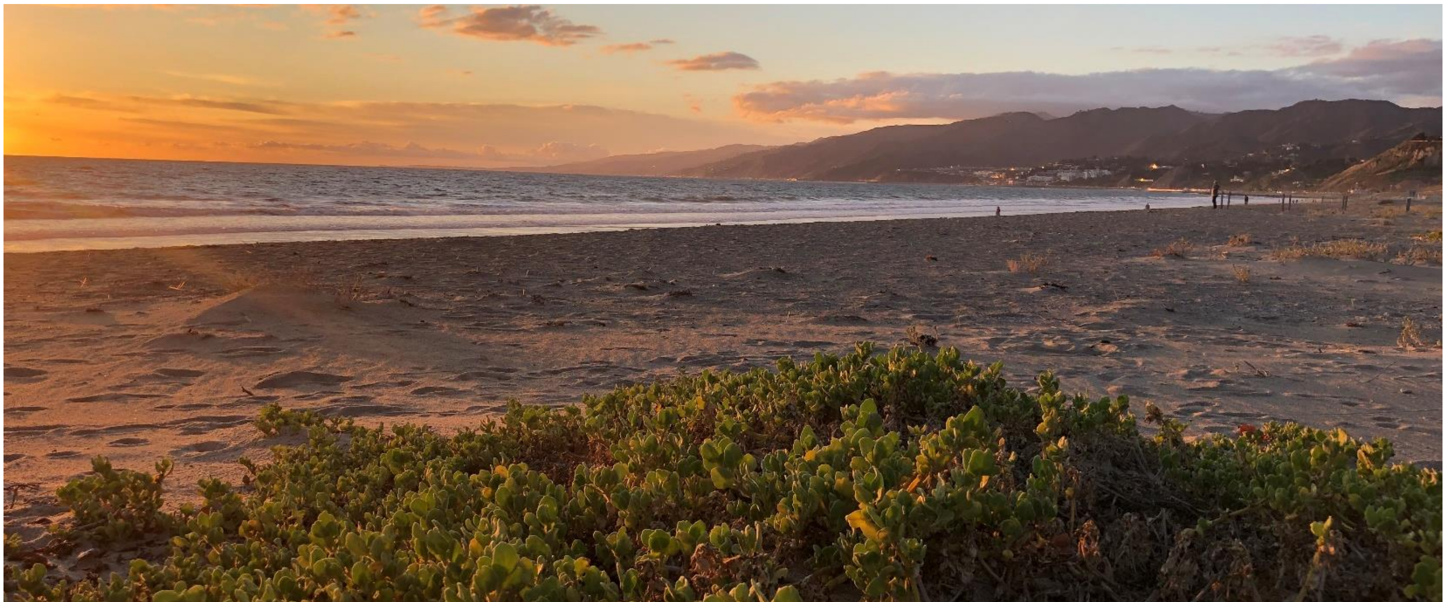

Santa Monica Beach Restoration Pilot Project

Year 4 Annual Report

September 2020

Prepared for:
City of Santa Monica
California Coastal Commission
US Environmental Protection Agency
California Department of Parks and Recreation

The Bay Foundation
8334 Lincoln Blvd. #310
(888) 301-2527
www.santamonicabay.org

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Prepared by: The Bay Foundation

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City of Santa Monica, California Coastal Commission, US Environmental Protection Agency, California Department of Parks and Recreation

Authors:

Karina Johnston, Chris Enyart, Karina Alvarez, and Hanna Weyland, The Bay Foundation

Scientific Contributors:

David Hubbard, Coastal Restoration Consultants, Inc.
Dr. Jenifer Dugan, University of California Santa Barbara
Dr. John Dorsey, Loyola Marymount University's Coastal Research Institute
Dan Cooper, Cooper Ecological Monitoring, Inc.
Dr. Karen Martin, Pepperdine University
Dr. Sean Anderson, California State University Channel Islands
Dr. Guangyu Wang, Santa Monica Bay Restoration Commission
Evyan Sloane, California State Coastal Conservancy

Suggested Citation:

Johnston, K., C. Enyart, K. Alvarez, and H. Weyland. 2020. Santa Monica Beach Restoration Pilot Project: Year 4 Annual Report. Report prepared by The Bay Foundation for City of Santa Monica, California Coastal Commission, US Environmental Protection Agency, and California Department of Parks and Recreation. 100 pages.

Acknowledgements

We would like to thank the US Environmental Protection Agency and the Metabolic Studio (Annenberg Foundation; Grant 15-541) for funding the implementation of this pilot project, and our partners: City of Santa Monica and California Department of Parks and Recreation. Their support has allowed us to explore soft-scape protection measures to increase coastal resilience, while bringing back an important coastal habitat to the Los Angeles region. Thanks also to the students and interns with Loyola Marymount University's Coastal Research Institute who contributed many hours to implementation and monitoring. We would also like to thank the many supporters of this project and members of the public, without whom it would not have happened.

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Executive Summary

This report summarizes activities for the Santa Monica Beach Restoration Pilot Project from December 2015 through August 2020. The restoration was implemented in two phases over the course of two weeks in December 2016 including the installation of fencing and seeding of native coastal strand vegetation species. For details on the implementation efforts and prior monitoring, please reference prior reports (Johnston et al. 2017, 2018, 2019). Post-restoration physical and biological monitoring has occurred since 2016 and is ongoing. As the project was meant to be an experimental pilot for the region, no specific, quantifiable success criteria were set; however, the project can be evaluated against its ability to meet the project goals. The project positively engaged the public, created new partnerships and outreach connections, restricted grooming in an approximately 3-acre area, allowed vegetation to grow, encouraged sand hummocks to form along fence lines and within the project area, provided comprehensive science-based monitoring data to inform nature-based beach restoration solutions, and is bringing back a rare coastal habitat type to the Los Angeles region.

Additionally, the increased functions within the restoration habitat area included benefits to several notable species. Nesting of the federally threatened western snowy plover had not been recorded in the Los Angeles region for almost 70 years, and the first nest for the Los Angeles region was found in April 2017 within the restoration area and contained three eggs. Plovers have been repeatedly identified on bird surveys throughout all three survey years, where previously they had not been documented on site. Furthermore, a new native plant species, possibly a rare variant of woolly heads (*Nemacaulis denudata*), was identified as germinating in the project area in 2017 and was identified in all future years. As the seeds of this species are not sold by the seed provider, it is probable that there was either an existing seed bank for this species already along Santa Monica Beach, or that it was transported by wind, waves, birds, or humans. It was not identified in areas adjacent to the project site. Another native plant, pink sand verbena (*Abronia umbellata*) was also identified on site and was not seeded. Another biological addition to the restoration project area found in surveys from 2017 through 2020 were dune beetles, which provide an increased layer of the food web available to foraging birds and wildlife.

Data suggest that the restoration area is considerably different from both the control sites and from itself over time as compared to the baseline surveys, especially for increased vegetation cover and changes in sand morphology. Absolute vegetation cover continues to increase slowly over time, to a maximum in Year 4 of nearly 7% native cover, with patches of dense vegetation interspersed with bare sand, similar to natural coastal strand habitats. It is likely that the vegetation community will continue to establish over time, but will probably remain patchy, as is the trend for coastal strand habitats. Elevation data continued to show differences between restoration site transects and controls. Whereas the control (groomed) areas were flattened and uniform; in the restoration area, small dune hummocks, increases in berm height, and sand retention was persistent between seasons and years within the restoration area. Adaptive management in the form of supplemental seeding and fencing is being considered for implementation in Year 5.

The variability of the berm over time and the notable increases in elevation along the fenced perimeters, oceanward berm, and throughout the restoration area surrounding patches of vegetation suggest that longer periods of time for scientific evaluation for these parameters will also allow for

additional trends to be defined. Future monitoring will continue to inform sand morphology within the restoration site in response to vegetation growth, fence placement, and seasonal changes from storms, king tides, and wave energy. Additionally, elevation profile and topographic data will continue to provide information to understand the effects of sand grooming versus the development of natural beach morphology over time. For more information, details, artistic renderings, and links to public documents, reports, and photographs, please visit the project website.

Figure ES-1. Post-restoration site photographs taken in Year 4 on 11 June 2020.

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 nature-based protection as components of a living shoreline. 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 buffer climate change impacts. By restoring natural processes to impacted beach systems, we 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” (US Fish and Wildlife Service) 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*), beach 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 for most of the beaches in Los Angeles and the Santa Monica Bay 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).

Restored conditions of the beach include no mechanized ‘flattening’ of the sand and removal of vegetation. After seeding and planting vegetation, sandy coastal strand habitats and plant hummocks are forming, which 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). This project represents one example of that model.

Project Goals

This pilot project restored approximately three acres of sandy coastal strand habitat 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 continue to evaluate a living, restored shoreline with a diverse wildlife community as an alternate approach to combat climate change (Figure 1).

Another project goal was to assist in bringing back a native, diverse, endemic-rich, coastal plant and wildlife community which has been almost completely extirpated from the Los Angeles region. Enabling the return of 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 continues to 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 also evaluates "soft" low-cost nature-based shore protection from sea-level rise and storms while providing public benefits and enhancing natural resource values. All these benefits are also evaluated in the context of existing recreational uses of the beach.

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
- Familiarizing residents, especially children, with a healthy, natural landscape
- Promoting tourism 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 and food web support
- Detrital processing and nutrient recycling

Figure 1. Photograph of the oceanward portion of the restoration area on 21 January 2020.

Project Description

The pilot project of approximately three acres aims to return a healthy and beautiful ecosystem to Santa Monica State Beach (Figure 2), which in turn, will help evaluate and address climate change issues for both humans and wildlife. This pilot project used low-lying sand fencing and native plant seeds to actively restore approximately two out of three acres of a highly impacted beach system (Figures 3, 4, 5, and 6). The third acre is comprised of the dry and wet sand shore-ward of the project area that remained ungroomed (passive restoration through not raking the sand), and the area immediately adjacent to the perimeter of the sand fence, which also remained ungroomed.

Design aspects feature curved, flowing, low-lying fence lines, a path through the restoration area, and an unenclosed perimeter along the water's edge – all components requested by various members of the public during the first few months of outreach about the project. Many of these design components were incorporated to minimize disturbance, and even enhance different forms of interactions and recreation along the beach. The site allows visitors to continue to recreate as well as enjoy the local native flora and fauna that are currently absent along the groomed beaches of the Santa Monica Bay.

Specialized coastal strand and foredune vegetation was seeded and is currently growing, developing, and trapping sand transported by wind. Wind-driven sand bumps into vegetation, falls, and accretes, naturally increasing the elevation of plant hummocks over time. Additional trapping of sand has occurred through the deployment of sand fencing. Because beach dunes have the potential to accrete sediment transported from the ocean they could 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. Long-term monitoring will define trends at this site.

Project implementation began in November and December 2016, and required approximately three weeks, including monitoring. It is being followed by post-restoration monitoring for a time period of no less than five years. This report details results of the fourth year of monitoring (Year 4). For more information, details, artistic renderings, maps, 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 have been possible without two additional project partners: City of Santa Monica (land managers) and California Department of Parks and Recreation (land owners). We are very grateful for their support and enthusiasm in the implementation of this pilot project. Additionally, we are also grateful for the many proponents and supporters of this project, including but not limited to: Audubon Society – Santa Monica Chapter and Los Angeles Chapter, Loyola Marymount University, Coastal Research Institute (CRI), University of California Santa Barbara, Cooper Ecological Monitoring, Inc., Coastal Restoration Consultants, Inc., California Native Plant Society, Congress Member Ted Lieu, Assembly Member Richard Bloom, Senator Fran Pavley, Los Angeles World Airports, 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, Studio-MLA, US Green Building Council – LA, beach managers, and many local residents.

Figure 2. Photograph of the project site prior to restoration at Santa Monica Beach, Santa Monica, CA.

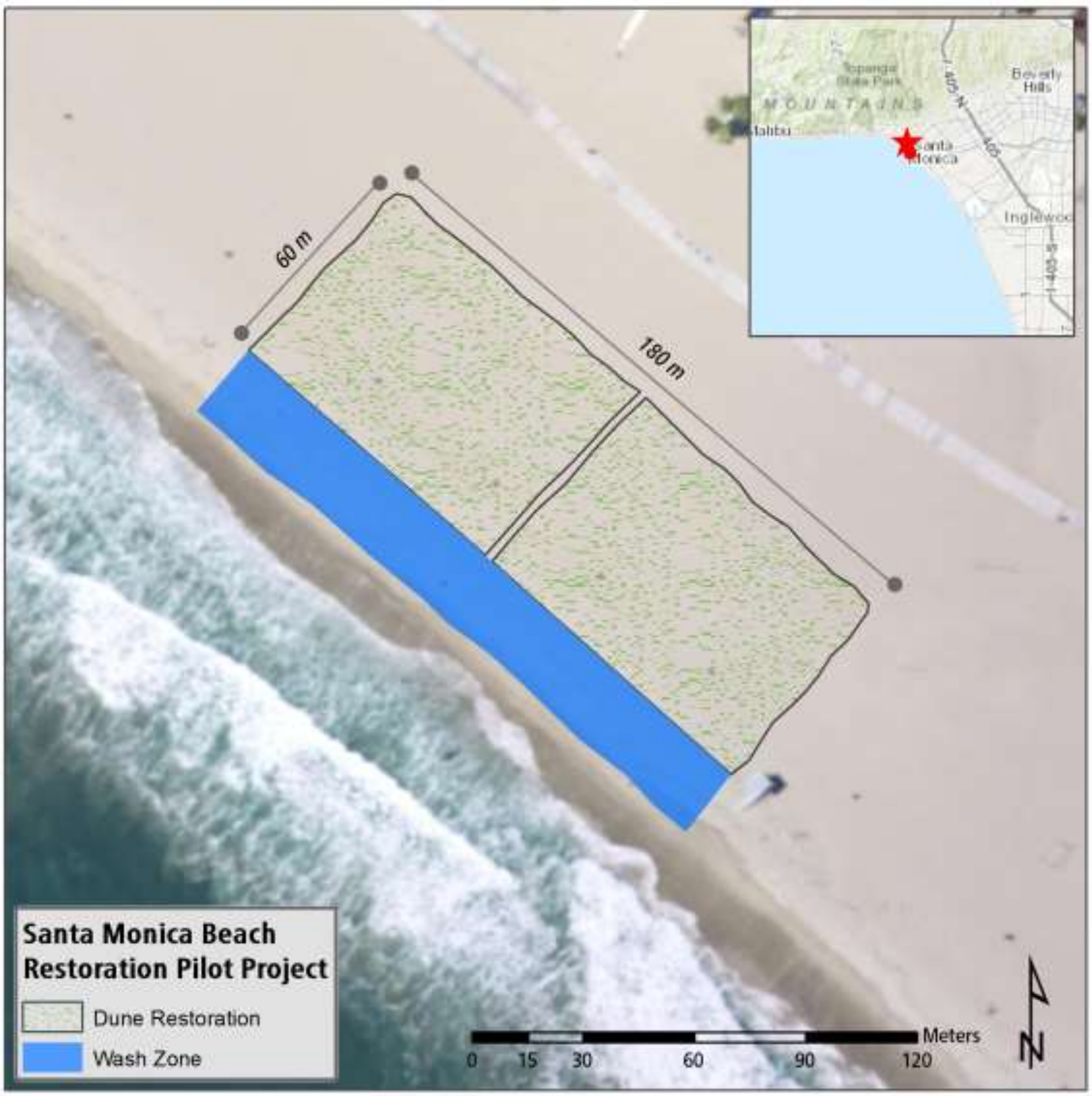


Figure 3. Map of the Santa Monica Beach Restoration Pilot Project location and general vicinity.

Figure 4. Artistic rendering overview of project area, post-establishment of vegetation (rendering credit: Studio-MLA).

Figure 5. Photograph of post-restoration project site in Year 1 (25 January 2017).

Figure 6. Photograph of post-restoration project site in Year 4 (21 January 2020).

Public Outreach

Significant public outreach has been conducted as part of this project through meetings, events, tours, social media, newspaper articles, newsletters, and a project webpage (Figure 7). Outreach is ongoing and also occurs on-site to beach visitors who have questions and through local media. The ability for the public to interact with, learn from, and benefit from this project are vital components of the project goals.

Members of the public had multiple opportunities to provide feedback about the project, and suggested changes were incorporated into the project design. Public-requested components include, but are not limited to, the curved sand fence, a 3-foot maximum fence height, several of the flowering plant species (e.g., red sand verbena), no fence along the open ocean side of the project, and an extra buffer of open space on the ocean-ward side of the project area to allow for pedestrian traffic and lifeguard vehicle emergency access. Additionally, outreach occurred in advance of the application for permitting from the California Coastal Commission, in accordance with permit conditions for the project. More than 20 public meetings, tours, or media articles occurred for this project prior to its implementation. Since implementation in December 2016, many additional news articles and tours have occurred. Additionally, several television segments have also aired, including on KNBC, KCAL, and KSCI.

Several important outreach components occurred for this project through the development of a website that highlighted artistic renderings, photographs, project information, and additional materials. Perhaps even more importantly from an outreach perspective was the installation of two interpretive signs designed to educate visitors on the importance of recreating natural ecosystems as an approach to combat sea level rise and provide vital habitat for plants and wildlife. Both the artistic renderings and interpretive signs were designed by Studio-MLA. Funding for the signs was provided by the Los Angeles County Supervisor District 3 (Sheila Kuehl's Office) and City of Santa Monica. The project website and frequently asked questions can be found at the following link: http://www.santamonicabay.org/explore/beaches-dunes-bluffs/beach-restoration/santa-monica-beach-restoration-pilot/. Selected media links are presented below the outreach photographs. The site is frequently written up in local newspapers, blogs, newsletters, and social media postings.

During Years 1-3, following implementation TBF staff presented at Beach Ecology Coalition meetings (Southern California stakeholder group), LA County Beach Commission meetings, and a Southern California Living Shorelines workshop. Additional outreach for the project included presentations with the NOAA Coastal Resiliency Network, 9th National Summit on Coastal and Estuarine Restoration and Management (December 2018), serving as a key member of a panel with the City of Santa Monica's LCP and sea level rise event (15 March 2018), and a presentation at the Southern California Academy of Sciences annual meeting (3 May 2019). Tours aimed to engage the community on the impacts of sea level rise have occurred through the Annenberg Community Beach House, the Santa Monica Bay Audubon Society, Girl Scouts, and CRI.

Over the course of Year 4, TBF continued to find opportunities to share the project and ongoing monitoring results with the public, as well as to beach managers and coastal scientists in the region. One highlight of Year 4 was a site tour with a local Santa Monica Girl Scout Daisy Troop (Figure 8). This tour was organized by TBF and the City of Santa Monica and was intended to be the first in a series as part of a docent tour program. The program was planned to have TBF give site tours and provide outreach and educational materials to local scout troops, who would in turn give tours to the general public.

Unfortunately, due to COVID-19, on-site outreach activities including the docent tour program were postponed during the latter half of Year 4. Beginning in December 2019, a novel coronavirus outbreak began in Wuhan, People's Republic of China (SARS-CoV-2), which caused a disease known as COVID-19. Over the subsequent months, the virus and its associated disease spread globally and turned into a worldwide pandemic. Beginning in March 2020, the State of California and Los Angeles County Department of Public Health issued a "stay-at-home" order with specific restrictions on all activities. While COVID-19 prohibited some on-site outreach activities during the latter half of this reporting period, TBF continued to explore and utilize virtual means of outreach.

TBF presented on the Santa Monica Beach project and several other living shoreline projects during an AdaptLA webinar on 4 June 2020 to approximately 55-60 attendees. AdaptLA is a regional group of municipalities, agencies, coastal planners, climate scientists, NGOs, and members of the public who are focused on coastal adaptation planning in the Los Angeles region. Another brief update presentation was given at the public Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC) virtual meeting on 7 May 2020 to approximately 50 attendees and another on 9 July 2020. LARC is hosted by UCLA and is a network of local and regional decision-makers ensuring a sustainable LA County prepared for the impacts of climate change. TBF also provided a virtual presentation to the City of Santa Monica's Sustainability Department on 27 July 2020 to update them on the project and discuss possibilities for the future. TBF and partner, CRI, will also be giving five presentations and co-leading a session at the American Shore and Beach Preservation Association Conference in October 2020, including data results and research from this project. Lastly, TBF continues to promote the project through social media and through multiple classes at LMU.

Figure 7. Social media post promoting the project site on 11 June 2020.

Figure 8. Photographs taken during tour of project site with local Girl Scout Daisies on 21 January 2020.

Selected Media Links

- KPCC 89.3 interview with Executive Director Tom Ford on 7 December 2016.
- Santa Monica Lookout article on 5 December 2016.
- Curbed LA article on 6 December 2016.
- Next City article about the project on 16 March 2017.
- City of Santa Monica press release about the ribbon cutting event on 3 May 2017.
- Ventura County Star article about the project and plovers on 8 May 2017.
- Daily Breeze article about the Western Snowy Plovers nesting on site on 9 May 2017.
- KCET article about the project on 9 May 2017.
- Los Angeles Times article about the project and plovers on 10 May 2017.
- Santa Monica Daily Press article about the Western Snowy Plovers nesting on 11 May 2017.
- The Argonaut article mentioning project in context of sea level rise in LA on 5 July 2017.
- Stormwater Solutions article on 10 August 2017.
- Baywire feature Quarter 3 – 2017. The Baywire provides news and updates from the Santa Monica Bay National Estuary Program.
- Baywire feature Quarter 4 – 2017: Annual Report.
- Hakai Magazine (international) article about the pilot project, trash maintenance, and Santa Monica beaches on 31 July 2018.
- KPCC 89.3 interview with Director of Watershed Programs, Melodie Grubbs, on 20 September 2019 highlighting the potential of the project to combat sea level rise.

Permitting

TBF, in coordination with the City of Santa Monica (City) and California Department of Parks and Recreation (DPR), 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 included 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 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 project. The dune habitat created pursuant to the permit may remain in place. The third permit condition was met by the Implementation and Monitoring Plan and the Site 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 publicly available on The Bay Foundation's (TBF) website: www.santamonicabay.org. For details on the implementation of the project in December 2016 and prior years of summary data, please reference the previous reports on TBF's website. Conversations about adaptive management options are ongoing and may be considered in Year 5.

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 is currently implementing a biological, physical, and human use long-term monitoring plan to quantifiably evaluate the project over time. Additional “control” data are collected along the adjacent unrestored beach as part of a before-after-control-impact ecological assessment monitoring program. Specialist scientists such as ornithologists and invertebrate biologists are partners in this project and contribute their expertise in implementation of the monitoring program. Data will be collected for a minimum of five and 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.

The development of the monitoring plan was conducted with input from many scientific advisors throughout southern California (details can be found in the “Implementation and Monitoring Plan” document available on the website). Additionally, data were collected to help inform other projects in southern California evaluating nature-based methods of shoreline protection.

Pre-restoration baseline monitoring occurred prior to the implementation of the seeding component of the restoration project to allow a comparison of the pre- and post-project conditions of the area. Post-restoration monitoring occurred beginning in January 2017. Table 1 summarizes the monitoring sampling design that occurred from the time period 1 December 2016 through 21 August 2020. Quarterly monitoring protocols were also conducted on 27 August 2020, though were not processed in time to be included in this report. These data will be included in the Year 5 Report. Spring 2020 surveys were postponed due to COVID-19 and the stay at home order for Los Angeles County. Table 1 lists ten major parameters, the primary protocol(s) implemented for each parameter, and the frequency of implementation. Additional protocols for management efforts such as trash collection, human use, and invasive vegetation removal are described in the adaptive management section of the report, below.

Individual Protocols and Results

Each of the following subsections summarizes an individual protocol methods and results 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, publicly 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.

Table 1. Summary of key parameters, protocols implemented, and survey dates. Asterisk indicates baseline survey.

Parameter	Protocol	Survey Dates
Wrack Cover	Percent cover and composition by species	28 December 2016*; 14 February, 12 March, 21 June, 20 September 2017; 11 January, 8 March, 24 May, 15 August, 16 November 2018; 22 February, 21 May, 1 August, 6 November 2019; 5 February, and 24 July 2020
Vegetation Cover and Seedling Density	Transects assessing cover by species; quadrat density counts	13 December 2016*; 24 March, 21 June, 20 September 2017; 11 January, 24 May, 15 August, 14 December 2018; 22 February, 21 May, 1 August, 6 November 2019; 5 February, and 24 July 2020
Vegetation Mapping **	Polygons depicting species composition (once vegetation sufficiently established)	4 October 2019; 21 August 2020
Invertebrates	Cores along transects using 1mm mesh bags as sieve	28 December 2016*; 18 July 2017; 8 March, 15 August 2018; 7 March 2019
Avifauna	Visual presence and behavior surveys; nesting surveys by USFWS; plover surveys by Audubon Society	10 December 2016*; 5 January, 22 February, 18 April, 24 April 2017, 13 July 2018; 7 March, 28 August 2019; 5 February, and 24 July 2020; throughout quarterly surveys and supplemental surveys by Audubon Society
Grunion and Other Wildlife	Protocols follow www.grunion.org, and use the Walker Scale	April and June 2017; March, April, and July 2018; June 2019; and additional surveys by grunion volunteers
Weather Conditions	Wind speed (Kestrel), max wind speed, air temperature, precipitation data (NOAA)	14 and 28 December 2016*; 13 and 25 January, 4, 14, and 23 February, 24 March, 12 April, 21 June, 21 August, 13 September 2017; 11 January, 8 March, 13 April, 24 May, 15 August, 12 December 2018; 22 February, 25 April, 21 May, 1, 28 August, 4 October, 6 November 2019; 21 January, 5 February, 24 July, and 21 August 2020
Elevation	Elevation profiles and cross-sections; topographic map	13 December 2016*; 24 March, 21 June, 13 September 2017; 13 February, 24, 29 May, 15 August, 14 December 2018; 22 February, 21 May, 1 August, 6 November 2019; 5 February, and 24 July 2020
Sand Deposition and Sediment Grain Size	MWAC method (Goossens et al 2000); sieve method; Empirical sand transport calculations (Hsu 1981)	13 December 2016*; 24 March, 13 September 2017; 24 May, 16 November 2018; 21 May, 3 June, 6 November 2019; and 24 July 2020
Photo Point	Georeferenced photograph series from fixed locations	13*, 17 December 2016; 13, 25 January, 4 February, 24 March, 25 April, 21 August, 13 September 2017; 11 January, 8 March, 13 April, 24 May, 15 August, 19 December 2018; 22 February, 25 April, 21 May, 1 August, 6 November 2019; 5 February, 24 July 2020

*** Indicates additional monitoring parameter added in Year 4.*

For details on the individual protocols and sampling design, refer to the Santa Monica Beach Restoration Pilot Project Implementation and Monitoring Plan.

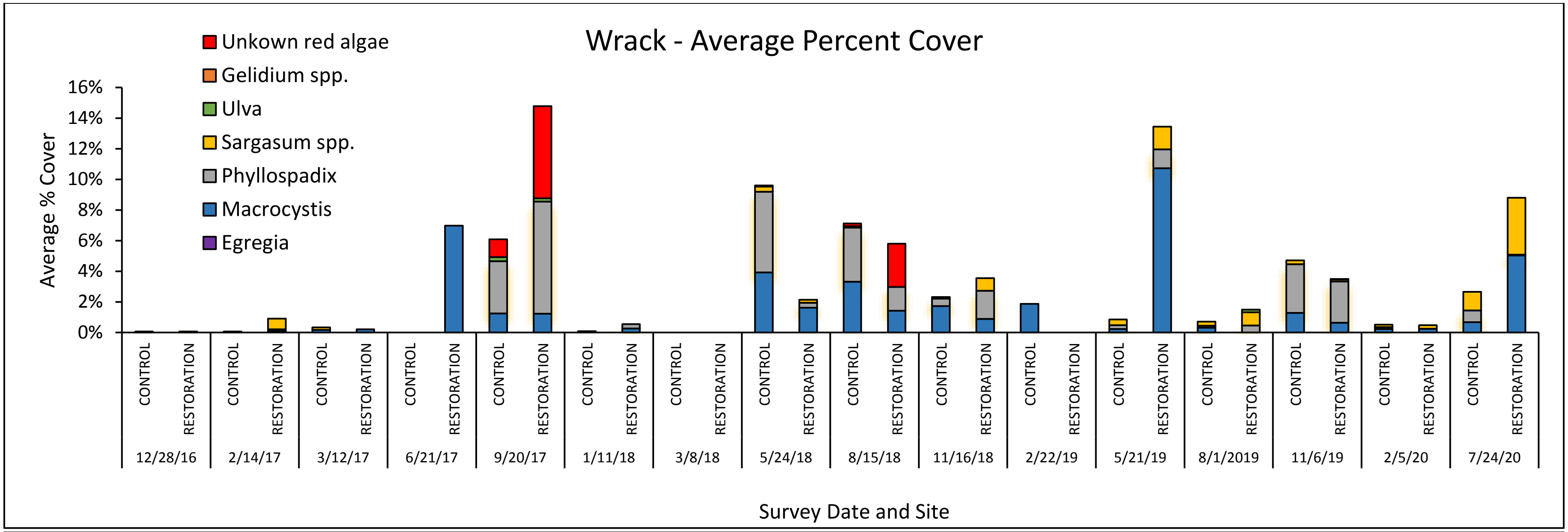
Wrack Cover

Wrack cover surveys were 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 at a control site. A total of four line-intercept transects were 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 (Figure 9). Wrack was identified to species when possible [e.g., giant kelp (*Macrocystis pyrifera*)]. These transects also recorded trash, tar, driftwood, or other detritus in a similar manner. Wrack cover surveys were conducted on 28 December 2016; 14 February, 12 March, 21 June, and 20 September 2017; 11 January, 8 March, 24 May, 15 August, and 16 November 2018; 22 February, 21 May, and 1 August, 6 November 2019; 5 February, and 24 July 2020.

Wrack cover included seven species: *Macrocystis pyrifera, Phyllospadix torreyi, Sargassum* spp*., Egregia menziesii, Ulva* spp., *Gelidium* spp., and an unknown red turf algae. Cover was frequently dominated by giant kelp (*M. pyrifera*) and surfgrass (*P. torreyi*) but was highly variable by survey. Both the restoration and control sites had the same low cover of wrack during the baseline surveys (December 2016) (Figure 10, top). Post-restoration surveys display a pattern of increasing wrack cover during the summer surveys and decreasing during the winter surveys, possibly indicating seasonal fluctuations. This trend continued into Year 4, showing low cover in the winter survey (February 2020) and higher cover in the Summer survey (July 2020; Figure 10, top). Cover between the restoration and control site were also highly variable and are likely to remain so, as the surveys are conducted along the high tide line, below most grooming activity (for the control sites). Year 5 data will inform this metric of assessment further.

Terrestrial debris and trash were variable throughout the surveys (Figure 10, bottom). Terrestrial debris (e.g., twigs, leaves, feathers, other natural debris, etc.) in Year 4 remained relatively low across all surveys, with a maximum average cover of approximately 3% in the restoration site (February 2020). Trash also remained low across all surveys, at less than 1% cover in both the control and restoration sites. This indicates either a lack of trash in the survey areas, or beneficial adaptive management measures such as hand-removal of trash that are shown to be effective at maintaining the restoration and control areas with very low overall trash cover.

Figure 9. Photograph of wrack line in control site (top) on 5 February 2020 and photo of clump of mixed wrack found on 24 July 2020 (bottom).



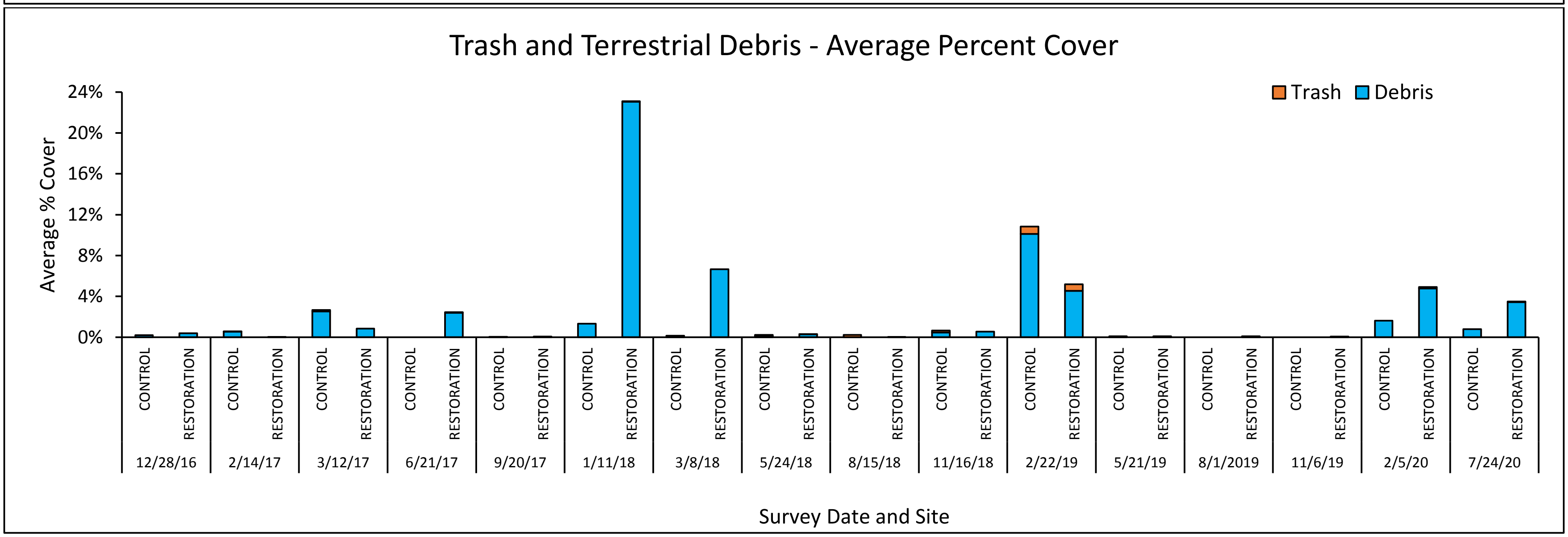


Figure 10. Average percent cover of wrack by species (top) and trash and terrestrial debris (bottom) in the restoration area and control site across all surveys. Note variable y-axis for each graph.

Vegetation Cover and Seedling Density

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 was to assess the approximate cover of native coastal strand vegetation over time. The line-intercept transect and cover class quadrat survey methods are described, along with example field data sheets, in SOP 3.2 Vegetation Cover Surveys (TBF 2015b). Data were evaluated as percent cover by species. Additionally, individual seedlings were counted within randomly selected quadrats as part of the Cover Class Quadrat vegetation cover assessment method semi-annually. Data are 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), and seedling data are also extrapolated up to the whole restoration area at approximately 6,900 m^2. Four vegetation transects were surveyed within the restoration area and compared to two control transects surveyed outside the restoration area (approximately 100 m south of the restoration area). Vegetation cover surveys were conducted on 13 December 2016; 24 March, 21 June, and 20 September 2017; 11 January, 24 May, 15 August, and 14 December 2018; 22 February, 21 May, and 1 August, and 6 November 2019; 5 February, and 24 July 2020.

All four of the seeded vegetation species germinated within and immediately adjacent to the restoration area [i.e., beach evening primrose (*Camissoniopsis cheiranthifolia*), red sand verbena (*Abronia maritima*), beach bur sage (*Ambrosia chamissonis*), and beach salt bush (*Atriplex leucophylla*) (Figures 11a and 11b). Additionally, three other vegetation species germinated within the project area, two native and one non-native. The two natives were woolly heads (*Nemacaulis denudata*) and pink sand verbena (*Abronia umbellata*), and the non-native species was European sea rocket (*Cakile maritima*) (Figures 11a and 11b). Neither woolly heads, a native and possibly rare species variant, nor pink sand were in the seed mix as confirmed by the seed provider; thus, it is probable that there was either an existing seed bank for these species already along Santa Monica Beach, or that they were transported by wind, waves, birds, or humans. Combining all transects surveyed in Year 4, the highest proportions of cover were found to be beach evening primrose and beach saltbush (Figure 12). In all years, sea rocket exhibited the lowest cover of any of the present species and was periodically removed by hand from within the restoration area as an adaptive management maintenance activity. As Figure 12 displays, the vegetation has become more diverse over time (rather than dominated by one or two species), with a more even cover distribution of the native vegetation (see the most recent survey, 24 July 2020).

Vegetation cover assessed during the baseline (December 2016) surveys within both the restoration area and control site was zero and remained zero at the control site throughout all surveys (Figure 13). Native vegetation cover was much higher than non-native cover (sea rocket) during all surveys, with zero non-native vegetation in all Year 3 and 4 surveys. Native cover has increased over time, with some seasonal variation. Native cover increased to a maximum cover of approximately 7% in the November 2019 survey and decreased slightly in the February 2020 survey. However, the most recent survey (July 2020) shows vegetation again increasing to over 5%. Vegetation is likely to continue to increase and become more complex over time, though naturally occurring coastal strand habitats also usually have a significant portion of bare sand, even after becoming mature vegetation communities (Figure 14).

Figure 11a. Photograph of various vegetation in restoration site. Top left: pink sand verbena (*Abronia umbellata*); top right: red sand verbena (*Abronia maritima*); bottom left: beach evening primrose (*Camissoniopsis cheiranthifolia*); bottom right: (*Atriplex leucophylla*).

Figure 11b. (continued). Photograph of various vegetation in restoration site. Top left: woolly heads (*Nemacaulis denudata*); top right: non-native sea rocket (*Cakile maritima*); bottom: beach bur sage (*Ambrosia chamissonis*).

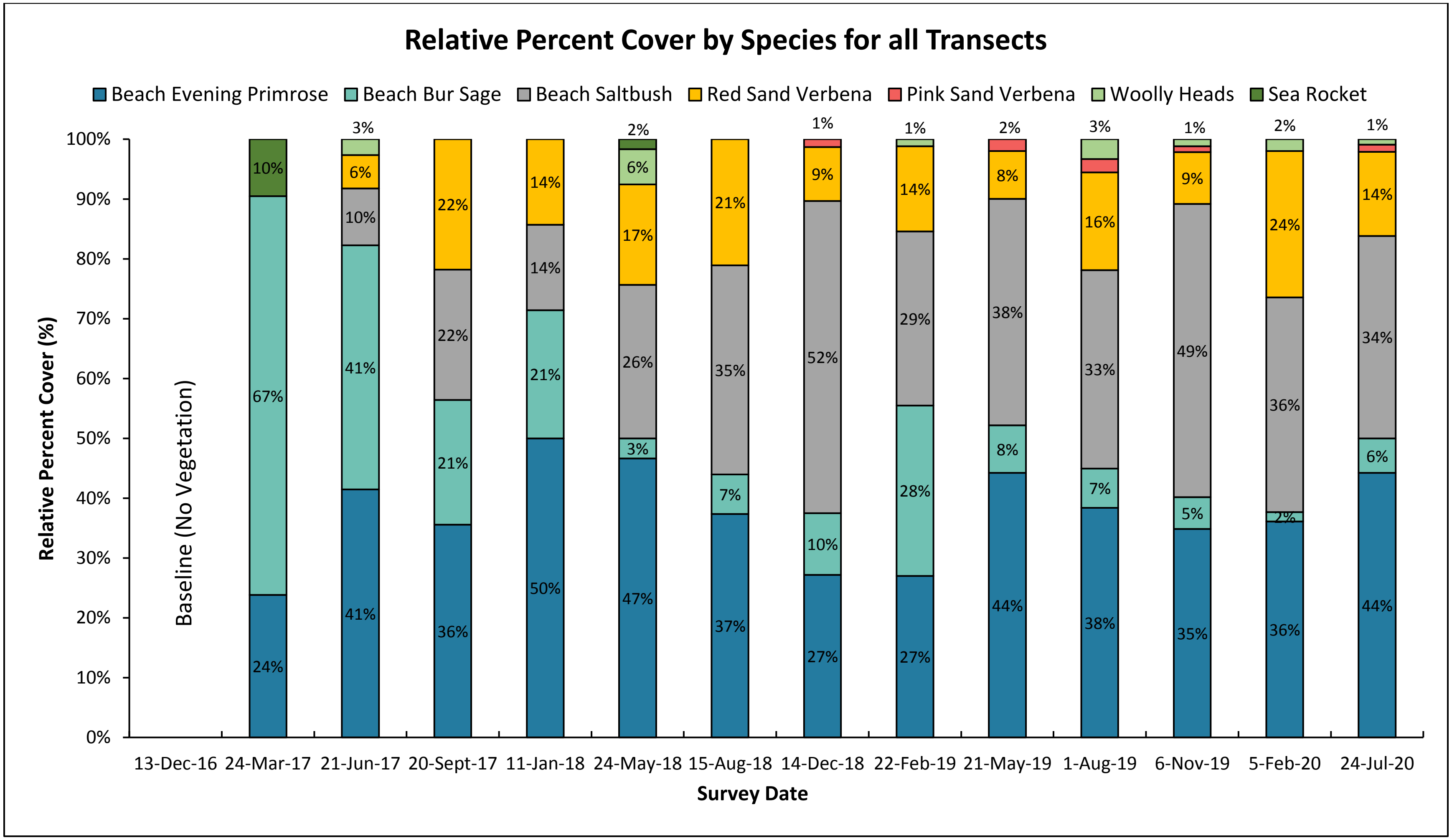
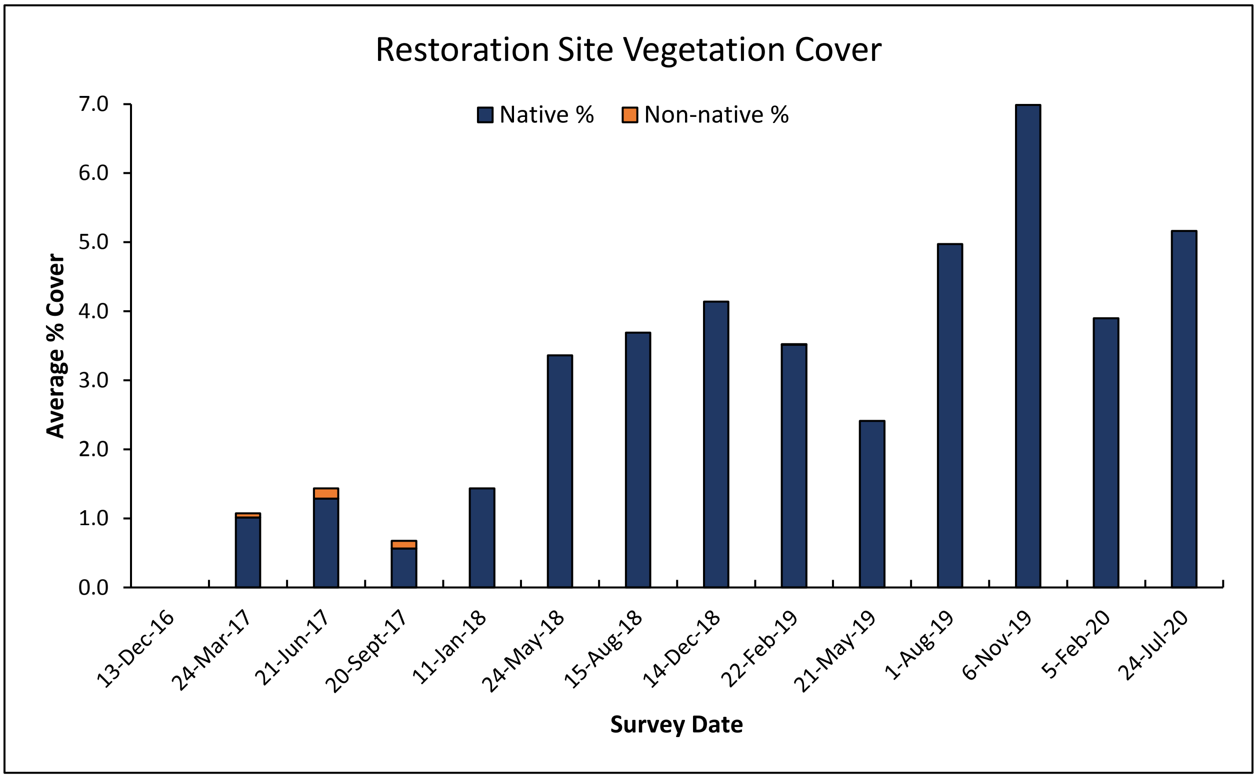


Figure 12. Relative percent cover by species for all transects (live vegetation only, 13-Dec-16 was baseline survey with no vegetation identified).



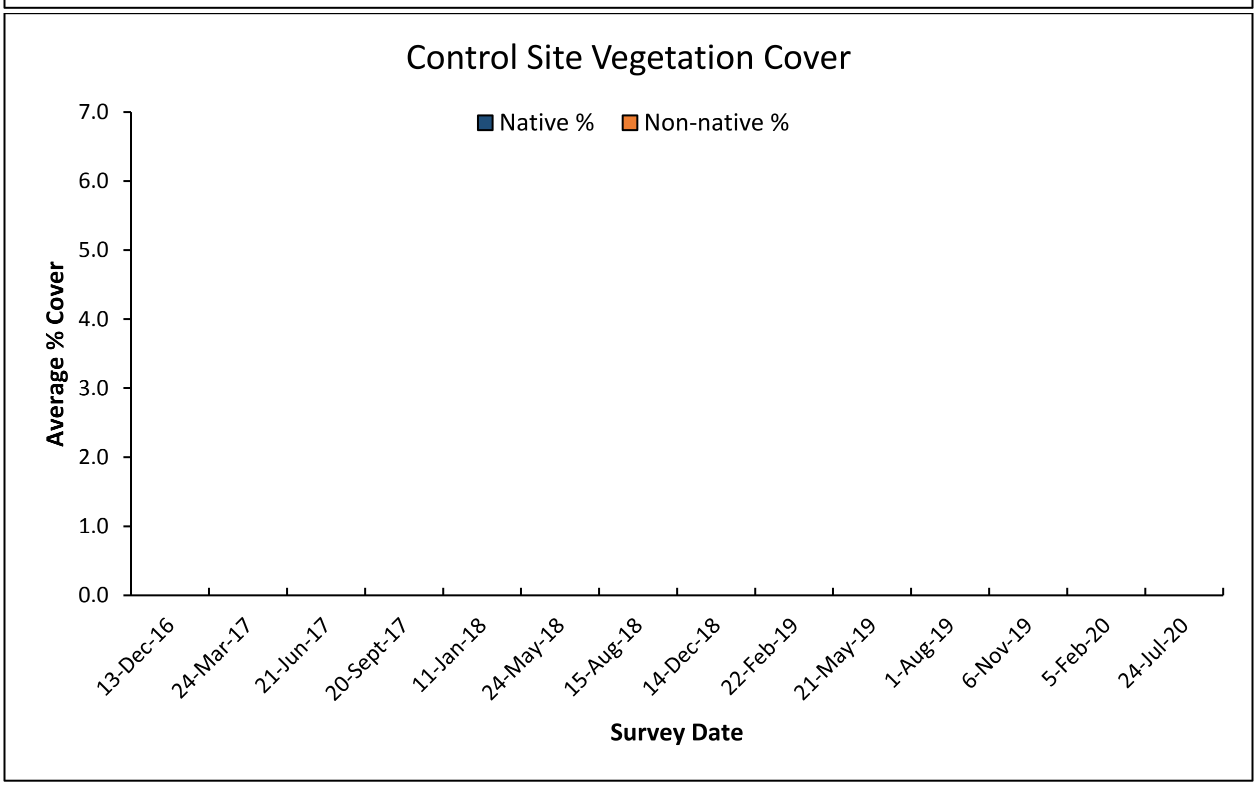


Figure 13. Average native and non-native vegetation cover during all surveys within the restoration area (top) and at the control site (bottom).

Figure 14. Photograph of various interspersed native vegetation scattered throughout the project site with areas of sandy bare ground (5 February 2020).

Both the baseline survey and each of the control surveys found zero seedlings on all transects. Table 2 displays the results of the seedling counts from within the restoration area on the 24 March 2017, 11 January 2018, 22 February 2019, and 5 February 2020 surveys and extrapolates the results up to the total project area (approximately 6,900 m^2) by species. Note that the extrapolated data are based on averages and are thus not likely to represent an exact numerical count for the area but are considered estimates (rounded down to the closest thousand). Surveys conducted but not listed in Table 2 found no seedlings. The March 2017 survey found more seedlings within the restoration area than the subsequent surveys, since it closely followed the initial vegetation seeding in December 2016 (Figure 15). The latter three surveys are better represented as flowering plants that produced germinated seedlings. The February 2020 survey recorded a low number of seedlings within the surveyed area, though many small juvenile individuals were present, which were too large to be categorized as seedlings. This survey indicates ongoing natural re-seeding and germination by existing plants occurring throughout the site across the post-restoration survey years, as no additional seeds have been placed on site since December 2016.

Table 2. Seedling data results by species for 24 March 2017, 11 January 2018, and 22 February 2019 reported as counts, average number / m², and extrapolated counts for the entire restoration area (bold rows). Asterisk indicates non-native species.

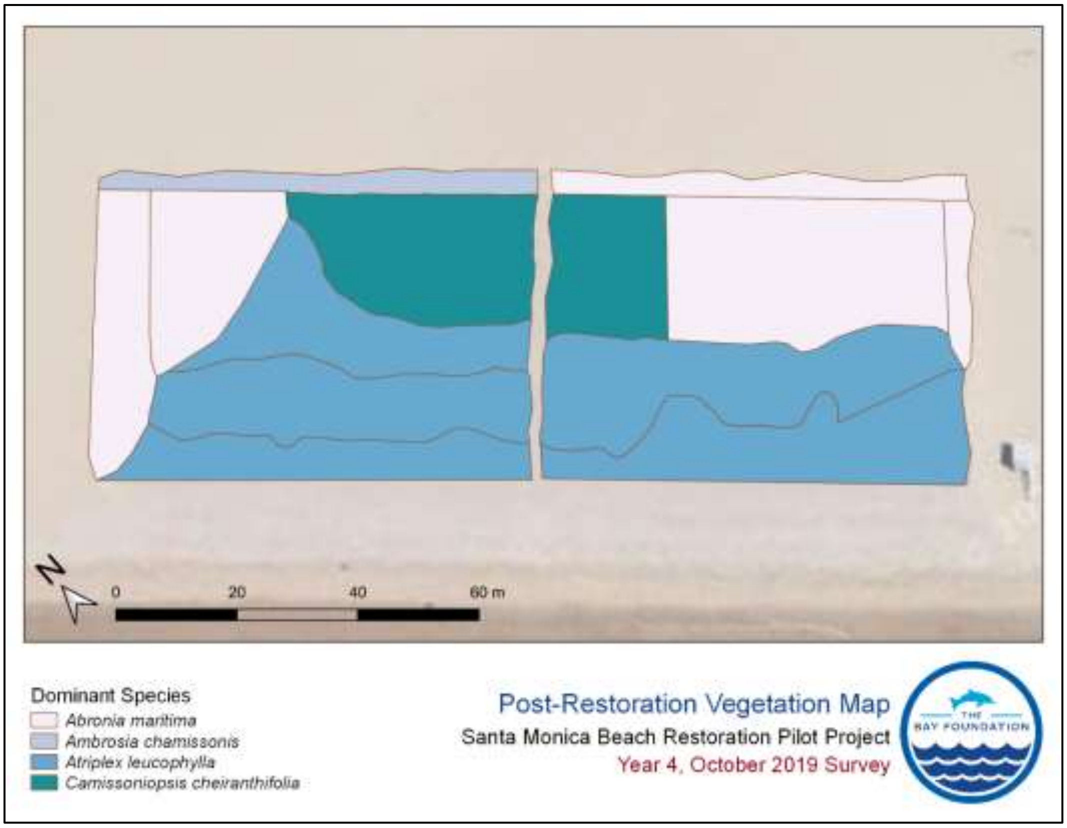
		Beach bur sage	Beach saltbush	Red sand verbena	Pink sand verbena	Beach evening primrose	Woolly heads	Sea rocket *
March 2017	Total Number of Seedlings	337	35	9	0	71	0	9
	Avg. Seedling Count / m²	16.85	1.75	0.45	0	3.55	0	0.45
	Total Estimated for Restoration Area	**116,000**	**12,000**	**3,000**	**0**	**24,000**	**0**	**3,000**
January 2018	Total Number of Seedlings	36	16	2	0	56	0	0
	Avg. Seedling Count / m²	1.80	0.80	0.10	0	2.80	0	0
	Total Estimated for Restoration Area	**12,000**	**6,000**	**1,000**	**0**	**20,000**	**0**	**0**
February 2019	Total Number of Seedlings	207	10	5	0	36	0	0
	Avg. Seedling Count / m²	10.35	0.50	0.25	0	1.80	0	0
	Total Estimated for Restoration Area	**71,000**	**3,000**	**2,000**	**0**	**12,000**	**0**	**0**
February 2020	Total Number of Seedlings	50	0	0	0	1	0	0
	Avg. Seedling Count / m²	2.50	0	0	0	0.05	0	0
	Total Estimated for Restoration Area	**17,000**	**0**	**0**	**0**	**350**	**0**	**0**

Figure 15. Seedlings intermixed with other juvenile native vegetation (5 February 2020).

Vegetation Mapping

Vegetation mapping was a new monitoring parameter added during Year 4, once the vegetation was more established on site. This protocol uses a combination of aerial imagery, high-resolution Trimble GPS, and in-situ observations to delineate polygons depicting species composition. Vegetation mapping protocols are described in more detail in SOP 3.5 Vegetation Mapping (TBF 2015c). Figure 16 displays dominant vegetation species polygons within the restoration area for surveys conducted on 4 October 2019 and 21 August 2020. Note that the individual polygons only identify the most common species within the assessment polygons; there are intermixed individuals of other species throughout the site, as well as high percent cover of bare ground throughout.

Beach evening primrose, beach salt bush, and red sand verbena were found to be most dominant species during the October 2019 survey. During the August 2020 survey, beach evening primrose and beach saltbush continued to be the most prevalent species throughout most of the site. Beach bur was also represented as a dominate species within a single polygon for both surveys, in larger quantities along the fence perimeter. Red sand verbena was found throughout the site, but did not dominate in 2020. Vegetation present through both surveys, but not displayed as a dominant species include woolly heads and pink sand verbena. Both species are annuals and exhibit high seasonal variability.



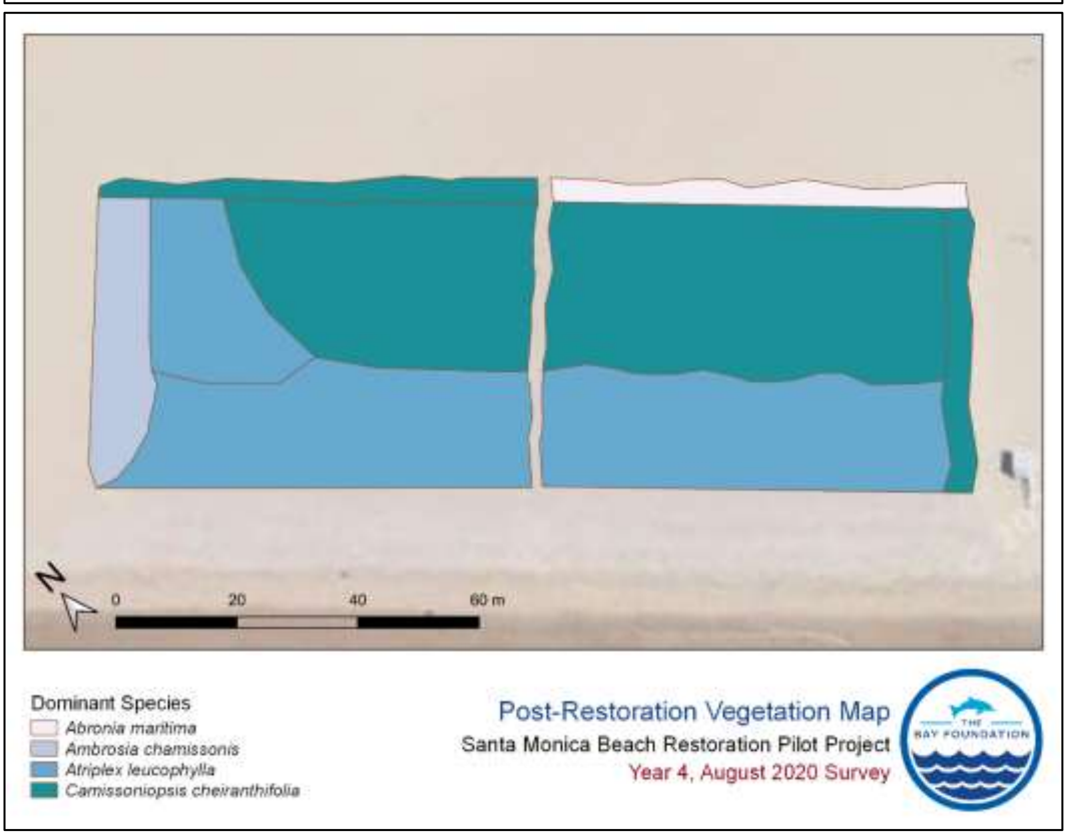


Figure 16. Dominant vegetation species within the restoration site for surveys on 4 October 2019 (top) and 21 August 2020 (bottom).

Invertebrates

Invertebrate data were collected using techniques described in detail in Dugan et al. 2015 and led by scientists from Coastal Restoration Consultants, Inc., and the University of California, Santa Barbara. Common examples of macroinvertebrate indicator taxa in southern California include talitrid amphipods (*Megalorchestia* spp.), and the common sand crab (*Emerita analoga*). Invertebrates were surveyed on 28 December 2016, 18 July 2017, 8 March 2018, 15 August 2018, and 7 March 2019 and led by expert beach scientists, David Hubbard and Dr. Jenifer Dugan. Surveys for this reporting period were scheduled for Spring 2020; however, they were cancelled due to COVID-19. Surveys are anticipated to resume in Year 5. Six within-restoration transects were surveyed and compared to data from six control transects located several hundred meters south of the restoration area (Figure 17). Additional sieving of sand adjacent to vegetation patches to assess dune beetle presence occurred on the 8 March 2018 survey. For additional method details, refer to the Santa Monica Beach Restoration Pilot Project Implementation and Monitoring Plan (October 2016).

Figure 17. Photograph of researchers conducting invertebrate core surveys (7 March 2019).

Upper beach fauna: There is little evidence that upper beach fauna has responded to the change in management at the pilot project site yet. There has been little or no contrast between samples at the control site and the demonstration project. The December 2016 baseline surveys indicated low background levels of upper beach invertebrates (e.g., beach hoppers, *Megalorchestia minor* and *M. benedictii*) at between 300-400 individuals per meter of shoreline, with similar numbers at the restoration site and the control site. These data are indicative of the frequent beach grooming regime prior to restoration. Analyses of the December 2016 and July 2017 data indicate similar results for both surveys. Data from the March 2018 and subsequent surveys were not able to be retrieved at the time of publication of this report due to logistical issues related to COVID-19, but they will be included in the Year 5 report. Further surveys will help assess whether there is divergence between the control site and restoration site over time.

Fauna associated with dune vegetation: There has been no significant difference in aerial insects captured on yellow sticky cards to date between control and pilot project sites, during the first two years of project implementation. Subsequent survey data have not been processed due to COVID-19. Other observations suggest that invertebrates associated with plants are responding to the restoration. Dune beetles rapidly colonized the pilot project. Dune beetles were not present during the baseline monitoring (December 2016) surveys but were present during the July 2017 surveys and all subsequent surveys; these data indicate that dune beetles colonized post-restoration, an event likely attributable to the presence of new vegetation (Figure 18).

Figure 18. Dune beetle identified on vegetation within the restoration area (5 February 2020).

Avifauna

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 was to provide a general understanding of the bird community and corresponding behavior in the restoration area before and after restoration. Bird surveys were conducted by an ornithologist on 10 December 2016 (baseline, pre-restoration survey); 5 January, 22 February, 18 April, and 24 April 2017; and 13 July 2018. Subsequent surveys were conducted by TBF staff on 7 March, 28 August 2019; 5 February and 24 July 2020. All bird data results are combined and reported below, comparing birds found within the restoration area and immediately adjacent to those found several hundred meters away or flying over the area.

Frequently identified species on surveys included gulls and several shorebirds (e.g., willet, *Tringa semipalmata*) (Table 3). Shorebirds were observed both roosting and foraging within the restoration area, most notably, the federally threatened western snowy plover (*Charadrius alexandrinus nivosus*), which produced the first egg-bearing nest in the Los Angeles region in almost 70 years within the restoration area (discussed further below) in 2017. In May 2018, a killdeer (*Charadrius vociferous*) nested within the restoration site. Several species of gull were also frequently identified in and around the restoration area, flying overhead, and in the adjacent 'control' sites. Urban species such as the rock pigeon (*Columba livia*) were identified primarily in adjacent areas, but not within the restoration site. On the July 2018 survey, an adult and juvenile peregrine falcon (*Falco peregrinus*) were observed circling low over the sand inland of the restoration site.

During Year 4, many of the same avifauna species were identified as in previous years, including the western snowy plover (*Charadrius alexandrinus nivosus*). Plovers were identified foraging in front and throughout the enclosure on multiple occasions, including on 5 February 2020 (Figure 19, top). New species identified in Year 4 within or adjacent to the restoration area include an osprey (*Pandion haliaetus*) and cormorant (*Phalacrocorax* sp.). Additional avifauna surveys will continue to inform the identified species present and activities within and adjacent to the restoration area.

Figure 19. Photograph of snowy plovers foraging directly outside of the project area (top) and whimbrels foraging throughout the site (bottom) on 5 February 2020.

Table 3. Avifauna species identified as present in the restoration area and in the surrounding area adjacent to the restoration. Data for all surveys were combined.

Category	Common Name	Scientific Name	Restoration	Adjacent
Shorebird	Western Snowy Plover *	*Charadrius alexandrinus nivosus*	X	X
	Whimbrel	*Numenius phaeopus*	X	X
	Willet	*Tringa semipalmata*	X	X
	Sanderling	*Calidris alba*	X	X
	Marbled Godwit	*Limosa fedoa*	X	
	Long-billed Curlew	*Numenius americanus*	X	X
Open Water	Surf Scoter	*Melanitta perspicillata*		X
	CA Brown Pelican **	*Pelecanus occidentalis californicus*	X	X
	Cormorant	*Phalacrocarax spp.*	X	X
Gull	California Gull	*Larus californicus*	X	X
	Ring-billed Gull	*Larus delawarensis*	X	X
	Western Gull	*Larus occidentalis*	X	X
	Heermann's Gull	*Larus heermanni*		X
Urban	Canada Goose	*Branta canadensis*		X
	American Crow	*Corvus brachyrhynchos*	X	X
	Rock Pigeon (Feral Pigeon)	*Columba livia*		X
	Peregrine Falcon	*Falco peregrinus*		X
	Killdeer	*Charadrius vociferous*	X	X
Raptor	Osprey	*Pandion haliaetus*	X	

** = rare species listed as threatened by USFWS*

*** = previously listed species, but delisted in 2008*

Western Snowy Plover

The first four western snowy plovers identified within the restoration area were found roosting during a TBF bird survey on 23 February 2017, two months after the installation of the project. Plovers are known to overwinter in the vicinity (within an enclosure approximately 500 m south of the restoration area) but had not previously been identified using the specific restoration area of the beach. Throughout all surveys, care was taken to avoid disturbance to the birds. The restoration area falls within approximately the middle of the Santa Monica Beach critical habitat area for plovers (Subunit 45A, Figure 22), southwest of San Vicente Boulevard. As migrant plovers may start trying to identify breeding locations as early as March, plovers are carefully monitored throughout the year moving in and out of the restoration area.

Dan Cooper, an ornithologist, detected a nesting plover within the restoration area on 18 April 2017 and confirmed the presence of one egg in a nest scrape containing bits of shells and adjacent debris. This confirmed nest was the first one in the Los Angeles region in almost 70 years. Local, state, and federal agencies were all immediately notified along with the Santa Monica Audubon Society, an important local stakeholder group who have conducted bird surveys in Los Angeles for many decades and who maintain the plover enclosure on the southern portion of Santa Monica Beach. On 24 April 2017, US Fish and Wildlife Service (USFWS), who have jurisdiction over federally threatened species, several ornithologists, and TBF installed a mini-enclosure over the nest and confirmed the presence of three eggs. After the mini-enclosure was installed, the male plover immediately returned to the nest (Figure 20). Unfortunately over subsequent weeks, extremely high winds buried the nest, which was subsequently abandoned. While plovers were identified within the restoration area in the breeding season in 2018-2020, no subsequent nesting attempts were made (Figure 21). Signs were posted around the perimeter of the site notifying the public of possible nesting. Crows and dogs have occasionally been observed and could potentially deter plovers and other shorebirds from using and nesting in the site.

Figure 20. Photograph of nesting western snowy plover (credit: Tom Ryan 24 April 2017).

Figure 21. Photo of snowy plovers foraging near restoration site in Year 4 on 6 November 2019.

Figure 22. Map of WSP critical habitat (Subunit CA 45A) and restoration area boundary (Data source: USFWS ECOS 2018).

Grunion and Other Wildlife

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 and other wildlife such as nearshore dolphins or fish can be indicators of the higher trophic levels of the sandy shore food web.

Grunion surveys were conducted in April and June 2017; March, April, and July 2018; and June 2019. No new surveys were conducted in Year 4 due to COVID-19, though surveys are planned to resume in Year 5. Surveys were conducted at night, during peak high tide events and following a full or new moon. Grunion surveys followed standardized regional protocols with some data provided by citizen scientists conducting surveys using the same protocols. Data summaries for surveys not conducted by TBF and LMU's Coastal Research Institute were provided by Dr. Karen Martin, Pepperdine University. The Grunion Greeter Observation Form was completed during each survey and subsequently entered onto the regional web database at www.grunion.org. The Walker Scale was used as a monitoring metric, which ranges from W-0 to W-5 as shown in Table 4.

All reported surveys in the vicinity of the restoration area recorded Walker Scale results of W-0. While no grunion were observed during survey dates, there was evidence that they spawned in the area at least once in June 2018, as eggs were identified within the restoration area (K. Martin, Pepperdine University, pers. obs.). Grunion surveys will resume in 2021.

Table 4. Walker scale for monitoring California grunion runs.

Walker Scale	Description
W-0	No fish, or 1 or 2 scouts, no spawning
W-1	10-100 fish spawning at different times in one or several locations
W-2	100-500 fish spawning at different times, in one or several locations
W-3	Hundreds of fish spawning in several locations or over a broad area of the beach
W-4	Thousands of fish together, little sand visible between them over relatively small area for less than one hour
W-5	Fish covering beach, not possible to walk through the run without stepping on fish, run lasts for an hour or more over large area

In addition to birds frequently seen in and around the restoration area and human uses, wildlife present in the area included dolphins frequently seen offshore foraging in the surf zone (e.g., Figure 23), jumping fish, high densities of bean clams in the intertidal zone (*Donax gouldi*), and sea lions also seen in the surf zone offshore.

Figure 23. Dolphin photographed swimming offshore in front of restoration area (5 February 2020).

Physical Characteristics

Physical characteristics help to characterize the beach in comparison to other locations (e.g., elevation profiles; Dugan et al. 2015). Additionally, site checks were performed at least quarterly to assess the condition of the fence, collect trash, etc. Specific data for physical characteristics collected and summarized in this report include precipitation, wind, temperature, climate data, elevation profiles, sand deposition, and sand grain size. Supplemental weather data were downloaded from AccuWeather Premium and National Oceanic and Atmospheric Administration's (NOAA) Climate Data Online. Weather patterns and climate data collected from external sources are meant to be representative, not indicative of specifics within the restoration area at any given moment in time.

Overall, the restoration site exhibited physical differences as compared to control locations and itself over time, primarily through the accretion of sand along the fence line, plant hummocks, and wrack line. Elevation profiles and high-resolution topographical mapping of both the restoration area and control locations provide information on the change in physical topography over time.

Precipitation

The total rainfall for the wet weather months (October through May of the following year) was 16.32 inches during Year 1, 3.79 inches in Year 2, 16.94 inches in Year 3, and 13.80 inches in Year 4, as measured by the Los Angeles International Airport (LAX) rain gauge (Figure 24). Year 4 had less rainfall than Years 1 and 3, though much more than Year 2. The most rainfall for Year 4 came in the months of December 2019 and March 2020, accounting for almost 70% of the total wet season rainfall.

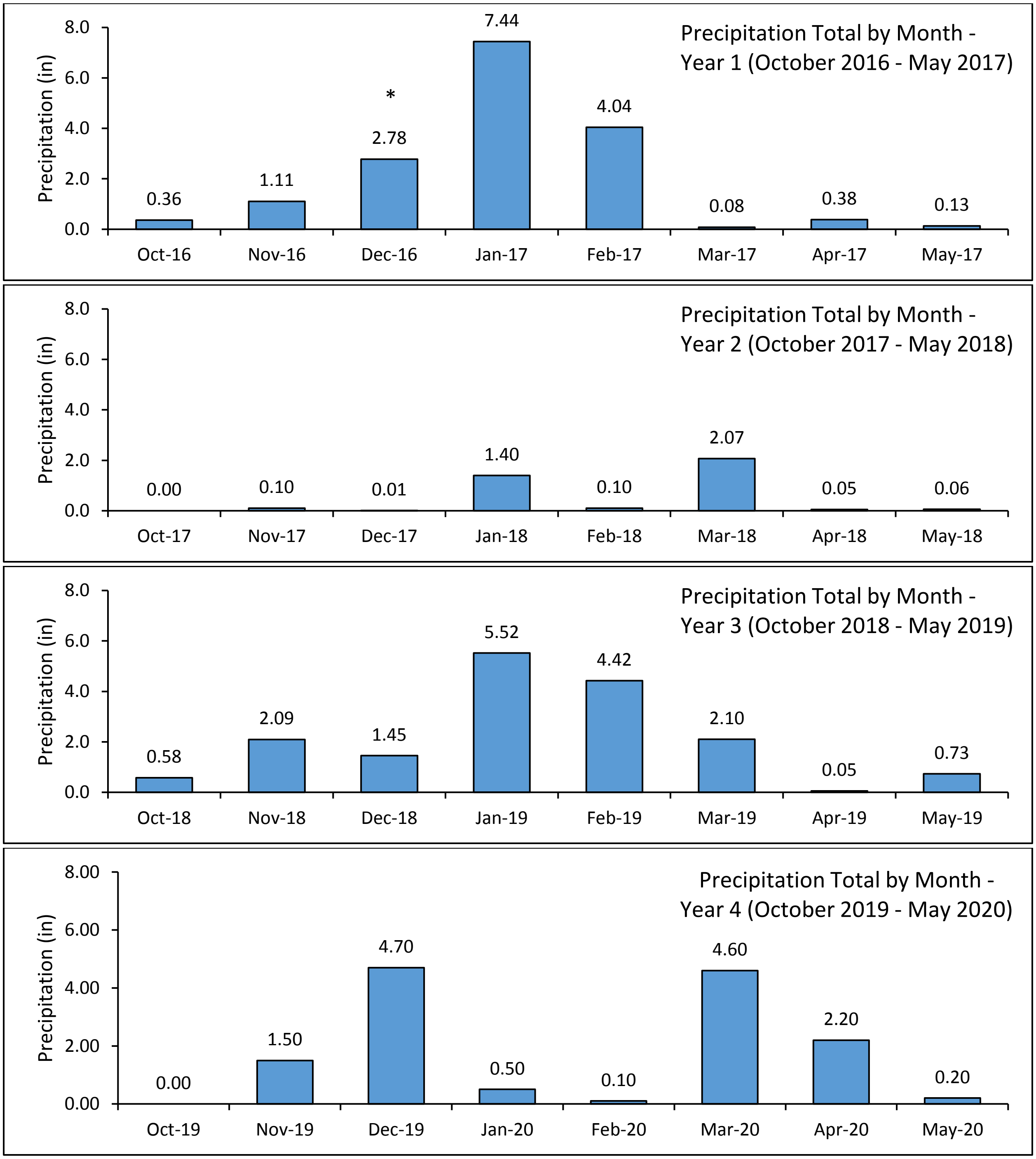


Figure 24. Monthly precipitation totals (inches) for the wet weather months (October-May). Daily precipitation data were downloaded from NOAA Climate Date Online (CDO) and originally recorded at the LAX rain gauge. Asterisk indicates project installation month in December 2016.

Wind and Temperature

Average sand temperature, wind speed, and maximum wind speed (over three minutes) were recorded in each of the two treatment plots using a small, hand-held weather meter (Kestrel®) and a Fluke Mini IR Thermometer®. Data were collected on 14 and 28 December 2016; 13 and 25 January, 4, 14, and 23

February, 24 March, 12 April, 21 June, 21 August, and 13 September 2017; 11 January, 8 March, 13 April, 24 May, 15 August, and 12 December 2018; 22 February, 25 April, 21 May, and 1 and 28 August, 4 October, and 6 November 2019; 21 January, 5 February, 24 July, and 21 August 2020. Note values that are missing from Year 4 are due to technical equipment issues that has since been replaced. These data are reported as collected from within the restoration area, specifically. NOAA climate data follow below.

Air temperature, sand temperature, and wind speeds were all highly variable depending on the specific conditions of survey days. Sunnier days / warmer summer months had higher sand temperatures over 40 °C (Table 5). The wind speed on average ranged from approximately 1.7 to 5.8 m/s with gusts of up to 7.1 m/s at 1.5 m in height, with the average wind speed recorded along the ground ranging lower at approximately 0.5 to 4.2 m/s with gusts of up to 5.0 m/s recorded during surveys (Table 5).

Table 5. Summary data for temperature and wind speed collected on site during surveys. Asterisk indicates NOAA data instead of *in situ* data due to equipment malfunction (January and February 2020).

Date		Temperatures (°C)		Wind Speed (m/s)			
Year	Month	Air	Sand	Maximum (1.5 meters)	Average (1.5 meters)	Maximum (ground)	Average (ground)
2016	December	18.7	18.8	2.1	1.7	1.6	1.0
2017	January	14.2	19.9	2.9	2.4	2.3	1.7
	February	14.5	26.7	7.1	5.7	5.0	4.2
	March	17.2	22.4	2.5	2.1	2.1	1.6
	April	----	----	3.0	2.7	2.4	2.0
	June	18.8	36.5	2.5	2.1	2.1	1.8
	August	24.4	29.3	4.0	3.2	2.6	2.0
	September	23.9	40.8	6.1	3.9	4.3	3.0
2018	January	21.5	25.7	3.9	3.2	2.5	1.9
	March	15.1	24.0	1.9	1.4	1.3	1.0
	April	21.0	46.6	2.1	1.7	2.8	2.2
	May	17.1	30.1	2.4	1.9	2.3	1.8
	August	----	46.3	5.3	4.1	3.9	3.0
	December	16.2	11.2	1.4	0.8	0.6	0.5
2019	February	18.5	29.1	5.3	3.6	2.7	2.5
	April	20.7	45.1	4.0	3.5	2.4	2.3
	May	21.0	34.0	6.5	5.8	4.2	4.2
	August	21.8	44.2	3.6	2.9	2.1	1.5
	October	---	28.7	---	---	---	---
	November	21.2	29.4	1.9	5.7	---	---
2020	January	12.8	----	----	4.5 *	----	----
	February	12.8	----	----	1.0 *	----	----
	July	21.6	27.6	1.7	0.5	1.7	0.5
	August	25.05	45.5	2.6	2.1	2.5	2.0

NOAA Climate Data

National Oceanic and Atmospheric Administration's (NOAA) Climate Data Online were downloaded for the Santa Monica Municipal Airport Station on 31 August 2020. The data results are summarized in Tables 6 and 7. Precipitation totals during the 2019-2020 winter were considerably lower than that of the previous year. Wind gust observations remain high (25-40 mph) during the months of December to April, with a new high (47 mph) recorded in February. Humidity data for Year 3 and Year 4 were unavailable from the NOAA climate portal at the time of this report.

Table 6. Table displaying NOAA temperature and humidity monthly data for the Santa Monica Municipal Airport Station (downloaded on 31 August 2020).

Year	Month	Temperature (°C)			Humidity
		Average	Maximum	Minimum	Average
2016	October	18.9	34.4	12.8	74.4
	November	17.0	34.4	7.8	60.8
	December	14.0	27.2	5.6	67.5
2017	January	12.7	23.9	4.4	79.0
	February	13.5	21.1	5	88.6
	March	15.0	25.6	7.2	73.0
	April	16.7	28.3	10	67.9
	May	16.2	29.4	8.9	77.1
	June	18.1	27.8	13.9	83.5
	July	20.9	31.1	16.1	81.5
	August	21.0	31.7	17.2	81.7
	September	20.9	36.1	13.3	76.8
	October	20.2	38.3	13.9	66.4
	November	17.0	33.3	9.4	72.3
	December	14.7	27.8	6.1	51.9
2018	January	15.2	30.6	6.7	67.7
	February	13.4	26.1	5.0	62.1
	March	13.6	26.7	5.6	77.9
	April	15.0	28.3	9.4	72.0
	May	15.7	24.4	11.1	77.4
	June	17.8	23.9	13.3	77.3
	July	21.8	36.7	16.1	76.6
	August	23.8	27.8	20.3	N/A
	September	22.1	25.3	18.9	N/A
	October	21.1	25.3	17.0	N/A
	November	19.2	24.5	13.9	N/A
	December	16.2	20.9	11.6	N/A
2019	January	15.6	20.1	11.0	N/A
	February	12.3	16.1	8.5	N/A
	March	15.1	19.2	11.0	N/A

Year	Month	Temperature (°C)			Humidity
		Average	Maximum	Minimum	Average
	April	16.7	20.3	13.1	N/A
	May	16.2	19.0	13.1	N/A
	June	18.7	21.3	16.1	N/A
	July	20.7	23.8	17.5	N/A
	August	20.9	24.3	17.7	N/A
	September	21.7	25.6	17.8	N/A
	October	19.7	25.6	13.8	N/A
	November	15.8	20.8	10.9	N/A
	December	13.6	17.9	9.2	N/A
2020	January	13.9	18.7	9.1	N/A
	February	14.4	19.2	9.6	N/A
	March	13.7	17.4	9.9	N/A
	April	15.9	19.6	12.3	N/A
	May	18.0	21.8	14.2	N/A
	June	19.3	22.4	16.2	N/A
	July	19.4	22.9	15.9	N/A

Table 7. Table displaying NOAA wind speed and precipitation monthly data for the Santa Monica Municipal Airport Station (downloaded on 31 August 2020).

Year	Month	Wind Speed (mph)				Precipitation (cm)
		Average	Maximum	Minimum	Maximum Gust	Total
2016	October	4.0	16.0	0.0	24.0	0.76
	November	4.2	17.0	0.0	33.0	1.80
	December	4.4	21.0	0.0	31.0	8.21
2017	January	4.9	22.0	0.0	32.0	15.71
	February	4.1	26.0	0.0	40.0	7.38
	March	4.6	20.0	0.0	36.0	0.38
	April	5.6	23.0	0.0	37.0	0.22
	May	5.2	17.0	0.0	31.0	0.11
	June	4.7	15.0	0.0	23.0	0.0
	July	4.9	14.0	0.0	21.0	0.0
	August	4.7	14.0	0.0	20.0	0.0
	September	4.5	15.0	0.0	23.0	0.0
	October	3.8	13.0	0.0	22.0	0.0
	November	3.4	13.0	0.0	20.0	0.14
	December	4.0	18.0	0.0	36.0	0.0
2018	January	3.9	20.0	0.0	31.0	3.04
	February	4.4	22.0	0.0	31.0	0.26

Year	Month	Wind Speed (mph)				Precipitation (cm)
		Average	Maximum	Minimum	Maximum Gust	Total
	March	4.6	16.0	0.0	29.0	8.1
	April	5.0	21.0	0.0	37.0	0.06
	May	4.8	16.0	0.0	25.0	0.18
	June	5.0	17.0	0.0	21.0	0.0
	July	5.1	14.0	0.0	22.0	0.0
	August	4.9	18.1	0.0	28.0	0.0
	September	4.5	16.1	0.0	21.9	0.0
	October	4.2	25.1	0.0	35.1	0.51
	November	3.7	21.9	0.0	31.1	1.57
	December	4.1	21	0.0	33.1	1.68
2019	January	4.4	19.9	0.0	36.9	5.14
	February	5.7	23.9	0.0	38.9	4.52
	March	5.2	21	0.0	31.1	2.02
	April	5.3	25.9	0.0	40.9	0.043
	May	5.3	23	0.0	34.0	1.14
	June	5.2	19.9	0.0	28.0	0.0
	July	5.0	14.1	0.0	19.9	0.0
	August	4.5	15.0	0.0	21.0	0.0
	September	4.5	16.1	0.0	24.0	0.0
	October	4.3	18.1	0.0	23.0	0.0
	November	3.8	18.1	0.0	31.0	0.6
	December	4.3	19.9	0.0	31.0	1.8
2020	January	3.8	18.1	0.0	33.0	0.2
	February	4.7	25.9	0.0	47.0	0.0
	March	4.7	23.0	0.0	33.0	1.8
	April	4.9	18.1	0.0	25.0	0.9
	May	4.9	19.9	0.0	30.0	0.1
	June	5.6	21.9	0.0	32.0	0.0
	July	4.7	17.0	0.0	25.0	0.0

Elevation Profiles

Elevation profile data were collected via four transects within the restoration area and two control transects outside the restoration area (approximately 100 m south of the restoration area) (Figure 25). Elevation profiles provide a method to measure topographical changes within the seeded fenced area and beach face over time. Elevation profile data were collected on 13 December 2016 (baseline); 24 March, 21 June, and 13 September 2017; 13 February, 24 May, 29 May, 15 August, and 14 December 2018; 22 February, 21 May, 1 August, and 6 November 2019; 5 February, and 24 July 2020. Elevation profiles taken over the four years post-project implementation show notable changes from both the baseline and control transects (Figures 26 – 31). Figures 26 – 31 are separated into 'winter beach' and 'summer beach' defined by the highly variable seasonal profile on beaches in Southern California. Data from Control Transect 2 on 24 July 2020 was removed during quality control checks due to equipment malfunction. Berm topology along the fenced perimeter of the site shows variations over time between the restoration site and control site, with up to a meter of sand deposition present in multiple locations.

All elevation profiles within the restoration area show an overall increase in elevation from the baseline surveys, indicating the deposition and retention of sand within the site. Sand build up is greatest along the berm, nearest the beach face and ocean, and along the northern and southern fence perimeter. The southeast corner of the restoration area continues to show a high relative buildup of sediment (e.g., Restoration Transect 4, Figures 29a and 29b), which can be explained by the predominant wind pattern moving sand in that direction. Survey data show that control sites have shown slight variability over time, with seasonal changes in the berm and beach face, elevation variability, and a generally flat and even beach profile, all likely due to maintenance by grooming. In general, all restoration transects have shown a higher overall increase in elevation compared to control transects. Additionally, restoration transects are also now capturing the formation of plant hummocks across multiple seasons (e.g., at approximately the 40 meter mark along Transects 2, 3, and 4). Future surveys will allow for a more thorough assessment of sediment movement to support the evaluation of the restoration area as a possible buffer from climate change impacts such as sea level rise and wave erosion, though seasonal changes may also be captured.

Figure 25. TBF staff and CRI interns conducting an elevation profile survey on 6 November 2019.

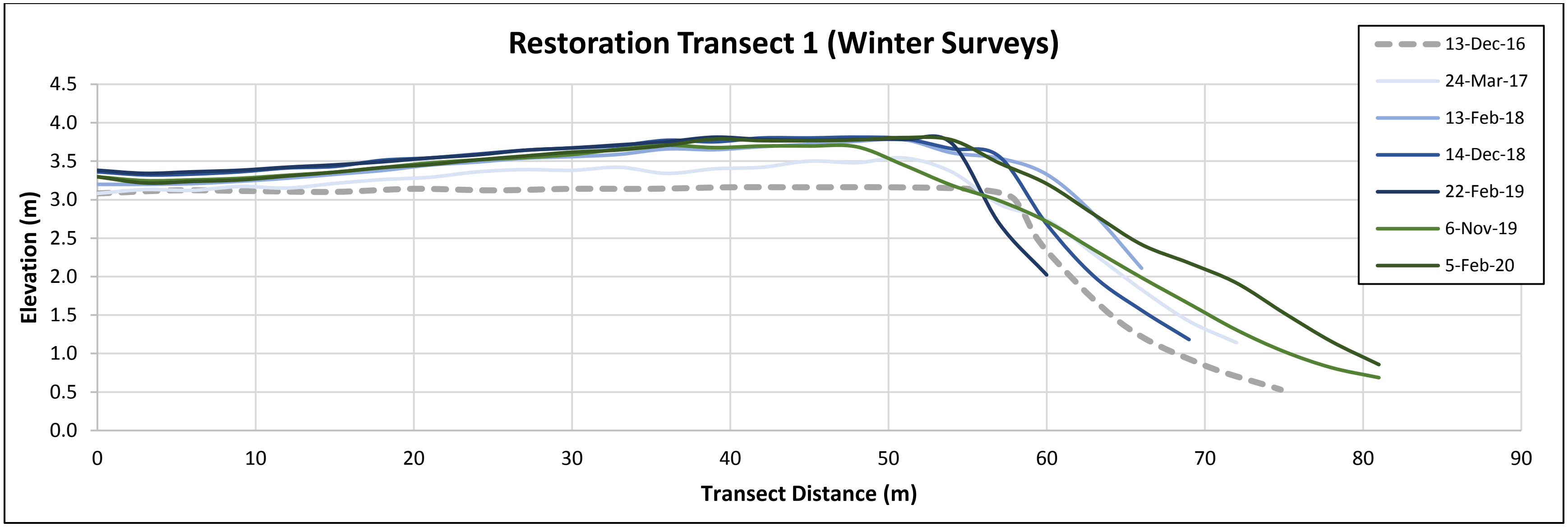


Figure 26a. Restoration Transect 1 elevation profiles during Winter Beach surveys (Elevation in NAVD88).

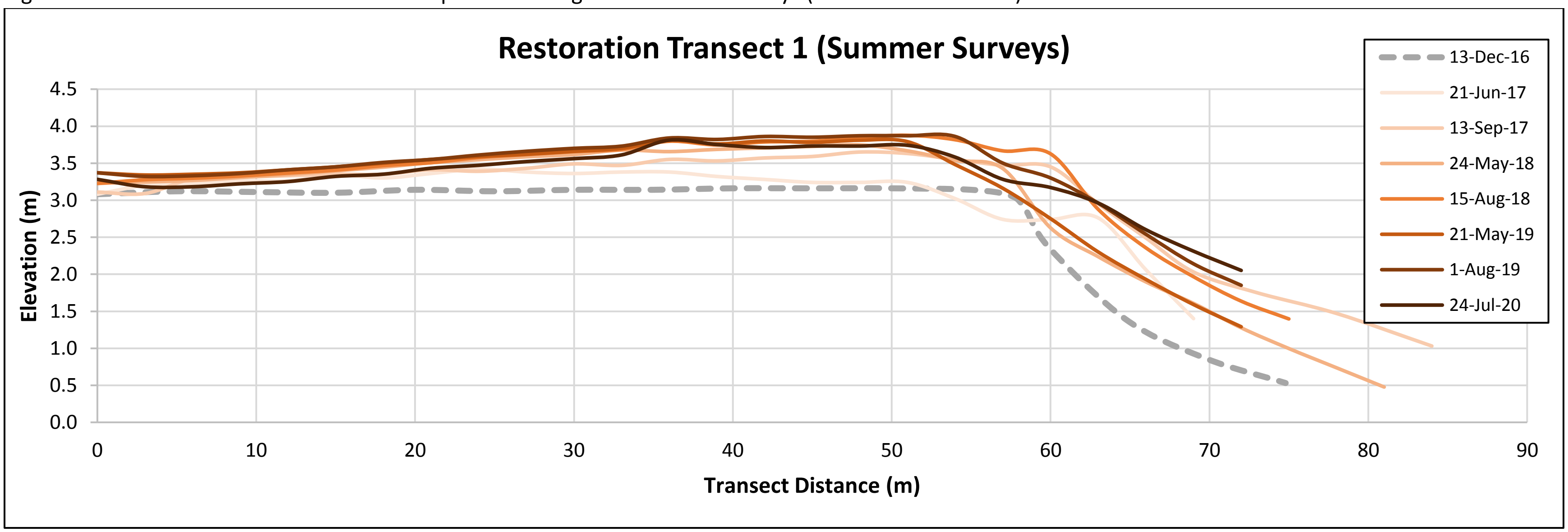


Figure 26b. Restoration Transect 1 elevation profiles during Summer Beach surveys (Elevation in NAVD88).

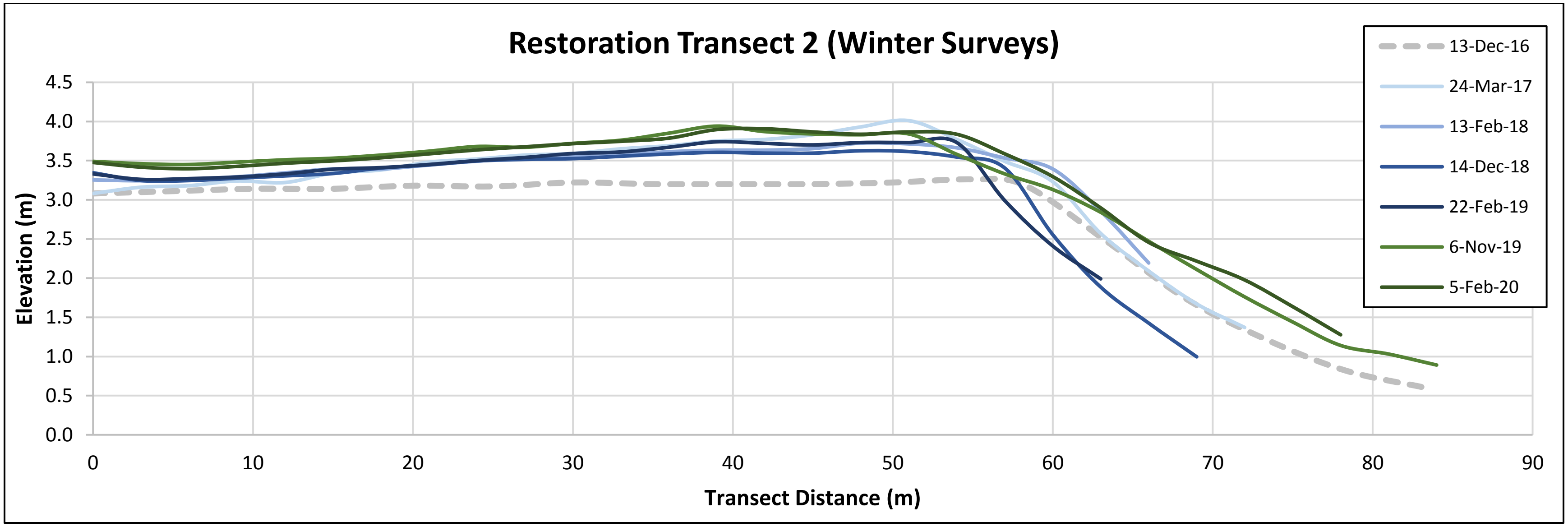


Figure 27a. Restoration Transect 2 elevation profiles during Winter Beach surveys (Elevation in NAVD88).

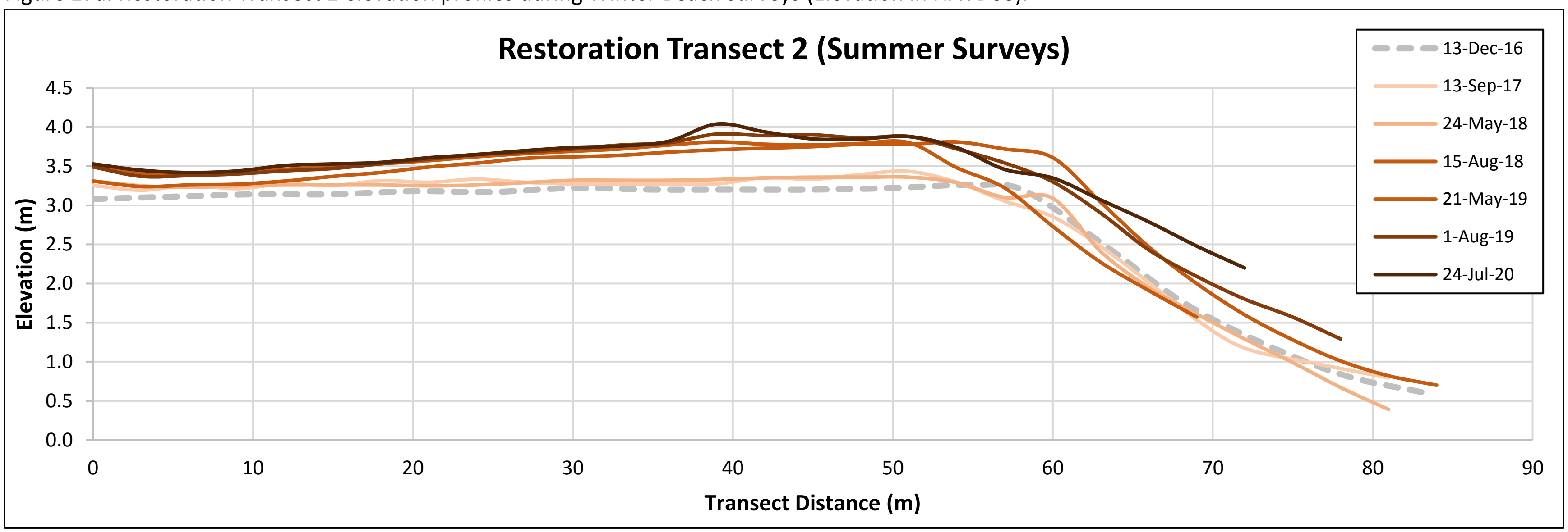


Figure 27b. Restoration Transect 2 elevation profiles during Summer Beach surveys (Elevation in NAVD88).

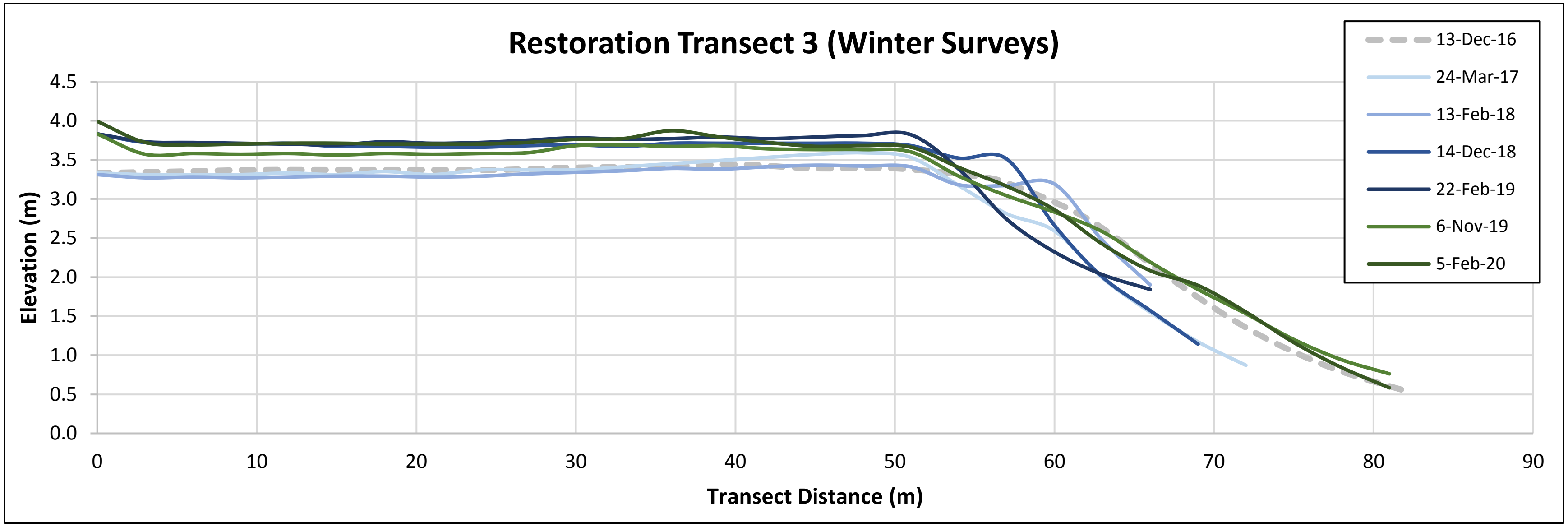


Figure 28a. Restoration Transect 3 elevation profiles during Winter Beach surveys (Elevation in NAVD88).

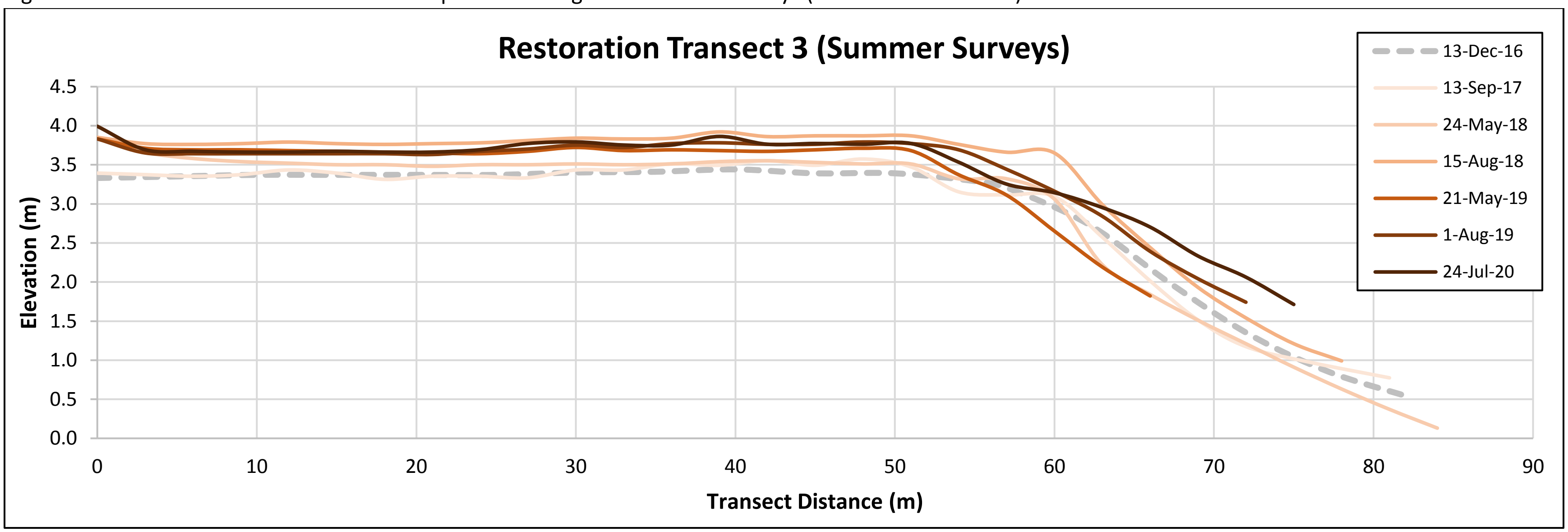


Figure 28b. Restoration Transect 3 elevation profiles during Summer Beach surveys (Elevation in NAVD88).

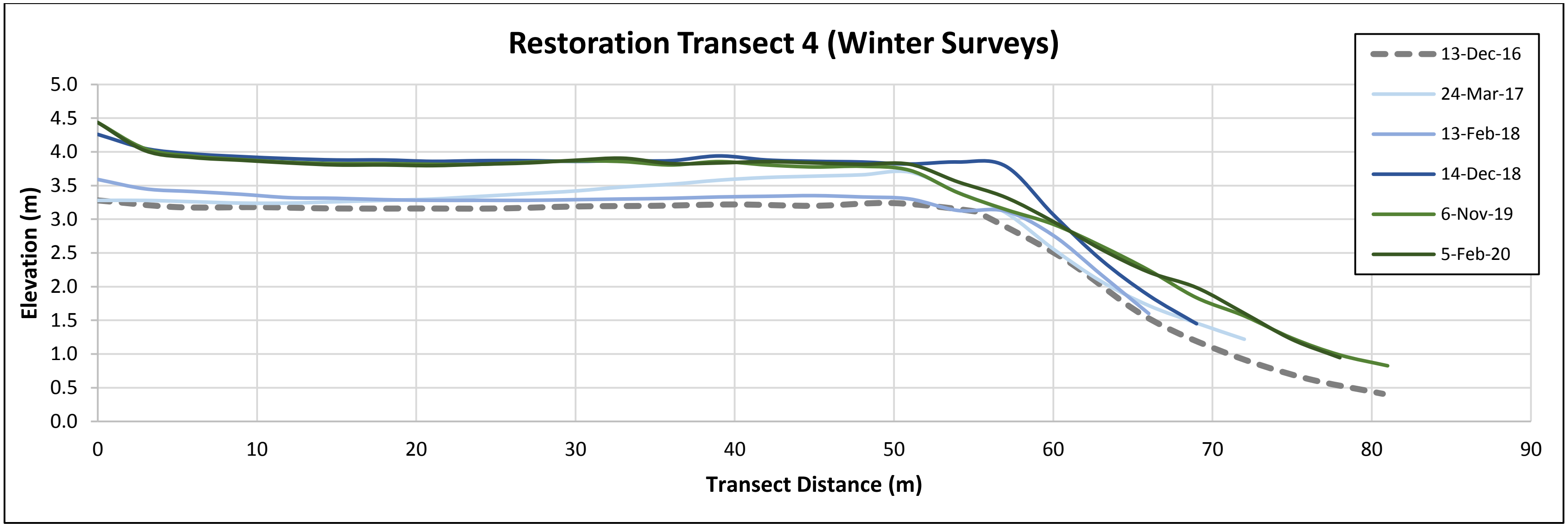


Figure 29a. Restoration Transect 4 elevation profiles during Winter Beach surveys (Elevation in NAVD88).

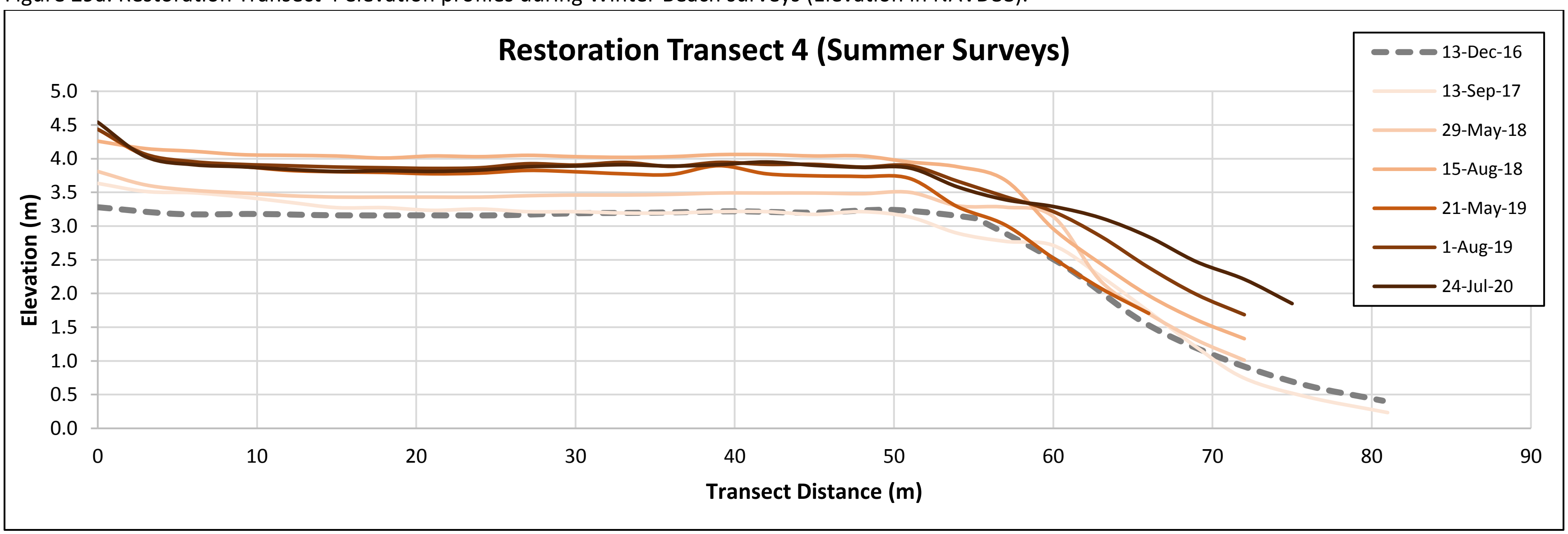


Figure 29b. Restoration Transect 4 elevation profiles during Summer Beach surveys (Elevation in NAVD88).

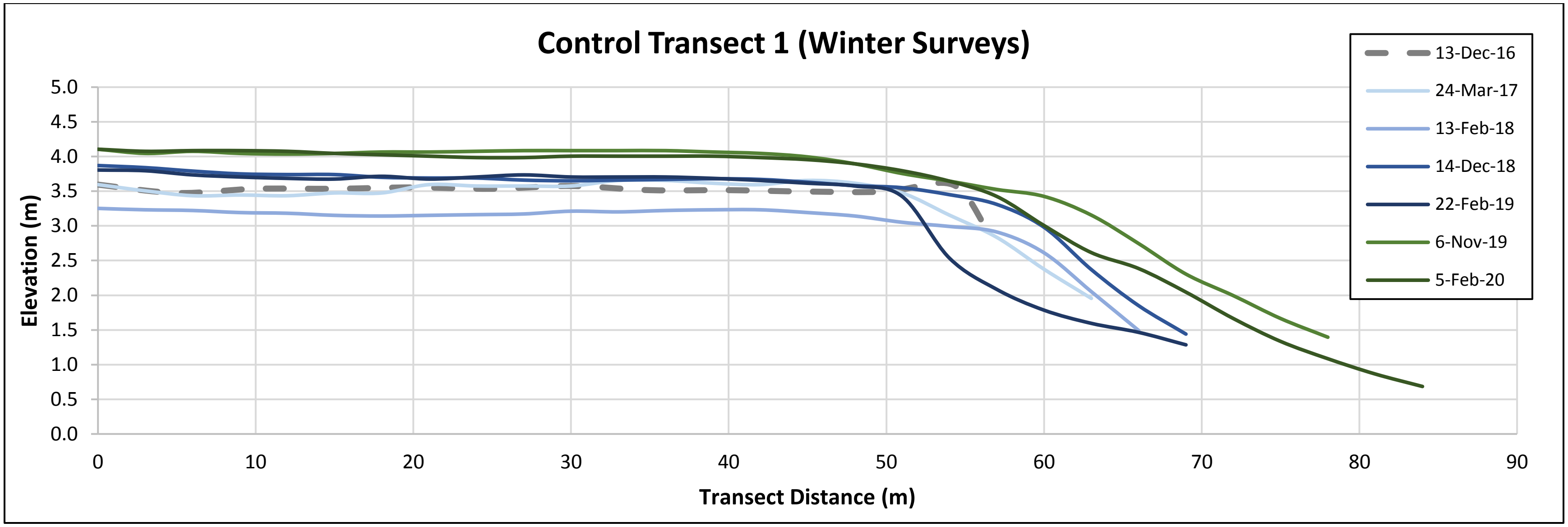


Figure 30a. Control Transect 1 (non-restored area) elevation profiles during Winter Beach surveys (Elevation in NAVD88).

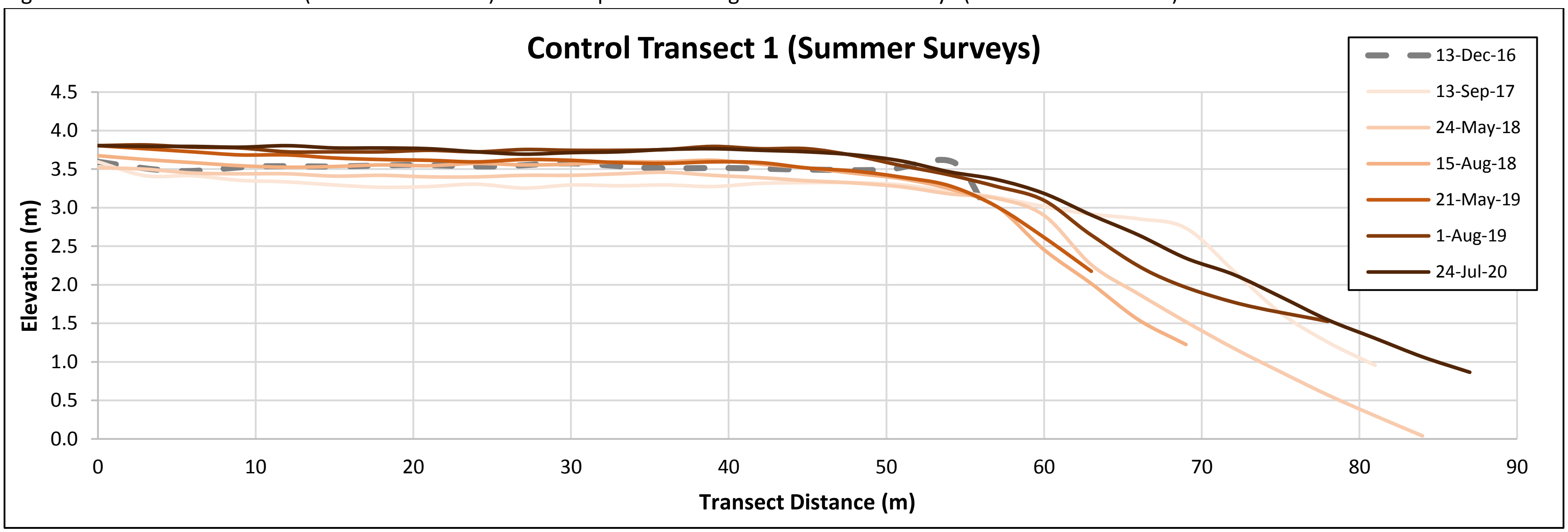


Figure 30b. Control Transect 1 (non-restored area) elevation profiles during Summer Beach surveys (Elevation in NAVD88).

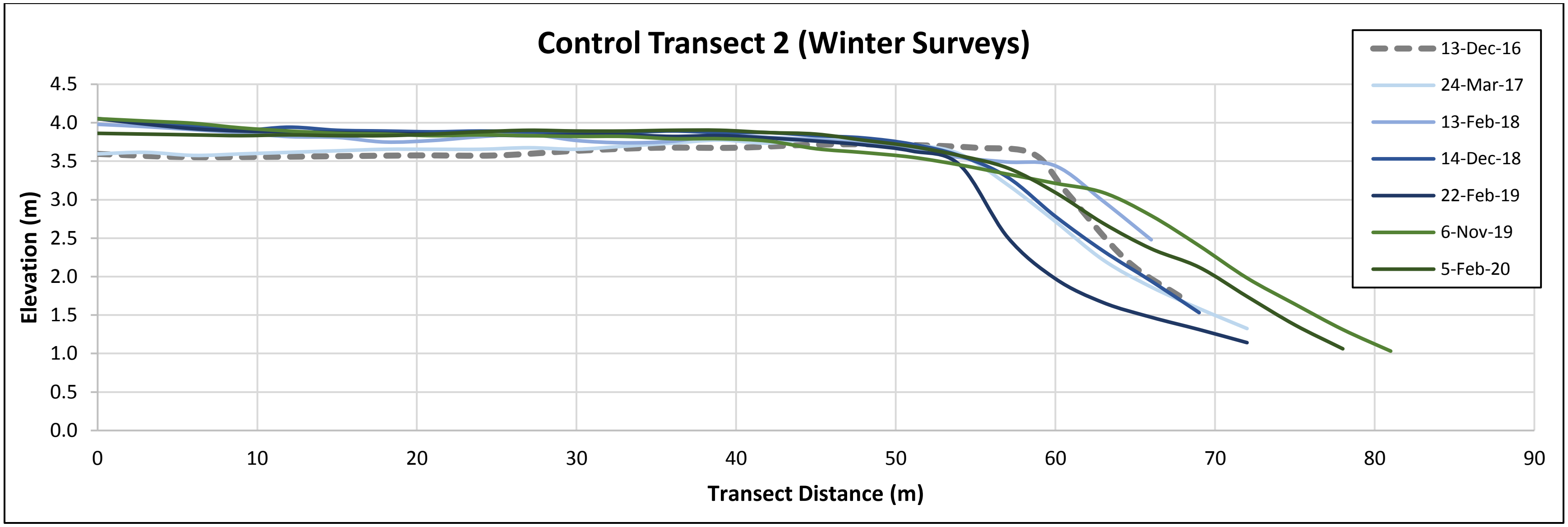


Figure 31a. Control transect 2 (non-restored area) elevation profiles during Winter Beach surveys (Elevation in NAVD88).

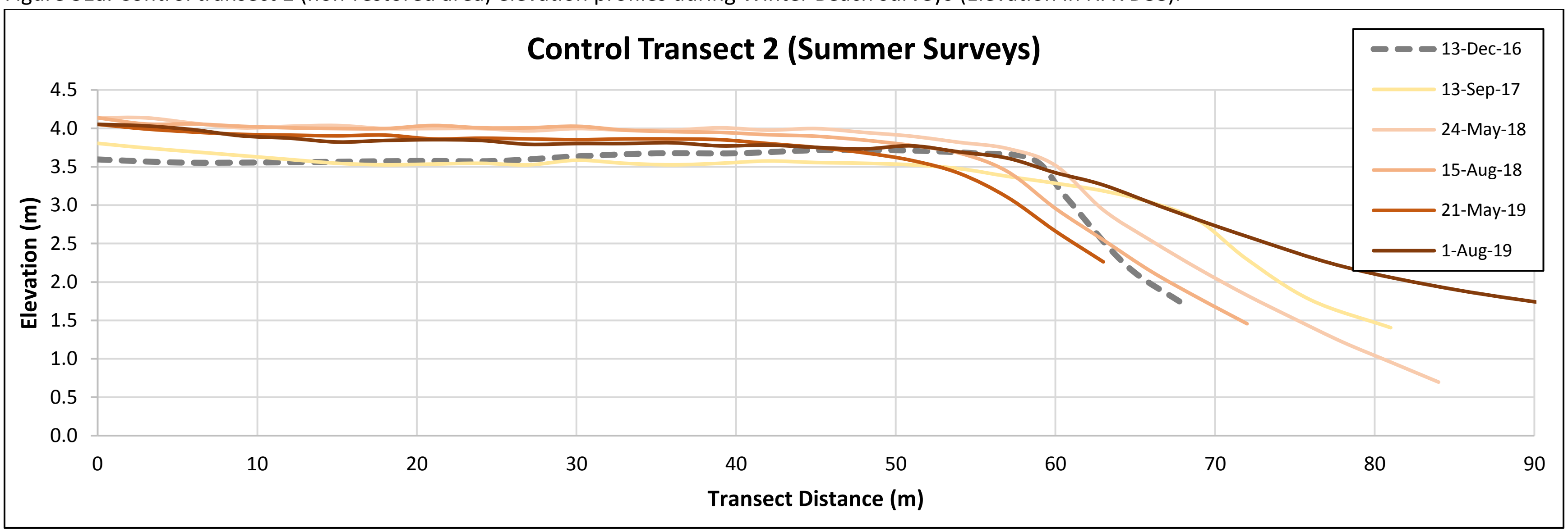


Figure 31b. Control transect 2 (non-restored area) elevation profiles during Summer Beach surveys (Elevation in NAVD88).

High-resolution elevation surveys using a Trimble Geo7x GPS were conducted on 12 April 2017 (Year 1), from 24 to 27 June 2018 (Year 2), and on 21 August 2020 (Year 4). Elevation points were downloaded, quality control checked, and analyzed in a geographic information system (GIS) to create a topographic surface of the restoration site. Figure 33a displays the topographic map results from the GPS elevation survey in May 2017 (top) and May/June 2018 (bottom) and Figure 33b displays results for Year 4. Note that Figure 32b (Year 4 survey) includes two additional elevation interval color categories due to increased height. The topographic data supplement the elevation profile transects and indicate a buildup of sand along the berm and fence perimeter, with smaller plant hummocks throughout the site. The Year 4 survey shows a noticeable increase in elevation throughout most of the restoration area. This is most apparent in the southern portion of the project footprint. Additionally, the micro-topography of the restoration site appears to become increasingly more complex across each subsequent survey, which supports visual observations of the formation of dune hummocks around vegetation and wrack within the restoration site (Figure 32). An additional topographic survey using GPS is planned for Year 5.

Figure 34 shows buildup of sand along the northern fence perimeter in May 2017 and again in February 2020, where an increase of vegetation, especially red sand verbena and beach bur are present. Berm changes parallel to the ocean have also been observed in photographic documentation and monitoring data with seasonal variations present. The beach berm ridge is higher in elevation and more prominent in the restoration site. Figure 35 shows a time-series of the berm changes observed post-restoration. Additional surveys will continue to tract the berm fluctuations over time. The continued rise in elevation of the berm in multiple elevation profiles and supporting topographical surveys indicate promising results that the site is potentially becoming more resilient to coastal flooding than other sections of the beach that retain a low, flat profile. Future surveys will continue to inform changes in the restoration site and berm morphology over time. Additional data may also provide the opportunity to begin modelling sea level rise scenarios under new restoration conditions compared to control sites.

Figure 32. Photograph of vegetated dune hummock within the restoration area (5 February 2020).

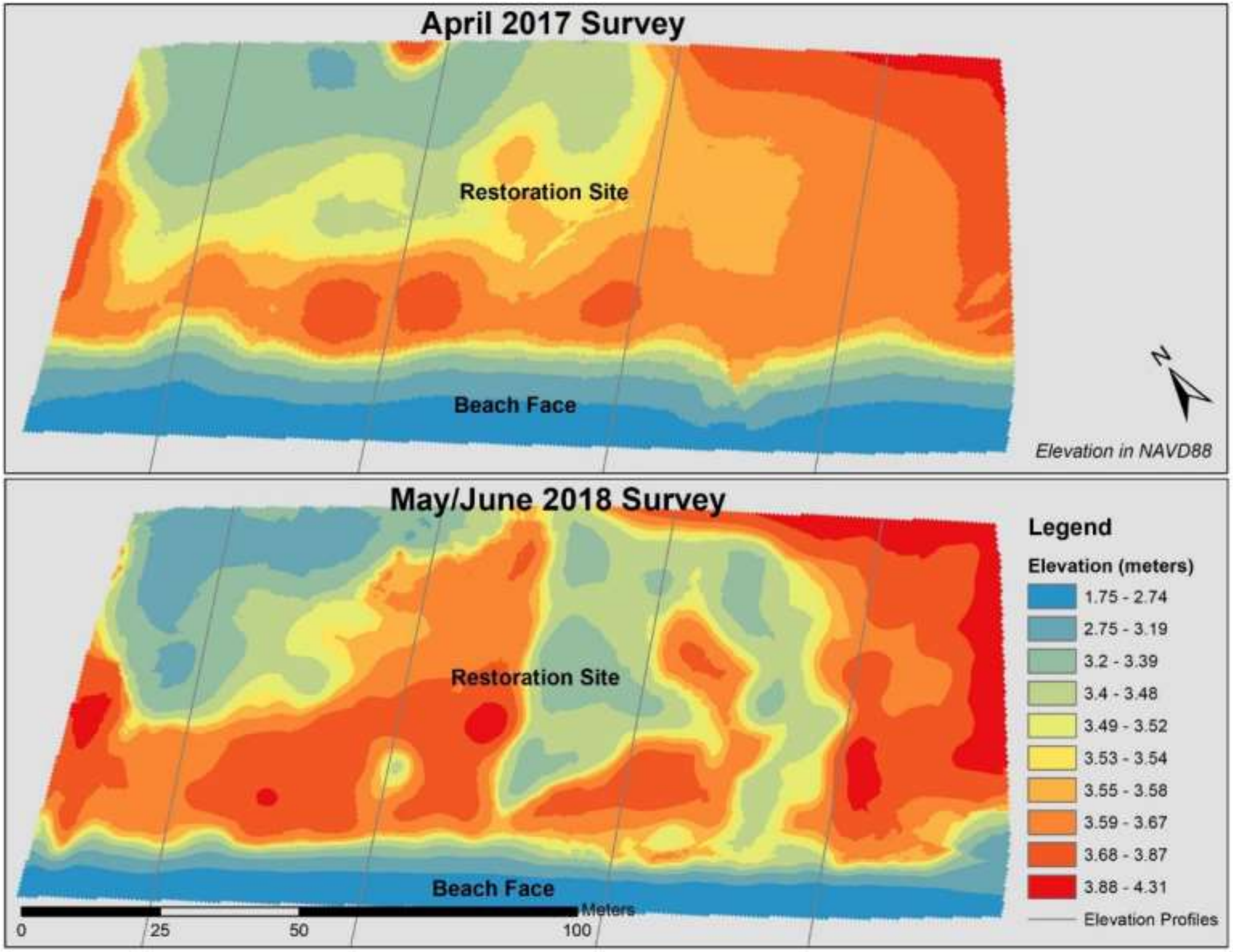


Figure 33a. Year 1 (top, four months after implementation) and Year 2 topographic map of restoration site.

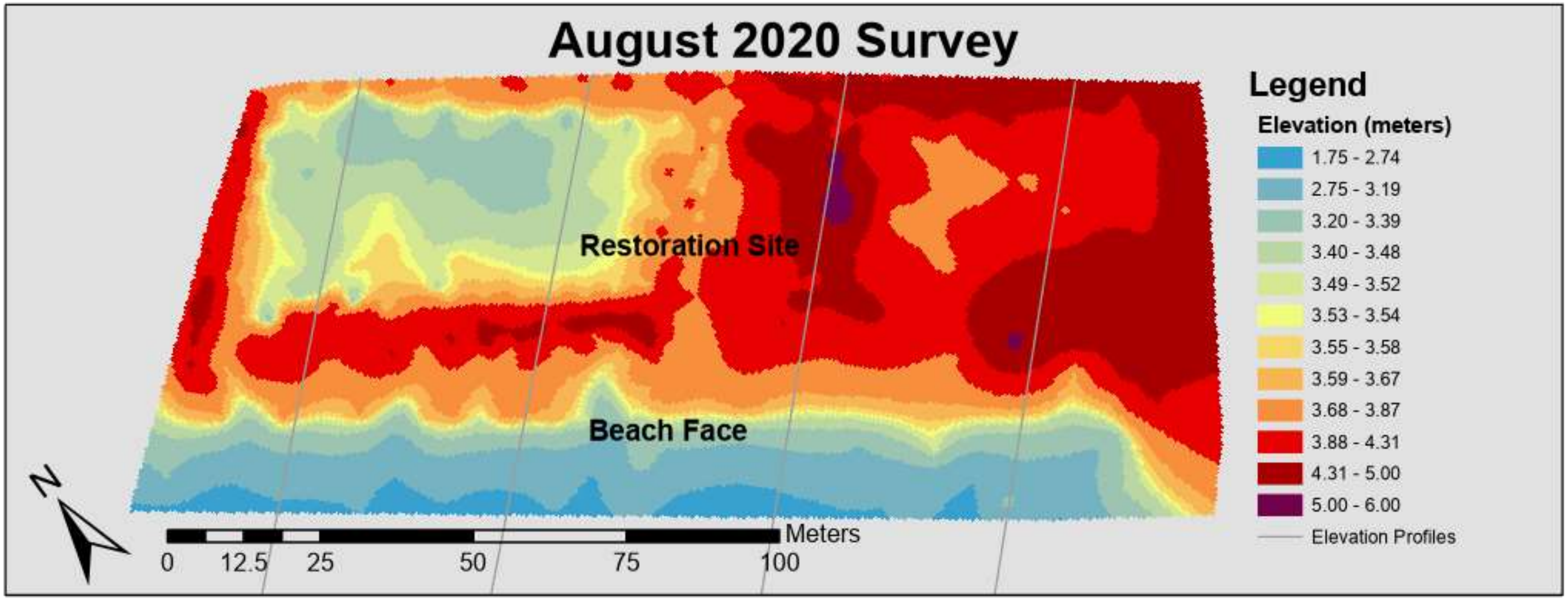


Figure 33b. Year 4 topographic map of restoration site. Note two additional elevation interval categories (dark red and purple).

Figure 34. Photograph of sand build-up along the northern fence line in the restoration area (top: 9 May 2017, approximately five months after implementation; and bottom: 5 February 2020).

Figure 35. Berm topography (top left: 17 December 2016, top right: 25 January 2017, bottom left: 8 March 2018, and bottom right: 3 March 2019).

Sand Deposition, Grain Size, and Organics

A set of baseline and post-restoration sand samples were collected from two control transects and four transects on 13 December 2016 (baseline); 24 March and 13 September 2017; 24 May and 16 November 2018; 3 June and 6 November 2019; and 24 July 2020. Three samples were collected from each transect (approximately 3 meters south of the transect line to avoid footprints), including two dry samples off the 15 and 30 transect meter mark, and a wet sample near the waterline on the beach face. Samples were weighed before and after drying to measure moisture content, then each sample was sorted using a set of sieves measuring from 2 mm (very fine pebbles) to 0.06 mm (very fine sand). A portion of each sample was also used to analyze organics based on the loss on ignition (LOI) method. TBF conducts all sediment analyses in a laboratory located on the campus of Loyola Marymount University. Due to COVID-19 regulations and guidelines, LMU's campus was closed from March 2020 through the time of this report. As a result, TBF did not lab have access to complete sediment analyses for samples collected during Year 4. Only grain size and moisture content for the samples collected in November 2019 were completed. TBF will complete remaining Year 4 sediment analyses once campus restrictions are lifted.

Sand within the restoration site varied from pebbles (very fine) to very fine sand (Figure 36). Small dunes and plant hummocks were observed to form with larger sized sediment at the base of the hummocks and finer grain sizes on top due to wind driven transport (Figure 37). Dry sand samples collected (averaged for 15 and 30 m) saw variable trends between surveys, with a small increase in very coarse sand and pebble percent composition within the restoration area (Figure 38). The latest survey in November 2019 shows that coarse sand continues to be one of the most dominate grain size types. Additionally, medium sand was found to be a co-dominant grain size in the Year 4 survey. This continues the trend from Year 3 of increasing medium sand grain size type.

Figure 36. Sand grain in restoration site (left: pebbles; middle: coarse sand; right: medium to very fine sand).

Figure 37. Photographs showing larger grains at the base of the dune and finer grains on top due to aeolian processes (top: 29 April 2019; bottom: 5 February 2020).

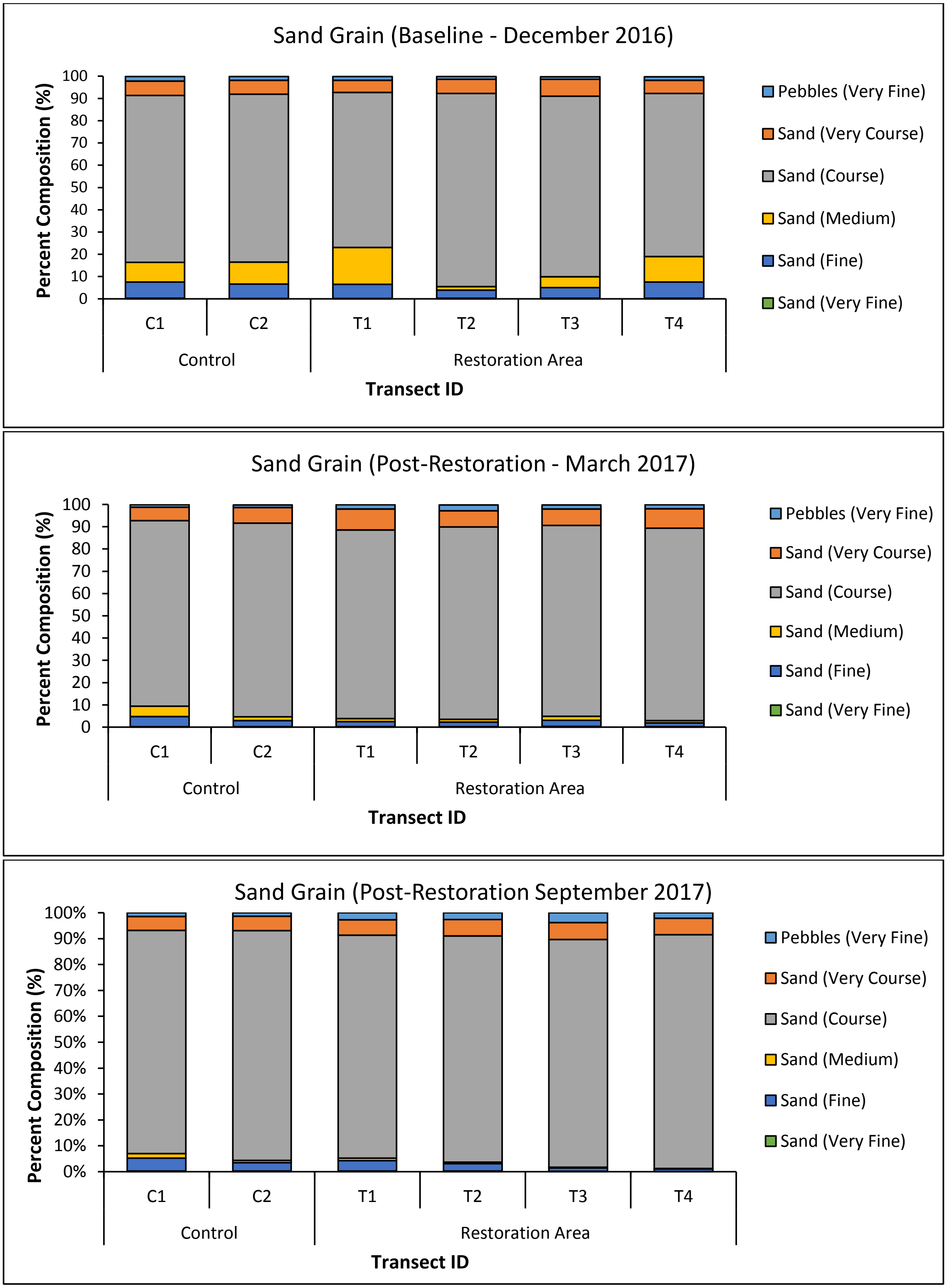
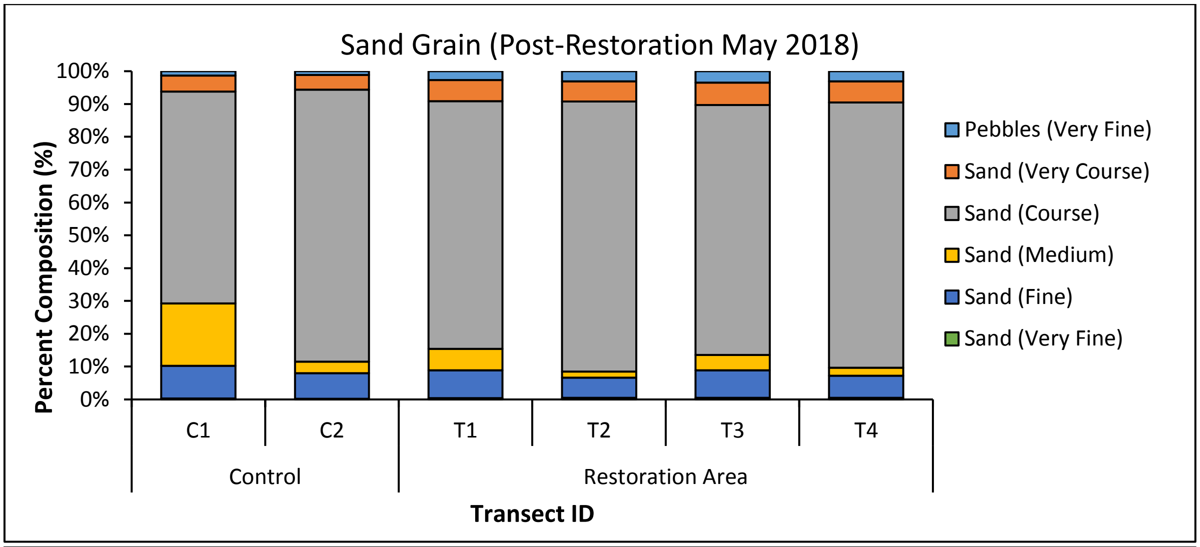
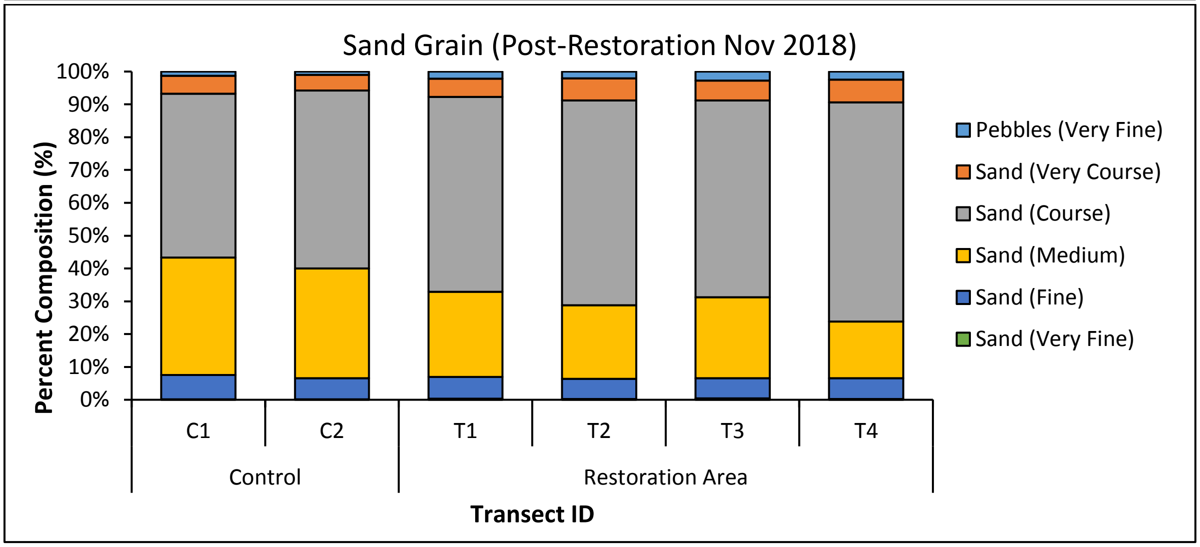


Figure 38. Baseline (top) followed by post-restoration sand grain results for all transects (dry sample averages).





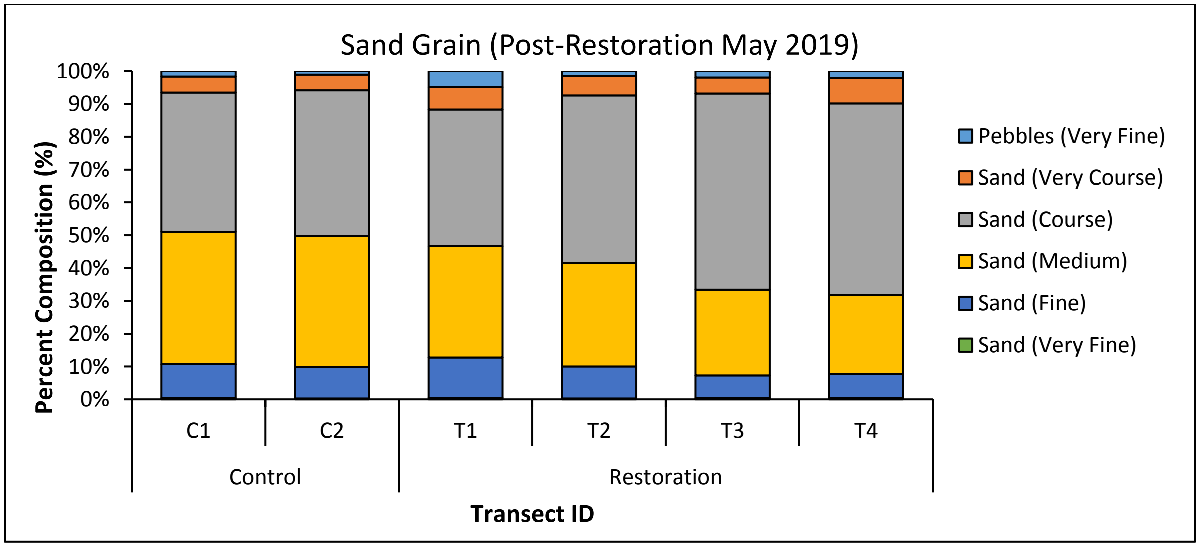


Figure 38 (cont'd). Post-restoration sand grain results for all transects (dry sample averages).

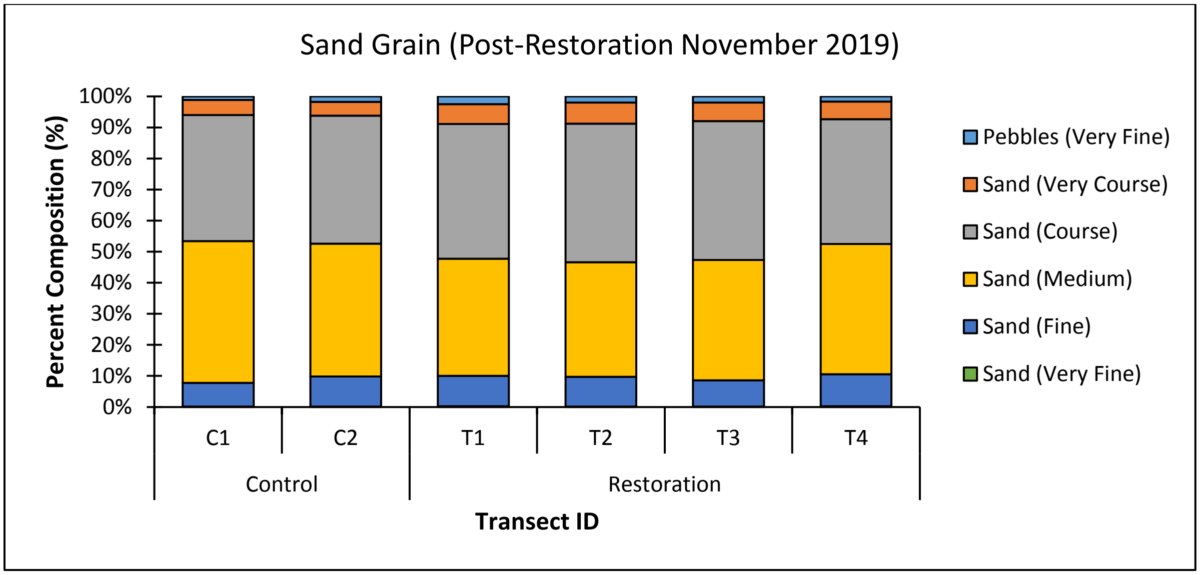


Figure 38 (cont'd). Post-restoration sand grain results for all transects (dry sample averages).

Wet sand results were reported separately (Table 8). Results from the wet sand samples were variable between the baseline survey and the post-restoration survey but displayed relatively similar results at both the control transects and the restoration transects. As the wet sand is outside of the area actively maintained for the restoration, the similarity between the control and restoration results for the wet sand was expected. The variability between the baseline and post-restoration surveys is likely due in part to the collection of the samples in two different wet sand locations based on the seasonal movement of the berm and wave erosion. Baseline sand composition, taken December 2016, was dominated by coarse and medium sand grains, and the data indicate an oscillation between medium grains during summer to coarse sand grains in winter season (Table 8). This shift in grain sizes is likely consistent with winter storms eroding the beach face followed by the deposition of sand in the calmer spring and summer months (Figures 39).

Figure 39. Photographs of eroded beach face following a winter king tide on 25 January 2017 (left) and a gentler sloping beach face on 15 August 2018 during summer season (right).

Table 8. Grain size results from December 2016 (baseline) and post-restoration (March 2017, September 2017, May 2018, November 2018, May 2019, November 2019).

		Control Transects		Restoration Area Transects			
	Grain Size	C1	C2	T1	T2	T3	T4
Baseline – wet (Dec 2016)	Pebbles (Very Fine)	0.07%	0.00%	1.05%	0.88%	0.23%	0.33%
	Sand (Very Coarse)	0.38%	0.00%	0.68%	1.02%	1.57%	1.01%
	Sand (Coarse)	78.52%	58.34%	8.01%	5.11%	93.44%	38.61%
	Sand (Medium)	10.84%	33.34%	32.22%	17.19%	0.66%	32.12%
	Sand (Fine)	10.12%	8.28%	57.01%	74.40%	4.00%	27.64%
	Sand (Very Fine)	0.06%	0.05%	1.01%	1.35%	0.09%	0.27%
Post-Rest –wet (Mar 2017)	Pebbles (Very Fine)	0.21%	2.01%	7.91%	0.06%	0.69%	0.82%
	Sand (Very Coarse)	4.13%	9.22%	3.77%	2.91%	3.58%	5.82%
	Sand (Coarse)	81.82%	78.78%	75.52%	95.89%	86.74%	88.43%
	Sand (Medium)	6.01%	5.69%	4.77%	0.67%	1.75%	1.36%
	Sand (Fine)	7.72%	4.24%	7.91%	0.42%	2.06%	3.37%
	Sand (Very Fine)	0.09%	0.05%	0.11%	0.04%	5.19%	0.16%
Post-Rest –wet (Sep 2017)	Pebbles (Very Fine)	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%
	Sand (Very Coarse)	0.53%	1.17%	0.69%	0.00%	0.41%	0.40%
	Sand (Coarse)	13.37%	4.69%	2.48%	2.33%	2.45%	2.38%
	Sand (Medium)	64.53%	70.77%	51.31%	66.62%	62.40%	69.31%
	Sand (Fine)	21.16%	22.89%	44.98%	30.51%	34.33%	27.5%
	Sand (Very Fine)	0.32%	0.47%	0.55%	0.55%	0.41%	0.40%
Post-Rest –wet (May 2018)	Pebbles (Very Fine)	0.10%	0.25%	0.13%	0.00%	0.00%	0.00%
	Sand (Very Coarse)	0.52%	0.74%	0.13%	0.30%	0.41%	0.42%
	Sand (Coarse)	84.04%	72.65%	89.62%	86.21%	88.16%	80.21%
	Sand (Medium)	1.55%	5.82%	1.14%	1.35%	1.09%	1.88%
	Sand (Fine)	13.47%	20.42%	8.73%	11.99%	10.20%	17.29%
	Sand (Very Fine)	0.31%	0.12%	0.25%	0.15%	0.14%	0.21%
Post-Rest –wet (Nov 2018)	Pebbles (Very Fine)	0.39%	0.36%	0.38%	0.19%	0.20%	0.24%
	Sand (Very Coarse)	0.78%	0.54%	0.57%	0.37%	0.20%	0.48%
	Sand (Coarse)	0.97%	1.26%	1.15%	0.93%	0.98%	1.21%
	Sand (Medium)	81.75%	93.54%	96.36%	93.64%	97.65%	97.34%
	Sand (Fine)	14.76%	3.95%	1.53%	4.67%	0.98%	0.72%
	Sand (Very Fine)	1.36%	0.36%	0.00%	0.19%	0.00%	0.00%
Post-Rest –wet (May 2019)	Pebbles (Very Fine)	0.10%	0.10%	0.85%	0.12%	0.00%	0.00%
	Sand (Very Coarse)	1.30%	1.28%	0.85%	1.60%	0.74%	1.13%
	Sand (Coarse)	34.03%	19.78%	21.90%	67.20%	66.08%	69.33%
	Sand (Medium)	59.48%	65.55%	58.57%	25.52%	27.48%	24.07%
	Sand (Fine)	5.09%	13.19%	17.74%	5.43%	5.61%	5.39%
	Sand (Very Fine)	0.00%	0.10%	0.08%	0.12%	0.09%	0.09%

		Control Transects		Restoration Area Transects			
	Grain Size	C1	C2	T1	T2	T3	T4
Post-Rest –wet (Nov 2019)	Pebbles (Very Fine)	0.81%	0.78%	0.52%	0.82%	0.52%	0.42%
	Sand (Very Coarse)	0.24%	0.28%	0.23%	0.36%	0.39%	0.36%
	Sand (Coarse)	1.15%	1.28%	0.66%	0.76%	1.21%	0.87%
	Sand (Medium)	89.28%	79.96%	4.13%	32.51%	93.01%	6.51%
	Sand (Fine)	8.31%	17.23%	90.72%	64.93%	4.70%	90.20%
	Sand (Very Fine)	0.13%	0.21%	2.44%	0.35%	0.11%	0.75%
	Pebbles (Very Fine)	0.08%	0.26%	1.30%	0.27%	0.06%	0.89%

Sand transport measurement protocols were attempted using Modified Wilson and Cooke (MWAC) samplers to determine actual in-field sand transport rates. MWAC samplers were deployed for 30 minutes to one hour on multiple field surveys and failed to collect sand. This protocol will continue to be attempted during future surveys, targeting high wind conditions to maximize sand collection success. Additionally, data collected in the field combined with sand grain analyses was used in an empirical model to calculate wind-blown sand transport (Hsu 1981). Hsu's calculations will provide a future method to cross-validate predictive wind-driven sand transport as compared to MWAC samplers for direct measurement. Observationally, a shift in coarser sand and cobble was seen in the restoration site. Additionally, sand transport and deposition has been occurring along fence lines and around larger vegetation patches and wrack. High resolution elevation surveys confirm an increase in sand deposition along the fences and behind the berm.

A portion of each sediment sample was analyzed for organic matter and carbonate content using the loss on ignition (LOI) method (Figure 40). Samples were placed in weighted crucibles and weight loss was measured after heating the samples in a high-temperature furnace to remove organic matter. Figure 41 compares the average percent organics in dry sediments from the control site and restoration site by survey date. The restoration site shows a slightly higher overall percent organics composition in samples compared to the control site on each survey; however, there are only slight differences from the baseline (pre-restoration, December 2016). Sediments are an important site for organic matter decomposition and nutrient regeneration in coastal marine environments, and continued data collection may inform the effects the beach restoration project has on carbon cycling and transformations.

Figure 40. Organics (loss on ignition) analysis on sand samples (18 July 2018).

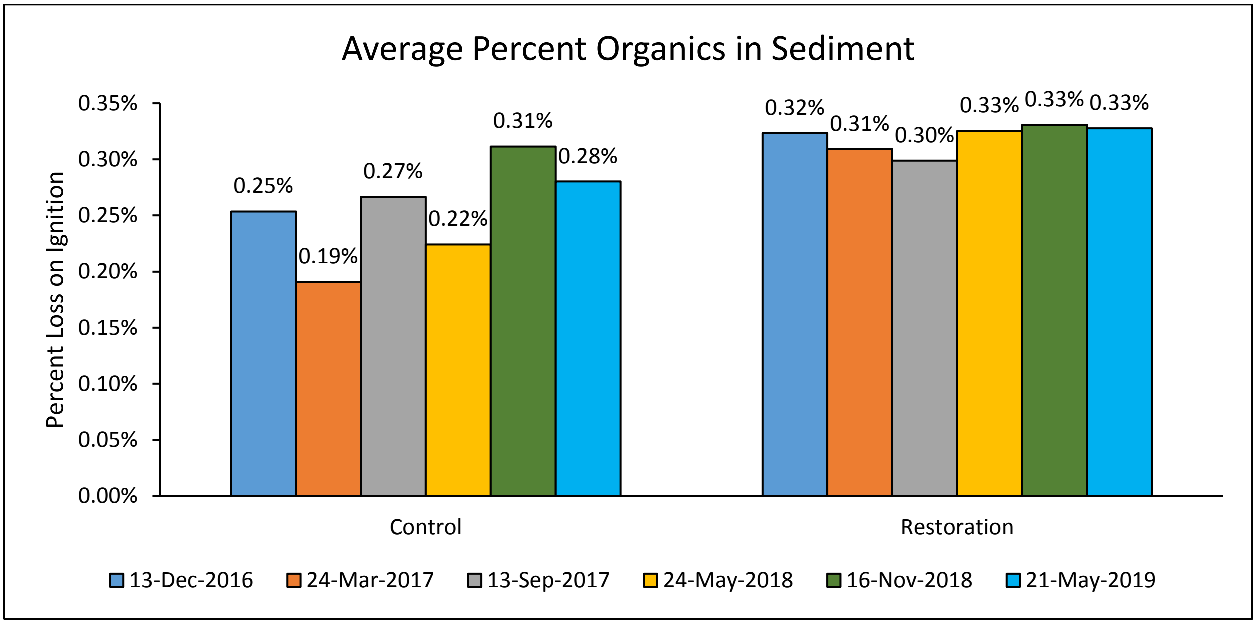


Figure 41. Average percent organics in sediment samples by survey date (dry samples only).

Photo Point

Photo point survey methods are described in detail in SOP 7.2 Level 2 Photo Point (TBF 2015a). Photographs can be used as qualitative assessments of seasonal variation and changes following restoration activities. Seventeen photographs were taken at nine stations on 13 and 17 December 2016; 13 and 25 January, 4 February, 24 March, 25 April, 21 August, and 13 September 2017; 11 January, 8 March, 13 April, 24 May, 15 August, and 19 December 2018; 22 February, 25 April, 21 May, 1 August, and 11 November2019; 2 February and 24 July 2020. Quarterly photos were reported for six representative photo point stations (Appendix A) because they best represent the site changes over time.

Photo points show slow gradual growth of individual plants in the first year (2016-17) and a noticeable increase in cover in the second (2018) and third (2019). In Year 4 (2019-20), vegetation cover continued its upward trajectory in establishment, with photos depicting a much more vegetated community throughout the entire restoration area. The permanent photo stations are established to document the restoration site over quarterly periods. Additionally, dune topography is continuing to become more complex over time with an increase in amount and size of vegetated dune hummocks, as well as continued sand deposition along the fence perimeter (Photo Point 2A). Also notable is the change in sand grain size, with an increase in coarser sand and fine pebbles (darker substrate) surrounding the dune hummocks (most noticeable in Photo Point 1A and 9B).

See Appendix A for quarterly photos from six representative photo point stations.

Figure 42. Representative site photograph from 5 February 2020 looking out oceanward from inside the back beach southern fence perimeter.

Adaptive Management, Maintenance, and Site Use

Adaptive management is implemented based on the success of the project as interpreted by TBF, the beach managers, the City of Santa Monica, California Coastal Commission staff, and an advisory group of scientists. The monitoring components and resulting data have been integral in an evaluation of the project. TBF, with the help of our volunteer internship program and several dedicated students from LMU's Coastal Research Institute, have undertaken a hands-on, community-level maintenance strategy without the use of mechanized equipment, including trash removal and invasive species removal. Site checks, invasive plant removal, and trash collection have occurred at least quarterly (twice monthly for the first few months), since the project was implemented. These efforts will continue for a duration of no less than five years after the project began in 2016. Evaluation of the project will continue to occur annually via an annual report, including a summary of monitoring data results, and will be provided to the City, California Department of Parks and Recreation, and the Commission and made publicly available on TBF's website (www.santamonicabay.org).

Site visits will continue to be conducted quarterly (or more frequently) to visually assess the restoration progress and evaluate the need for maintenance activities. The overall condition of the restoration areas will continue to 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 non-native invasive vegetation is found, adaptive management steps such as weed removal by hand or with hand tools will continue to be taken. Thus far, one non-native species, European sea rocket, has invaded the project area to a very minimal extent, with less present in the fourth monitoring year. Hand removal appears to be an effective means of management within the site, as no European sea rocket was found along any transects in all Year 4 surveys, and only a handful of individuals were observed and subsequently pulled throughout the entirety of the restoration area. The areas where it was present do not appear to be directly negatively affecting the native vegetation; however, it continues to be thoroughly monitored and removed. It is likely to continue sprouting because there are source seed populations along the bike path and back dune areas adjacent to the project site, and an assumed pre-existing seed bank in the sand of the project area.

New adaptive management options are under consideration for Year 5, including the potential for supplemental seeding to increase the diversity and cover of vegetation on site, and installation of additional small lengths of sand fence within the project area. Considerations such as stakeholder and agency input, scientific recommendations, and timing implementation to avoid disturbance to western snowy plovers are all being evaluated for Year 5.

Trash continues to be very low within the restoration area. Interestingly, there is often more trash that is picked up in the sand immediately adjacent to the restoration plot (tiny pieces), in beach areas that are frequently groomed. It is likely that the large grooming rakes either miss or bury some of the smaller tiny bits of plastic and polystyrene foam that are frequently found adjacent to and within the project area. Frequently seen trash items include cigarette butts, small bits of plastic, plastic straws, polystyrene foam, candy wrappers, and bits of coffee cups. Infrequently seen items include things like flip-flops, Frisbees, and tennis balls.

Site Use

An important goal of the pilot restoration project is to evaluate whether heavy recreational use of beaches in Los Angeles and natural habitats to benefit birds and wildlife can coexist. Human use data from this project may serve to inform other similar efforts in southern California. One goal of the project was to encourage another, less frequently seen, use of Los Angeles beaches, which is to allow people and families the chance to interact with natural habitats along the beach. As such, the restoration area is not fenced off completely from the public (the shoreward side is left fully open). Recreating inside the project area is only discouraged during western snowy plover breeding season (a federally threatened species). However, sightings of this rare species also bring birdwatchers and other tours to the area. Monitoring of plovers was conducted by the Santa Monica Audubon Society and several local ornithologists and followed protocols by USFWS. Santa Monica Audubon Society continues to provide updates to the project team regarding plover activity and other bird use of the site and is an important partner on the monitoring for this project.

Human use data from the site visits suggest that both locals and visitors are interacting positively with the site in ways that include everything from jogging through it along the symbolic pathway, surfing next to it, and birdwatching along the perimeter. Frequent human uses of the area include walking, jogging, biking along the adjacent bike path, sunbathing, walking dogs, surfing, paddle boarding, and skim boarding (Figure 43). Additional uses include birdwatching and fishing. Dogs have occasionally been observed just outside the site, which could potentially deter birds like western snowy plovers from using the site. Many people have questions as they interact with TBF staff collecting data for surveys such as: "Why is the vegetation here?" "Is this better for birds?" "Will this help with climate change?" All of these questions and many more are answered by staff, and all interactions have thus far been positive. It appears that both locals and visitors alike are responding encouragingly to the restoration area, which bodes well for the future of the site and its ability to answer other goals such as whether or not it can increase coastal resilience against climate change stressors like wave erosion and sea level rise. It is heartening when most people suggest expanding into a larger area. The site has also provided many opportunities to teach students about beach ecology. Several students from LMU's Coastal Research Institute have conducted independent research, and many more have visited the site since implementation. In May 2019, two new educational interpretive signs were deployed at the entrance and along the symbolic pathway of the restoration area. Based on TBF's interactions with people reading the signs, they have been both enjoyed and appreciated for additional context about the site and its importance.

Figure 43. Human use of the restoration site [top: beach visitors reading one of the interpretive signs in the restoration area (13 December 2019); middle: a family using the symbolic pathway through the middle of the restoration area (15 August 2020); bottom: summer beach visitors setting their chairs and towels around the restoration area 15 August 2020].

Conclusions and Recommendations

The first four years following the pilot project implementation had a number of valuable successes and learning experiences. As the project was meant to be an experimental pilot for the region, no specific, quantitative success criteria were set; however, the project can be evaluated against its ability to meet the project goals and objectives. The project positively engaged the public, created new partnerships and outreach connections, restricted grooming in an approximately 3-acre area, allowed vegetation to grow and sand hummocks to form along fence lines, provided comprehensive science-based monitoring data to inform soft-scape beach restoration solutions, supported wildlife, and is bringing back a rare coastal habitat type to the Los Angeles region.

Additionally, the increased functions within the restoration habitat area included benefits to several notable species. Nesting of the federally threatened western snowy plover had not been recorded in the Los Angeles region for almost 70 years, and the first nest for the Los Angeles region was found within the restoration area in 2017 and contained three eggs. Though no nests have been identified in subsequent years, plovers were repeatedly identified on bird surveys throughout all survey years. The presence of plovers throughout breeding and wintering seasons on site suggests that the possibility of future nests by plovers in the area is likely, and the site is now an important plover roosting area.

Furthermore, two native plant species that were not seeded, woolly heads and pink sand verbena, were identified as germinating in the project area. It is possible that there was either an existing seed bank for these species already along Santa Monica Beach, or that they were transported by wind, waves, birds, or humans. Neither species was identified in areas adjacent to the project site. Vegetation surveys also indicate ongoing natural re-seeding and germination by existing plants occurring throughout the site. Another addition to the restoration project area was dune beetles, which provide an increased layer of the food web available to foraging birds and wildlife. Dune beetles were confirmed using a sieving technique by UCSB researchers, monitoring partners of TBF. Specimens were not collected for species-level identification but may potentially be collected in the future.

Data suggest that the restoration area is considerably different from both the control sites and from itself over time as compared to the baseline surveys, especially for increased vegetation and sand morphology, though (as expected) vegetation cover remains relatively low after the fourth growing season. Additional years will allow an evaluation of the vegetation cover trend over time. It is likely that the vegetation community will continue to establish, but will probably remain quite patchy, with expanses of bare ground in between plant hummocks, as is the trend for natural coastal strand habitat types. Elevation remains a good indicator that the restoration area is considerably different from both the baseline and control surveys, with multiple protocols indicating an increase in elevation within the restoration area. The variability of the berm over time and the notable changes in elevation along the fenced perimeters, oceanward berm, and throughout the restoration area surrounding patches of vegetation suggest that longer periods of time for scientific evaluation for these parameters will also allow for additional trends to be defined. Future monitoring will continue to inform sand morphology within the restoration site in response to vegetation growth, fence placement, and seasonal changes from storms, king tides, and wave energy. Additionally, elevation profile data will provide information to understand the effects of sand grooming versus the development of natural beach morphology over time.

One suggestion for future projects with a similar set of existing uses is to have a similar set of strong public outreach components prior to the initiation of the project and to directly engage local stakeholder groups. A significant effort was made to reach out to local residents, stakeholder groups, interested parties, beachgoers, and all of the agencies and organizations who provide some input to beach management in the area. This effort went far beyond requirements for the permits and included setting up stakeholder meetings to answer questions, incorporating feedback on project planning from the public, and working with the City of Santa Monica to announce the project in public meetings and to all of the user groups such as lifeguards, police, maintenance workers, and other City and County groups. Additionally, much of the credit for the aforementioned results also goes to the City of Santa Monica for their efforts to engage the public, take a leadership role on permitting, and for their ongoing support and vision.

Another suggestion for future projects along beaches is to incorporate many of the same or similar monitoring methods that will allow for comparisons between-projects. This will allow for an evaluation across multiple scales and in different areas with different levels of sand accretion or erosion, wave patterns, weather patterns, and vegetation growth over time. Other, more passive restoration projects could also be evaluated, such as restricting grooming to other areas of the beach.

Annual reports will continue to be made available for public download on TBF’s website: www.santamonicabay.org.

Figure 44. Beach evening primrose growing atop a small dune hummock within the restoration area on 11 June 2020.

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Figure A-1. Photo Point 1A on (A) 17 December 2016; (B) 24 March 2017; (C) 21 August 2017; (D) 13 September 2017.

Figure A-2. Photo Point 1A on (E) 11 January 2018; (F) 8 March 2018; (G) 15 August 2018; (H) 19 December 2018.

Figure A-3. Photo Point 1A on (I) 22 February 2019; (J) 15 May 2019; (K) 1 August 2019; (L) 5 February 2020.

Figure A-3. Photo Point 1A on (M) 24 July 2020.

Figure A-4. Photo Point 2A on (A) 1 January 2017; (B) 25 April 2017; (C) 21 August 2017; (D) 16 December 2017.

Figure A-5. Photo Point 2A on (E) 3 March 2018; (F) 24 May 2018; (G) 15 August 2018; (H) 19 December 2018.

Figure A-6. Photo Point 2A on (I) 22 February 2019; (J) 15 May 2019; (K) 1 August 2019; (L) 5 February 2020.

Figure A-6. Photo Point 2A on (M) 24 July 2020.

Figure A-7. Photo Point 4A on (A) 17 December 2016; (B) 4 February 2017; (C) 21 May 2017; (D) 13 September 2017.

Figure A-8. Photo Point 4A on (E) 11 January 2018; (F) 8 March 2018; (G) 24 May 2018; (H) 15 August 2018.

Figure A-9. Photo Point 4A on (I) 22 February 2019; (J) 15 May 2019; (K) 1 August 2019; (L) 5 February 2020.

Figure A-9. Photo Point 4A on (M) 24 July 2020.

Figure A-10. Photo Point 4C on (A) 17 December 2016; (B) 4 February 2017; (C) 21 May 2017; (D) 21 August 2017.

Figure A-11. Photo Point 4C on (E) 11 January 2018; (F) 8 March 2018; (G) 24 May 2018; (H) 15 August 2018.

Figure A-12. Photo Point 4C on (I) 22 February 2019; (J) 21 May 2019; (K) 1 August 2019; (L) 5 February 2020.

Figure A-12. Photo Point 4C on (E) 24 July 2020. Note the new interpretive sign is still present, but was just not in the frame of the photograph.

Figure A-13. Photo Point 6A on (A) 17 December 2016; (B) 24 March 2017; (C) 21 May 2017; (D) 13 September 2017.

Figure A-14. Photo Point 6A on (E) 11 January 2018; (F) 13 April 2018; (G) 15 August 2018; (H) 19 December 2018.


I


J


K


L

Figure A-15. Photo Point 6A on (E) 24 July 2020.

Figure A-16. Photo Point 9B on (A) 17 December 2016; (B) 24 March 2017; (C) 21 May 2017; (D) 24 August 2017.

Figure A-17. Photo Point 9B on (E) 11 January 2018; (F) 8 March 2018; (G) 24 May 2018; (H) 15 August 2018.

Figure A-18. Photo Point 9B on (I) 22 February 2019; (J) 25 April 2019; (K) 1 August 2019; (L) 5 February 2020.

Figure A-18. Photo Point 9B on (M) 24 July 2020.