom seed mix along with the proposed seeding rate and number of pure live seeds per pound. Each of the coastal strand habitat plant species are discussed in detail below. Native plant species characteristics and growing patterns were taken from CalFlora (www.calflora.org) and S&S Seeds databases.

Table 1. Custom seed mix design by species.

Species Name	Common Name	Lbs / Acre	Number of Pure Live Seeds / Lb.
Camissoniopsis cheiranthifolia	beach evening primrose	0.10	2,441,000
Abronia maritima	sand verbena	12.00	16,000
Ambrosia chamissonis	beach bur sage	6.00	40,000
Atriplex leucophylla	sea scale	2.00	73,600

Camissoniopsis cheiranthifolia (beach evening primrose) is a perennial native to California and is a low-lying shrub that provides good ground cover and soil/dune stabilization. This plant species is native to open dunes and sandy soils, growing prostrate along the beach surface and forming mats. Typically blooming from as early as January to the end of August, beach evening primrose features small solitary bright yellow flowers, and is tolerant to low water conditions, surviving year round on seasonal winter rains and ocean spray (Figure 4).


Figure 4. *Camissoniopsis cheiranthifolia* (beach evening primrose) [CalFlora: L. Watson 2007 (Left) and J. Pawek 2013 (right)].

Abronia maritima (Sand verbena) is a beach-adapted perennial, native to the coastlines of southern California, including the Channel Islands, and northern Baja California. Sand verbena is a mat-like herb growing under 1 foot, with fleshy leaves, and clustered pink to purple flowers which bloom in the Spring and Summer (Figure 5). Sand verbena was chosen for its association with fore-dune habitats and ability to stabilize sand and create small dunes as well as its characteristics of high salt tolerance and low water requirements.


Figure 5. *Abronia maritima* (Sand verbena) [CalFlora: G.A. Monroe 2010 (Left) and L. Watson 2007 (right)].

Ambrosia chamissonis (beach bur sage) is a low-lying perennial herb native to California's coastline. This plant species is commonly found along the coastline and dune environments and produces tiny clustered blooms from June to July (Figure 6). Beach bur sage has a high salt tolerance, low water requirement, and is conducive for sand stabilization and dune formation.

Figure 6. *Ambrosia chamissonis* (beach bur sage) [CalFlora: N. Kramer 2008 (left) and M. Bors 2008 (right)].

Atriplex leucophylla (sea scale) is a perennial herb native to the sandy beaches and dunes of the California coastline. Like the other species in the seed pallet, sea scale has a high salt tolerance and low water requirement, with the capability of surviving harsh dynamic coastal environments. Sea scale forms low-lying mats that spread up to 3 feet and blooms from April to October with tiny inconspicuous green flowers (Figure 7).

Figure 7. *Atriplex leucophylla* (sea scale) [CalFlora: (left) and Z. Akulova 2015 (right)].

The combined seed mix with all four species will be distributed across the restoration site using a broadcast hand seeder. The combined seed mix will be spread at a rate of 20.1 pounds per acre and will be immediately raked into the sand. The restoration site fence placement and symbolic pathway are shown in Figure 8. Treatment 1 (T1) and Treatment 2 (T2) identify the North and South sections, respectively, of the restoration area, separated by the symbolic pathway. T1 and T2 are further segmented into quadrants. Sterile, weed-free, straw punching by hand will occur in four quadrants across the restoration site (Q2, Q3, Q6, and Q7). The purpose of the straw punching is to increase the stabilization of the sand and to scientifically monitor and compare different restoration techniques and document the rate of sand accretion and dune formation, as well as seed germination success.

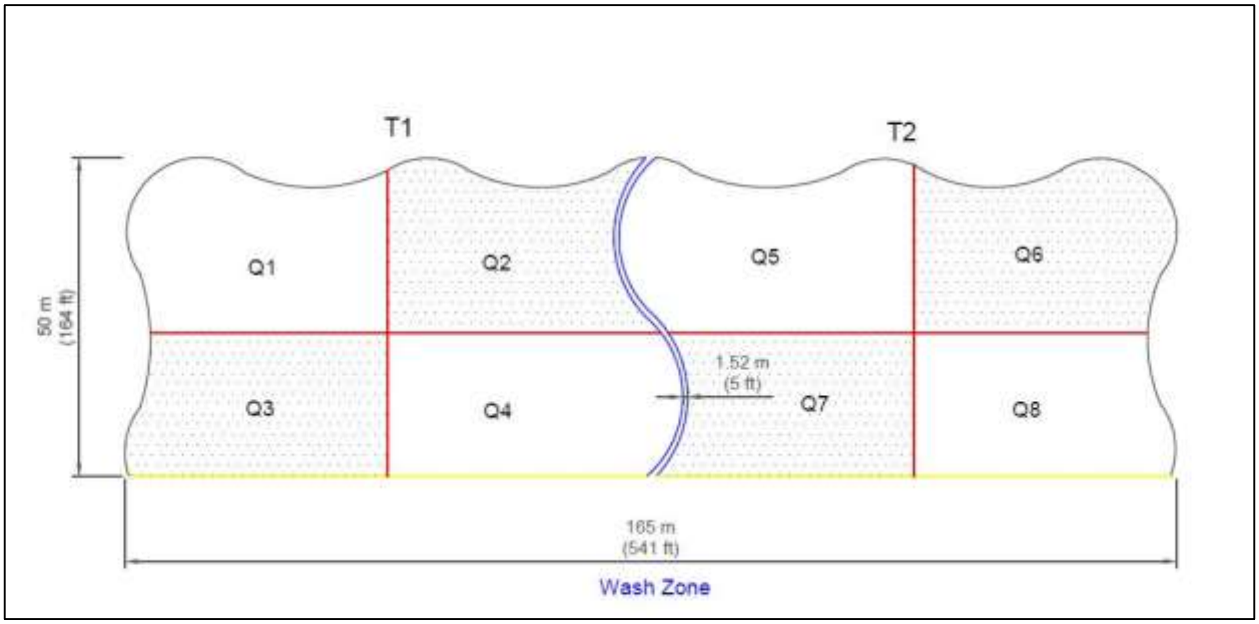

Figure 8. Restoration site graphic design, including two treatment plots (T1 and T2).

Adaptive Management

Adaptive management may be implemented based on the success of the project as interpreted by the beach managers and the City of Santa Monica. The monitoring components and resulting data will be integral in determining the success of the project both from a socio-economic and ecological perspective. TBF, with the help of our existing volunteer internship program, will also undertake a hands-on, community-level maintenance strategy without the use of mechanized equipment, including trash removal and invasive species removal throughout the implementation of the project and for a duration of no less than ten years afterwards. Evaluation of the project will occur annually via an annual report and will be provided to the City, DPR, and the Commission and will be made publically available.

Scientific Monitoring

Accurate and robust scientific monitoring is a vital part of any restoration project. Monitoring is used to assess successful project implementation; for example, in this project, monitoring will allow an assessment of accretion rates of sand and elevation increases to combat sea level rise. TBF will be implementing a biological, physical, and human use monitoring plan before the restoration to collect baseline data, for the duration of the restoration project, and several years afterwards to assess success. Additional “control” data along the adjacent unrestored beach will be collected as part of a before-after-control-impact ecological assessment monitoring program. Specialist scientists such as ornithologists and botanists are partners in this project and will use their expertise to advise both the monitoring program and its implementation. Data will be collected for up to ten years to evaluate the ecological health of the created coastal strand ecosystem and its potential for long-term adaptation to accelerated rates of sea level rise.

A rigorous scientific monitoring plan will allow for the evaluation of completed restoration activities. Table 2 summarizes the monitoring sampling design. It lists nine major parameters, the primary protocol(s) which will be implemented for each parameter, and the frequency of implementation.

Pre-restoration baseline monitoring will occur prior to the implementation of the restoration project to allow a comparison of the pre- and post-project conditions of the area. Ongoing implementation monitoring will occur throughout the duration of the restoration activities to adaptively manage and avoid impacts to native plant and wildlife species. Post-restoration monitoring will occur after restoration activities are concluded and will allow a scientific evaluation of the successes and challenges of the implementation strategies. Additionally, post-restoration data will contribute meaningful information towards adaptively implementing re-vegetation activities. It will allow for a thorough scientific evaluation of restoration efforts.

Figure 9. Photo taken during field site visit in September 2015.

Table 2. Description of protocols to be implemented during pre-restoration baseline monitoring, post-restoration evaluation monitoring, and their minimum frequency of occurrence.

Parameter	Protocol	Frequency
Photo Point	TBF SOP 7.2	Quarterly
Avifauna (+ pollinator presence)	Visual presence / behavior surveys; TBD if plover nesting	Semi-annually; Audubon: monthly
Wrack Cover	Percent cover, composition by species, average depth	Quarterly
Vegetation Cover	Selective mapping, fixed cover class quadrats along t-sects	Quarterly
Seedling Density	Fixed quadrat density counts	Semi-annually
Invertebrates	Cores along transects using 1mm mesh bags as sieve	Semi-annually
Grunion	Protocols follow www.grunion.org, and use the Walker Scale	Two times during grunion season
Physical Characteristics	Elevation profiles, cross-sections, beach width, distances from fence to berm, beach slope, hummock heights	Quarterly
Weather Conditions	Wind speed (Kestrel), max wind speed, air temperature, precipitation data (NOAA)	Quarterly
Sand Deposition	MWAC method (Goossens et al 2000)	Quarterly
Sediment Grain Size	Sieve method	Semi-annually
Site Checklist	Fence condition, trash presence and type, etc. (1-pg checklist datasheet)	Quarterly
Human Use	Visual presence / behavior surveys	Semi-annually; Audubon: monthly

Individual Protocol Details

Each of the following subsections summarizes an individual protocol to be implemented as part of the monitoring program. For in depth details on objectives, equipment, field preparation, field methods, quality control check procedures, and datasheets, refer to the individual Standard Operating Procedures listed below within the California Estuarine Wetland Monitoring Manual, publically available for free download: http://www.santamonicabay.org/california-estuarine-wetlands-monitoring-manual-level-3/. Additionally, some protocols were adopted from Dugan et al. 2015 Final Report: Baseline Characterization of Sandy Beach Ecosystems along the South Coast of California.

Photo-Point

Photo point monitoring will occur to identify seasonal site changes or project-level changes as a result of the restoration activities (e.g. native vegetation growth, plant hummock formation). Survey methods are described in detail in SOP 7.2 Level 2 Photo Point (TBF 2015a). A minimum of eight permanent photo point locations will be established during baseline monitoring and the locations recorded using a GPS. Photographs can be used as qualitative assessments of broad-scale changes following restoration activities and plant hummock development over time.

Wrack Cover

Wrack cover surveys will be conducted to determine the percent cover, composition by species, and average depth of macrophyte wrack in the wash zone area directly in front of the restoration site and control site. A total of four line-intercept transects will be surveyed, consisting of two transects in the wash zone directly in front of the restoration site and two transects in the wash zone of the control areas (outside the project area). These transects will also record any trash, tar, driftwood, or other detritus in a similar manner. Surveys will occur prior to and immediately following restoration implementation, and will be continued quarterly for a period no less than five years. The wash zone is a dynamic area, therefore, transect locations may vary over surveys.

Vegetation Cover

Vegetation cover surveys can be used to provide a wide range of information and data, including: summarizing the prevalence of native and non-native plant cover, determining species cover, relative species richness and diversity, and assessing canopy height. The primary objective of the transect- and quadrat-level cover surveys for this project is to assess the approximate cover of native coastal strand vegetation over time. A minimum of two transects in each treatment plot will be surveyed and four transects outside, but immediately adjacent to, the project area.

The transect survey methods are described, along with field data sheets, in SOP 3.2 Vegetation Cover Surveys (TBF 2015b). Line-Intercept Transects document every species observed directly below the transect tape where the vegetation crosses a minimum of 0.01 m (or 1 cm). This transect survey method is useful when collecting vegetation cover data in patchy habitats or those with a significant amount of bare ground (or sand). Line-intercept data will be summed by species and divided by the total length of transect to determine percent cover for each transect. Cover Class Quadrat surveys will be conducted using 1 m^2 PVC quadrats subdivided into 16 sub-quadrats. Ten fixed-location quadrats will be surveyed along each transect. Cover class species data will be analyzed using the median of each Daubenmire cover category and averaged to determine percent cover within each transect with variability represented as standard deviation or error (TBF 2015b).

Seedling Density

A seedling density survey will be conducted within the project site and compared to the control areas immediately adjacent to the project. This quantitative assessment method will allow for a post-restoration evaluation of germination success of native coastal strand and foredune plant species. Individual seedlings will be counted within randomly selected quadrats as part of the Cover Class Quadrat vegetation cover assessment method. Data will be presented as germinated seedlings per square meter categorized by species and nativity, following assessment procedures described in SOP 3.4 Seed Bank Germination (TBF 2015c). Seedling density will be determined by adding the total number of individuals of each species in all quadrats per area and dividing by the total area of all the quadrats surveyed to determine density (e.g., Species A, 100 seedlings / 10 m^2 = 10 seedlings/m^2). Photographs of each quadrat will also be collected concurrently.

Invertebrates

Invertebrate data will be collected using techniques described in detail in Dugan et al. 2015. Common examples of macroinvertebrate indicator taxa in Southern California include talitrid amphipods such as *Megalorchestia,* and the common sand crab, *Emerita analoga.* Invertebrates will be sampled once in spring and once in the fall of each survey year to capture and evaluate the intertidal and associated invertebrates in the wash zone and coastal strand communities. A minimum of one transect (perpendicular to the ocean) in each treatment plot and two adjacent (control) transects will be surveyed during each of the two survey seasons. Quantitative sampling will begin approximately 10 m east of the eastern fence line, bisect the treatment plot, and extend to the lowest level exposed by swash of the intertidal sands at each location. The distances between transects will be greater than 10 m to allow for a buffer zone in between transect locations as walking adjacent to transects can significantly affect invertebrate densities.

Each transect will be divided into zones based on physical characteristics of the beach (e.g. vegetated habitat, upper intertidal, swash zone, etc.) and ten cores will be collected from each zone on each transect. A cylindrical core (0.0078 m^2, 10 cm diameter) will be taken to a depth of 20 cm at uniform intervals that will vary depending on the width of the beach zone. The 10 cores from each of the zones will be placed in a mesh bag with an aperture of 1.5 mm for sieving. Most species of macroinvertebrates that are likely to be prey of shorebirds are retained on a 1.5 mm sieve (Dugan et al. 2015). Sediments will be removed from the accumulated core samples from each of the zones by sieving in the swash zone.

Invertebrate samples will be retained in plastic bags, chilled on ice in a cooler, and transported to the laboratory at Loyola Marymount University for preservation and processing, or an equivalent partner University with experience identifying sandy beach invertebrates (e.g. University of California Santa Barbara). Samples without polychaetes may be frozen, but samples with polychaetes should be preserved in seawater and buffered formalin for identification. Invertebrates will be identified, enumerated, and size class estimated.

Grunion

California grunion are a species of marine fish found only along the coast of southern California and northern Baja California. They exhibit unique spawning behavior, laying and fertilizing eggs completely out of the water, on high spring tides along sandy beaches (Martin 2006). Grunion spawn between March and August, with peak events between April and June. Grunion surveys will be conducted at least twice during the spawning season following standardized protocols and datasheets found at http://grunion.org/sighting.asp. These surveys use the Walker Scale (W-0 through W-5) to estimate the abundance and activity of the grunion during spawning events. Data will be submitted through the online portal at www.grunion.org).

Avifauna (and pollinator presence)

The presence and distribution of avifauna within an ecosystem is often used as an index of habitat quality due to their diet and vulnerability to environmental conditions (Conway 2008). Avifauna data are useful to characterize representative avian assemblages and spatial distributions within a particular area. Bird survey methods are described in detail, along with field data sheets, in SOP 5.1 Bird Abundance-Activity (TBF 2015d). The primary purpose of avifauna surveys for this project is to provide a general understanding of the bird community and corresponding behavior in the restoration area before and after restoration.

Bird surveys will be conducted at multiple times throughout the day corresponding to one low and one high tide survey during each set of surveys. This will allow for the collection of data on both roosting (high tide) and foraging (low tide) bird activities. This survey will be performed by an ornithologist and will entail both observational visual and auditory bird surveys. Additionally, breeding or nesting activity of birds will be recorded and, if present, will require the immediate delay of any restoration activities within the project area. Lastly, presence of various species of pollinators such as butterflies or bees will also be recorded as part of these surveys.

Physical Characteristics

Physical characteristics will be collected using techniques described in detail in Dugan et al. 2015. To physically characterize the beach, surf, and swash zones, measurements will be taken of the beach width from the fence edge to the lowest intertidal level exposed by swash, locations of the water table outcrop (WTO) and high tide strand line (HTS) and beach slope at these two locations. These measurements will be collected along one transect perpendicular to the ocean in each treatment plot, and along two transects (one on either side) outside the project area. In addition, surf zone wave height and period, and swash width and period will be visually estimated. Any vehicle tracks on the beach, including grooming marks and categorical estimates of the number of recent footprints in the sand made by people or other readily identifiable animals were also noted. The physical characteristic surveys will also include a “site checklist” which will collect data on things like fence condition, trash presence and type, etc.

Weather Conditions

Average air temperature, wind speed, and maximum wind speed (over three minutes) will be recorded at the middle of each transect using a small, hand-held weather meter (Kestrel®). Precipitation data will be downloaded quarterly for Santa Monica Beach from NOAA weather.

Sand Deposition

Sand deposition is an important component of this monitoring plan, as it will allow for an evaluation of the sand accretion over time, and may provide a proxy for potential plant hummock development. Sand deposition will be calculated using the third sampling method described in Goossens et al. (2000): *Sampler 3: MWAC*. The MWAC sampler consists of a plastic bottle, acting as a settling chamber, to which an inlet tube and an outlet tube have been added. The bottle is installed vertically, with the inlet oriented towards the wind. Sand entering the bottle will be deposited due to the pressure drop created by the difference in diameter between the bottle and the inlet and outlet tubes. MWAC samplers will be deployed for a fixed amount of time, allowing for a calculation of sand accumulation.

Sediment Grain Size

Sediment grain size will be collected using techniques described in detail in Dugan et al. 2015. Average sediment grain size will be determined from sand samples taken at the WTO and HTS of each transect. Sediments will be rinsed in fresh water to remove salt residue, dried to constant weight and then shaken through a series of sieves with a variety of screen aperture size (in microns) to determine the relative abundance of sand in each size class. The geometric mean and standard deviation will be calculated for each sample.

Volunteer Event Data

Volunteer event data will be collected for all public restoration events or tours, including the date of the event, the number of participants, hours worked, and any incidental useful supplemental information such as the school and age group, zip code, other demographics, etc.

Maintenance

Site visits will be conducted quarterly for a period of no less than two years to visually assess the restoration progress and evaluate the need for maintenance activities. The overall condition of the restoration areas will be noted, along with detailed observations including presence of invasive species re-growth or environmental stressors (e.g. prolonged dry periods). Photographic documentation of any observations of concern will occur. If invasive vegetation is found in a restored area, adaptive management steps such as weed removal with hand tools may need to be taken. Similarly, litter or trash collection and removal from site will be conducted at least monthly.

Reporting

Collected data will be entered into excel (or equivalent) datasheets and quality control checks will be performed. A publically-available annual report will be compiled and produced at the culmination of each year of work. A year of work is approximately between the beginning of September through end of August each year. It will be published on The Bay Foundation's website: www.santamonicabay.org, on the Technical Report page. Each annual report will contain summary details on restoration activities and monitoring results as well as photographs documenting the restoration activities over time. Annual reports will be published for a minimum of five years.

Literature Cited

Conway, C. 2008. “Standardized North American Marsh Bird Monitoring Protocols.” Arizona Cooperative Fish and Wildlife Research Unit, Wildlife Research Report 01.

Johnston, K.K., Medel, I.D., Anderson, S., Stein, E., Whitcraft, C., and Crooks, J. 2015b. California Estuarine Wetland Monitoring Manual (Level 3). Prepared by The Bay Foundation for the United States Environmental Protection Agency. pp 297.

TBF. 2015a. Level 2 Photo Point Standard Operating Procedures (SOP 7.2). Unpublished protocols. The Bay Foundation, Los Angeles, CA. 30 June 2015.

TBF. 2015b. Vegetation Cover Surveys Standard Operating Procedures (SOP 3.2). Unpublished protocols. The Bay Foundation, Los Angeles, CA. 30 June 2015.

TBF. 2015c. Vegetation Seed Bank Standard Operating Procedures (SOP 3.4). Unpublished protocols. The Bay Foundation, Los Angeles, CA. 30 June 2015.

TBF. 2015d. Bird Abundance and Activity Standard Operating Procedures (SOP 5.1). Unpublished protocols. The Bay Foundation, Los Angeles, CA. 30 June 2015.

Dugan, J.E., D.M. Hubbard, and G. E. Davis. 1990. Sand Beach and Coastal Lagoon Monitoring Handbook. Channel Islands National Park California. Prepared for the National Park Service, Ventura, California. 50 pp.

Dugan, J.E., D.M. Hubbard, M. McCrary, M. Pierson. 2003. “The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California.” Estuarine, Coastal and Shelf Science 58S: 25-40.

Dugan, J.E., Hubbard, D.M., Rodil, I.F., Revell, D.L., and Schroeter, S. 2008. Ecological effects of coastal armoring on sandy beaches. 2008. Marine Ecology. 29(1): 160-170

Dugan, J.E., D.M. Hubbard. 2010. “Loss of coastal strand habitat in southern California: the role of beach grooming.” Estuaries and Coasts, 33(1): 67-77.

Dugan, J.E., D.M. Hubbard, K.J. Nielsen, J. Altstatt, and J. Bursek. 2015. Final Report: Baseline Characterization of Sandy Beach Ecosystems along the South Coast of California. Prepared for the South Coast Marine Protected Area Baseline Program. 134 pp.

Gilburn, A.S. 2012. “Mechanical grooming and beach award status are associated with low strandline biodiversity in Scotland.” Estuarine, Coastal and Shelf Science. 107:81-88

Grifman, P.M., J.F. Hart, J. Ladwig, A.G. Newton Mann, M. Schulhof. 2013. “Sea Level Rise Vulnerability Study for the City of Los Angeles.” USCSG-TR-05-2013.

Goossens, D. Z. Offer, and G. London. 2000. Wind tunnel and field calibration of five aeolian sand traps. Geomorphology 35: 233-252.

Hubbard, D.M., J.E. Dugan, N.K. Schooler, S.M. Viola. 2013. Local extirpations and regional declines of endemic upper beach invertebrates in southern California. http://dx.doi.org/10.1016/j.ecss.2013.06.017

Martin, K. 2006. Introduction to Grunion Biology. www.grunion.org. 4 pp.

National Oceanic and Atmospheric Administration Coastal Services Center, 2012. Incorporating Sea Level Change Scenarios at the Local Level, a companion report for Technical Considerations for Use of Geospatial Data in Sea Level Change Mapping and Assessment.

* Nordstrom, K.F., Jackson, N.L., and Korotky, K.H. 2011. "Aeolian transport across beach wrack." Journal of Coastal Research. 1(59):211-217

* Nordstrom, K.F., Jackson, N.L., Korotky, K.H., and Puleo, J. 2011. "Aeolian transport rates across raked and unraked beaches on a developed coast." Earth Surfaces, Processes, and Landforms. 36:779-789

* Nordstrom, K.F., Jackson, N.L., Freestone, A.L., Korotky, K.H., and Puleo, J. 2012. "Effects of beach raking and sand fences on dune dimensions and morphology." Geomorphology. 179:106-115

Schlacher, T.A, Dugan, J., Schoeman, D.S., Lastra, M., Jones, A., Scapini, F., McLachlan, A., and Defeo, O. 2007. "Sandy beaches on the brink." Diversity and Distributions. 13:556-560

* United States Fish and Wildlife Service (USFWS). 2007. "Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*)." In 2 volumes. Sacramento, California. xiv + 751 pages.

Western Snowy Plover (National Geographic 2016)

Santa Monica Beach (TBF 2015)