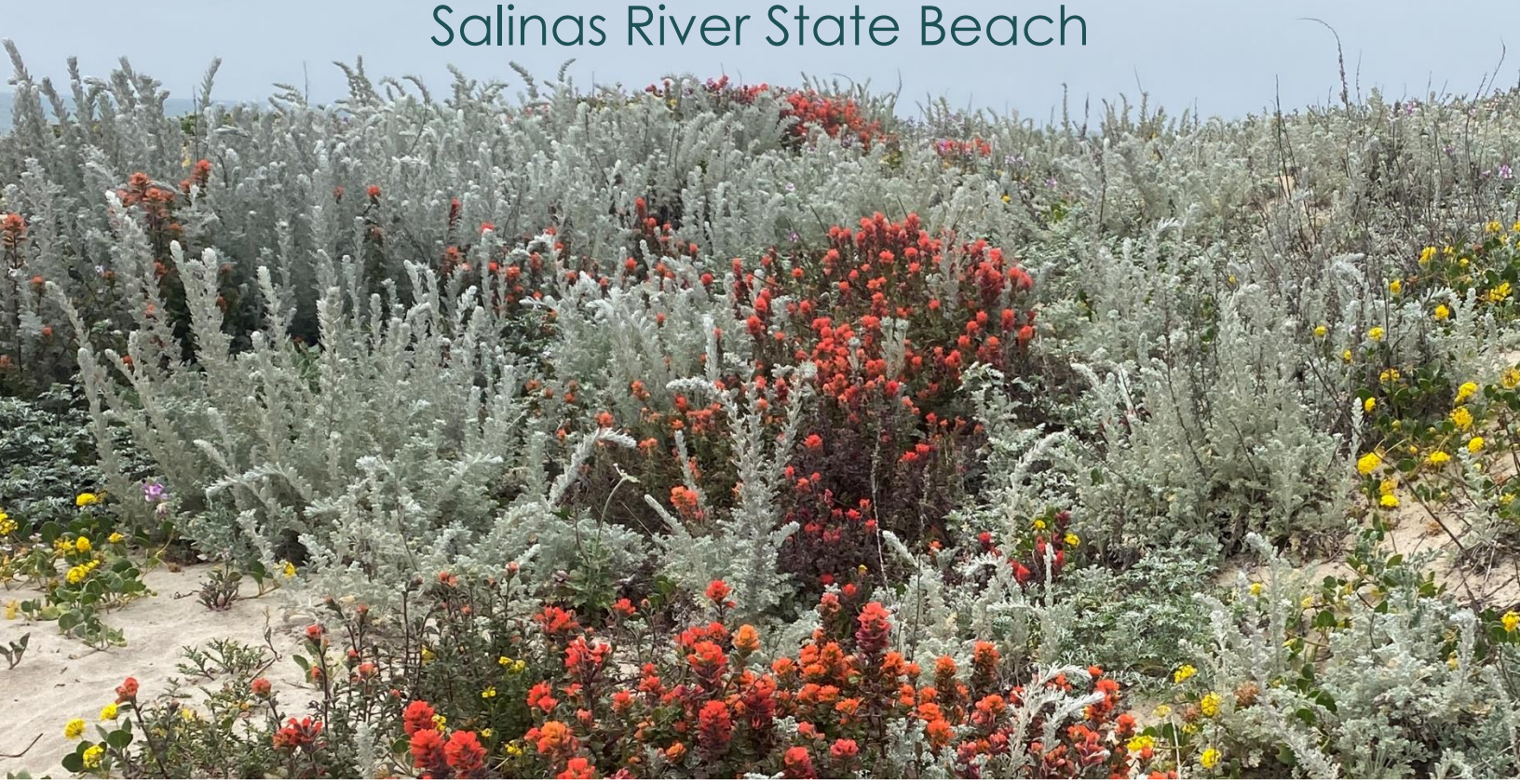
Restoring Coastal Dune Ecosystem Health and Resilience at Salinas River State Beach



Final Restoration & Monitoring Report

January 2024

Coastal Conservation and Research

in collaboration with

Central Coast Wetlands Group at Moss Landing Marine Laboratories

Coastal Conservation & Research, Inc.

CCWG
CENTRAL COAST WETLANDS GROUP

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Project Partners

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Central Coast Wetlands Group at Moss Landing Marine Laboratories
California State Parks
California Reforestation, Inc
California Ecological Analytics
Habitat Stewardship Project Monterey Bay
California Conservation Corps
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1. INTRODUCTION

Salinas River State Beach (SRSB), spanning approximately 280 acres of beach and coastal dunes in Northern Monterey County, California, plays an important role in safeguarding the Lower Salinas Valley's productive agriculture fields and coastal wetlands. The dunes at SRSB act as a natural buffer against ocean-derived processes, including waves and coastal storm flooding sand deposition, and salt spray. These dunes, in their natural state, help to dissipate wave energy and minimize ocean-induced erosion and flooding, while providing essential habitat for native plants and animals including several special status species.

However, the integrity of the natural dune vegetation at SRSB (as well as other areas of the central Monterey Bay) has been compromised by the introduction of invasive ice plant (*Carpobrotus edulis and Carpobrotus chilensis*) and other invasive plants. Ice plant outcompetes native species and disrupts physical processes, compromising the dunes' ability to act as a protective barrier against winter storms and sea level rise. Studies indicate that the removal of ice plant and the restoration of native species can enhance the resilience of dune complexes to wave impacts (De Lillis et al., 2004).

In 2019, the California Department of Fish and Wildlife (CDFW) provided funding to Coastal Conservation and Restoration (CCR) and Central Coast Wetlands Group (CCWG) through the Environmental Enhancement Fund Grant Program to expand restoration and monitoring efforts at SRSB. Initially focused on a 20-acre section between the Sandholdt and Potrero access points, the project was later expanded to other areas within the dune complex.

This report details the restoration, monitoring, and community engagement activities conducted as part of the project and presents results from various monitoring efforts, including vegetation surveys, photo monitoring, dune topography surveys, and special status plant and animal species surveys.

2. PROJECT DESCRIPTION

Site Location

SRSB comprises approximately 280 acres of beach and coastal dunes located in Northern Monterey County, California (Figure 1). SRSB is bordered by the Pacific Ocean to the west and the old Salinas River channel and agricultural fields to the east and extends northward to Sandholdt Road in Moss Landing and southward to the Salinas River mouth, wrapping around the Monterey Dunes colony in the lower half of the state beach. The most prominent feature of the state beach is the extensive sand dune system, which extends inland in some places for over 300 meters and is 15-20 meters above sea level at the highest point.

The SRSB was designated as a State Beach by the California State Park and Recreation Commission in November 1962, to "protect and perpetuate the area's natural resource values and to provide beach-oriented recreation opportunities for the enlightenment, inspiration, and enjoyment of present and future generations (DPR 1987). The State Park and Recreation Commission resolution establishing the state beach specifically distinguishes the foredune and coastal scrub plant communities, the solitary sandy beach, the visual texture of the dunes and the expanse of Monterey Bay as the important elements. SRSB is also zoned as "scenic and natural resource recreation" in the North County Land Use Plan and "recreational" within the Monterey Bay National Marine Sanctuary. SRSB is managed by the State Parks Monterey District (State Parks).

SRSB contains rare coastal dune and coastal marsh habitats that support many species of wildlife and migratory birds, and which host numerous special status animal and plant species including the Western snowy plover, Northern legless lizard, Monterey gilia, and Monterey spineflower. SRSB also contains two subunits classified as Natural Preserves: the Salinas River Dunes Natural Preserve and the Salinas River Mouth Natural Preserve (DPR, 1987).

The SRSB dunes provide a natural buffer from ocean derived processes (waves, sand deposition, salt spray) for the productive agriculture fields of the Lower Salinas Valley and coastal wetlands. Sand dunes, in their natural state, dissipate wave run-up erosive energy and minimize ocean induced dune undercutting and inland flooding, while providing critical habitat to many special status species. The natural dune vegetation at SRSB, however, has been disrupted by the introduction of ice plant (*Carpobrotus edulis* and *Carpobrotus chilensis*) and other invasive plants. The California Invasive Plant Council classifies the impact of *Carpobrotus edulis* on native ecosystems as high (Cal-

IPC, 2006). Species with a high rating have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure and their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment (Cal-IPC, 2006). Ice plant not only outcompetes native species but also disrupts physical processes, affecting the natural functions of dunes. This interference compromises the dunes' ability to serve as a protective barrier against the impacts of sea level rise.

Studies suggest that the removal of ice plant and reestablishment of native species will enable dune complexes to better respond to wave impacts, which will enable them to be more resilient to more frequent and more damaging storms (De Lillis et al., 2004). Specifically, native dune plants develop deep root systems that provide erosive resilience and support natural sand migration and accumulation patterns that are expected to dissipate wave energy without leading to significant dune face failure (Figlus et al., 2014). The foredune plants form low sloping dune faces that encourage wave run-up energy to dissipate rather than undercut foredunes dominated by ice plant.

Figure 1.Site vicinity map

SRSB Restoration History

MLML Dune Restoration

During the 1989 Loma Prieta earthquake, the original beachside Moss Landing Marine Laboratories (MLML) campus was destroyed. Part of the rebuilding effort of the new MLML building on the hill across the Old Salinas River included sand dune reconstruction and restoration on the 2-acre parcel (the current northern most 2 acres of SRSB) where most of the original MLML buildings and structures had been located prior to their destruction. The site was heavily disturbed due to trampling from people crossing the dunes to get to the beach from the parking lot. Reconstruction and restoration included removal of damaged buildings and infrastructure, recontouring the sand dunes, removal of ice plant, propagation and planting of native dune plants, and placement of signage and fencing to protect the vulnerable site. Work began in 1992 and was largely finished by 1999. After restoration, this parcel of land was transferred to State Parks and established as part of SRSB. However, since 1999 there has been little restoration follow-up in this area, leading to a re-establishment of ice plant within the 2 acre restored area. State Parks does conduct occasional spot spraying throughout the dunes but additional resources were needed to address the recruitment pressure of this invasive species.

State Coastal Conservancy Funded Restoration

In 2016, the State Coastal Conservancy provided funding to Coastal Conservation and Research (CCR) and the Central Coast Wetlands Group (CCWG) to restore and monitor 20 acres of dune habitat at SRSB through the Climate Ready Grant Program. The project focused on three areas within the dune complex that were identified as most vulnerable to sea level rise impacts by the Coastal Resilience modeling effort[1]. This grant was completed in 2019 and results helped to inform future restoration efforts at the site. Within this report these areas are referenced as Phase 1.

CDFW Funded Restoration

In 2019, the California Department of Fish and Wildlife (CDFW) provided funding to CCR and CCWG through the Environmental and Enhancement Fund Grant Program to expand restoration and monitoring efforts to other sections of the dune, helping to connect previous restoration efforts and enhance habitat quality and coastal resilience of the greater dune system. A portion of the total requested funding was available in 2019 and so efforts focused on 20 acres of dune habitat located between the Sandholdt and Potrero access points. In 2020, the remainder of the funding request was approved which allowed restoration activities to be expanded to other areas in the dune complex. Within this report, restoration areas funded by CDFW are referenced as part of Phase 2.

Project Overview

Task Descriptions

Restoration efforts at SRSB under the CDFW grant focused on ice plant eradication, native planting, enhancing foredune resilience, and community engagement. Descriptions for each project task are outlined below.

[1] https://maps.coastalresilience.org/california/

Task 1. Project Management

CCR and CCWG will oversee the completion of this 3-year[2] project, complete periodic progress reports and a final report, and manage all subcontracts. The final project report will be distributed to partners, funders, and posted on the CCWG website. The final report will include information on activities completed, possible next steps and initial data regarding enhancements in dune resiliency.

Task 2. Dune Restoration

Invasive Species Removal: Ice plant will be eradicated through the approved method of hand spraying herbicide (2% dilution of glyphosate) and hand pulling at the SRSB project site. Hand pulling of ice plant will be done in areas where sensitive plant species are present. Initial eradication will focus on the 50-acre unrestored section of SRSB. The second and third year will focus on hand removal, and spot spraying as needed on both the previously restored 20-acre project area and the new 50-acre project section. Dead ice plant will be left in place to act as mulch for newly installed native plants.

Native Plant Establishment: 15,000 native plants will be propagated and planted throughout the project period. Seeds from native plants will be collected from the SRSB dunes complex to ensure local genetic diversity. Seeds will also be hand broadcast and raked in dune areas with bare sand prior to the rainy season. Plants will be propagated at the CCR greenhouse by CCR staff as well as at the Asilomar State Park greenhouse by volunteers with DPR staff oversight (provided as match).

Foredune Resilience: In select areas, structural features, such as straw bales and locally derived large driftwood will be placed in areas along the foredune where dunes are steep and where previous wave erosion scars are evident. The wood or straw bales will be placed in low density to increase roughness and provide three-dimensional stability as native species reestablish. Native Dune Grass (*Elymus mollis*) will be planted within the foredune area to increase roughness and topographic complexity, reducing susceptibility to wave erosion and enhancing plover habitat. These features will aid in sand capture and increase the resilience of foredune habitat.

Task 3. Science, Monitoring, and Reporting

Plant Surveys: Surveys will be conducted using line-point intercept method along established transects to document reestablishment of native plant species, eradication of invasive plants, and identify areas where greater species diversity is needed. Vegetation monitoring will occur once before project initiation, twice a year during, and once post implementation.

Dune Profile Surveys: Surveys will be conducted during and after project implementation (two surveys of the dunes have been flown previously using Coastal Conservancy funding). LiDAR data and stereoscopic photo imagery will document beach and dune profiles. Surveys will document dune elevation changes expected within naturally evolving dune complexes. Plots will be established at several locations to study the effectiveness of restoration/planting techniques.

[2] The project was proposed as 3-year project, however a one-year grant extension was approved in 2022

Task 4. Community Engagement

Public Presentations and Stakeholder Engagement: Presentations describing the benefits of dune restoration for sea level rise and climate adaptation will be given to the public and stakeholders. These presentations will also include lessons learned that can be transferred to other communities and/or to be integrated into government programs and policies.

Interpretive Signage: Dune restoration interpretive signs will be installed at the SRSB Sandholdt Road access parking lot. Signs have been posted at two other locations where work has previously been completed.

Planting Days: A minimum of one public or school planting day will occur during the project period.

Salinas River State Beach Restoration and Management Plan

Project activities were conducted to help meet the goals and objectives established in the SRSB Dune Restoration and Management Plan (CCWG, 2016, rev 2021).

Salinas River State Beach Restoration and Management Plan Goals:

- **Goal 1:** Control invasive vegetation at the SRSB dune system.
- **Goal 2:** Increase native plant cover and establish a diverse native plant species composition in SRSB restored dunes
- **Goal 3:** Enhance storm resilience of the SRSB dune system.
- **Goal 4:** Support DPR in efforts to enhance long-term management (maintain safe access ways and minimize recolonization of ice plant) of SRSB.

Restoration Areas

Prioritized Areas

Much of the restoration efforts at SRSB to date have been conducted with available grant funding. The map in Figure 2 shows how dune areas were prioritized for restoration within the Salinas River State Beach Restoration and Management Plan. The map shows locations of the Coastal Conservancy funded efforts (Phase 1) as well as locations prioritized for restoration under the current CDFW grant (Phase 2). Areas were prioritized by determining if the locations 1) help to best meet the goals of the grant funding (e.g. coastal resilience, habitat quality), 2) help to expand the consecutive footprint of the restoration area to minimize edge effects that can lead to reintroduction of ice plant, 3) support the management goals of State Parks (special status species management, visitor access management, etc.), and 4) benefit and engage the local community.

Phase 1 (SCC Funded)

Phase 1 areas were selected as the focus for the 2016 Coastal Conservancy-funded project due to their identification as vulnerable zones affected by winter waves and unauthorized/mismanaged pathways. These sections, characterized by their narrowness within the dunes, are particularly susceptible to wave erosion and overtopping, posing a potential risk of inland flooding in the Salinas Valley. Funding was provided to increase dune stability/resiliency and enhance dune habitat to ensure the dune system remains a viable natural boundary between the low-lying Salinas Valley and winter waves of the Pacific Ocean.

Phase 2 High Priority (CDFW Funded- Restoration and Monitoring Project Focus Area)

The dune section located between the northern boundary of SRSB and the Potrero Rd access was identified as a high priority restoration area because it helps link previous restoration areas together into a large natural complex, provides valuable habitat for snowy plovers and other dune species, and contains key beach access trails. This section of dunes is relatively narrow (about 75 meters in width), is heavily covered by ice plant, and provides critical coastal resilience functions for the community of Moss Landing and Moss Landing Harbor. Funding from CDFW (Environmental Enhancement Fund grant provided in 2019) was secured to restore this section of dunes and became the focus area of the dune restoration project.

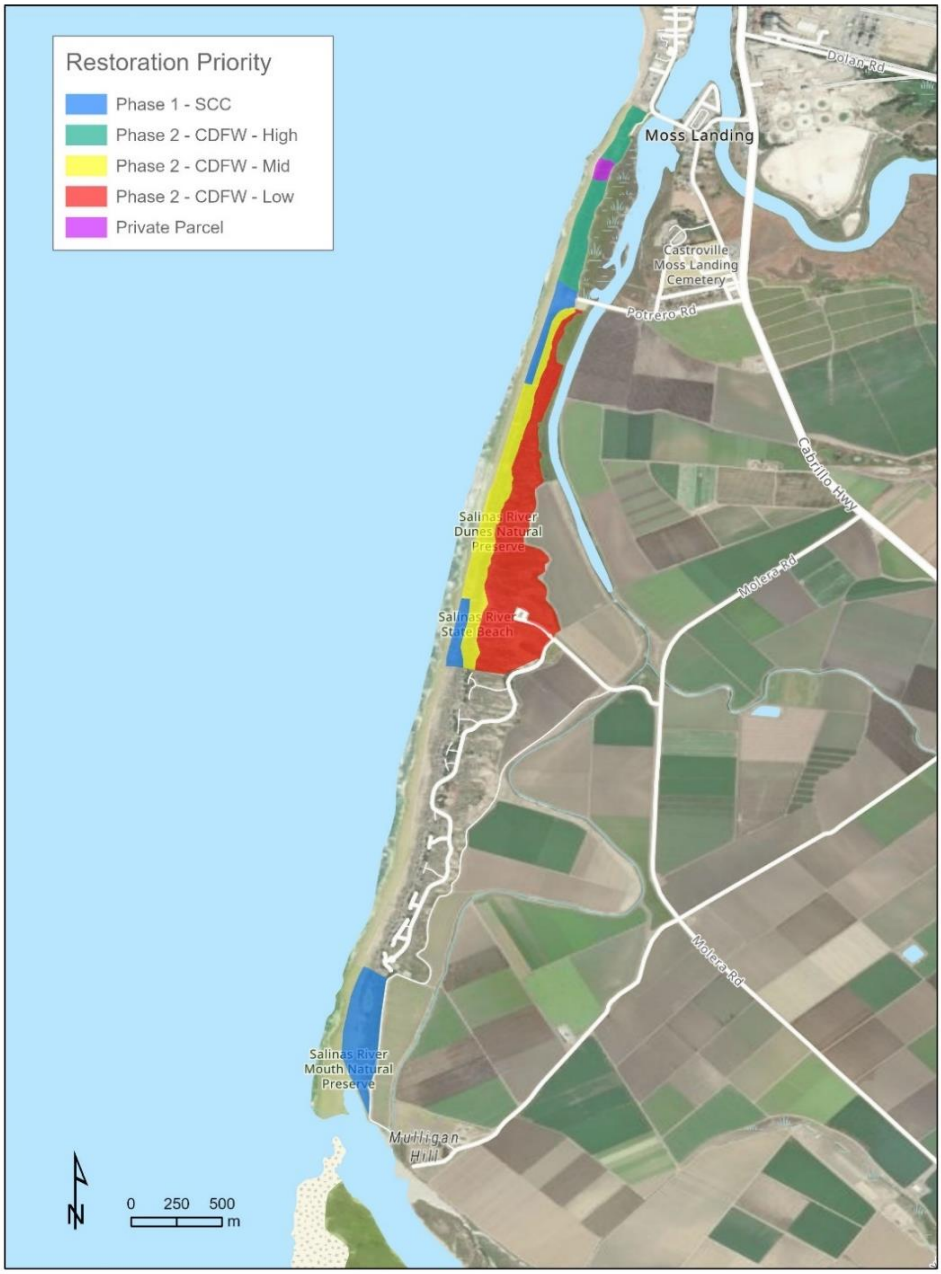

Figure 2. SRSB dune locations prioritized for restoration

Phase 2 Mid Priority (CDFW funded- Ice Plant Eradication Expansion Area 1)

This dune section was a second priority because of its greater size, distance from public foot traffic, and greater width that provides longer term protection to the Salinas Valley. As funding was made available, restoration activities within this area were integrated with other high priority areas.

Phase 2 Low Priority (CDFW- Ice Plant Eradication Expansion Area 2)

This dune section is far from wave impacts and thus less susceptible to coastal erosion. However, leaving this dune area covered in ice plant increases the boundary length between restored and unrestored areas that will continue to make maintenance of ice plant recolonization within restored areas challenging. As funding became available, this area was integrated with other high priority areas.

Private Parcel

The privately owned parcel sandwiched between SRSB land to the north and south is in the process of being purchased and transferred to a land conservation organization. Once this occurs, this parcel will be included as a high priority restoration area. Until this area is acquired and restoration completed, the area will continue to be used as a no action control area for habitat monitoring activities.

Dune Sections and Summary of Project Activities

For the purposes of this project, restoration and monitoring areas have been named according to Figure 3 and are summarized in Table 1, listing how each dune section was prioritized and the activities that took place within each section as part of this grant. With multi-year funding provided by CDFW, ice plant control activities became more efficient and cost effective, allowing grant funds to be expanded to even the lowest priority areas as outlined in the SRSB Restoration and Management Plan. Project activities (restoration, monitoring, and community engagement) are described in more detail in Chapters 3 through 5 within this report.

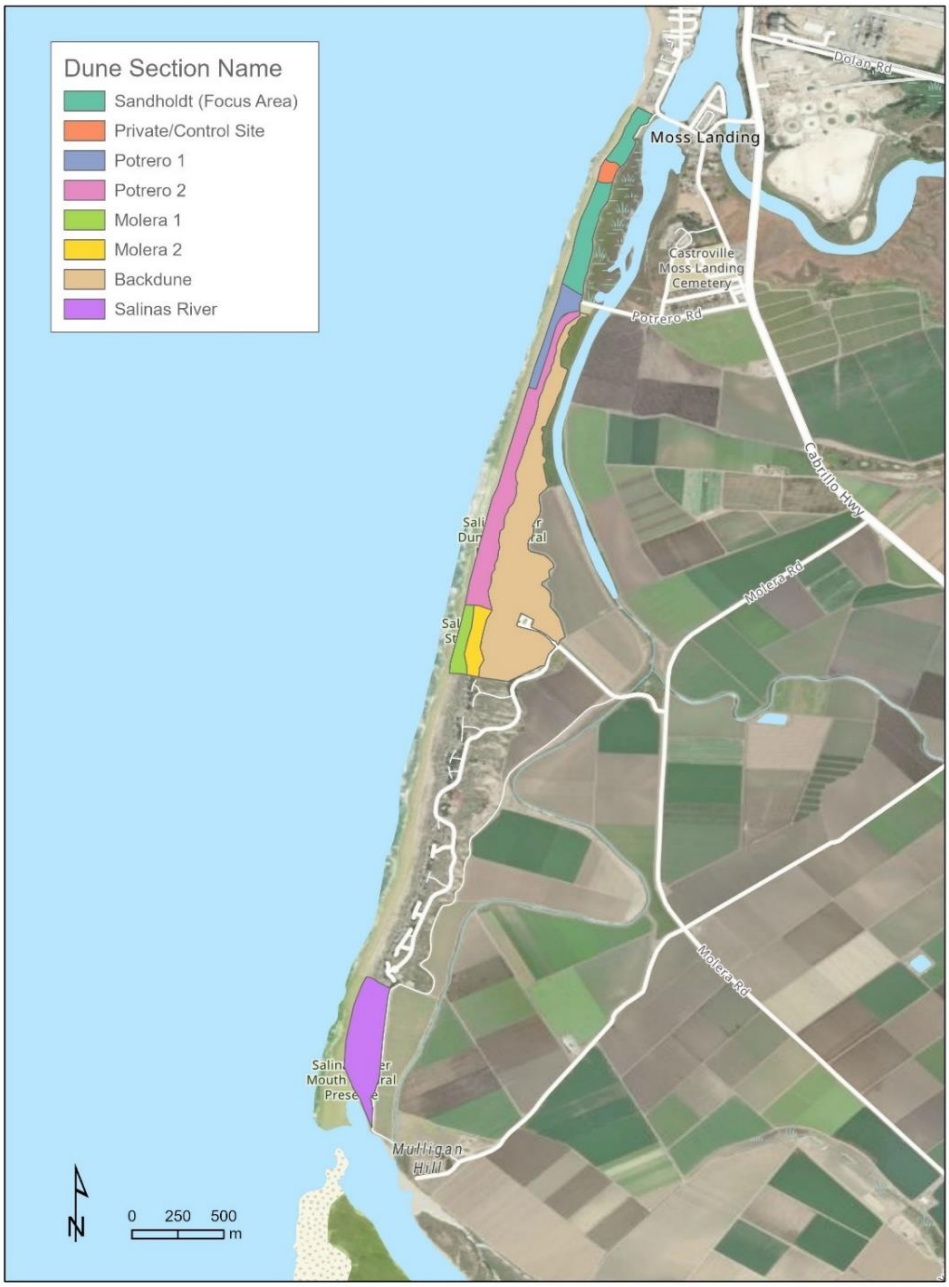

Figure 3. SRSB dune section names from North to South

Table 1. Dune section, acres of dune habitat, general plant cover description, restoration priority, and summary of activities (listed from North to South).

Location	Acres of Dune Habitat	Plant Community at start of project (2019)	Phase & Restoration Priority	Activities Conducted
Sandholdt-Restoration and Monitoring focus area	18	High cover of ice plant, low cover of natives	Phase 2- High	Restoration: ice plant control, *Ammophilla* control, native planting, haybale and wood placement Monitoring: veg surveys, UAV/topo surveys, rare plant surveys, legless lizard surveys Community Engagement: interpretive signs, school planting days
Sandholdt-Private/Control	2	High cover of ice plant, low cover of natives	N/A	Monitoring: veg surveys, UAV/topo surveys, rare plant surveys, legless lizard surveys
Potrero 1	7	High cover of natives, very low cover of ice plant	Phase 1 - SCC	Restoration: ice plant maintenance, haybale and wood placement Monitoring: veg surveys, rare plant surveys (2022 only)
Potrero 2 (Potrero-Molera)	27	Medium-high cover of natives, medium cover of ice plant	Phase 2- Mid	Restoration: ice plant control, native planting Monitoring: veg surveys, rare plant surveys (2022 only)
Molera 1	5	High cover of natives, very low cover of ice plant	Phase 1 - SCC	Restoration: ice plant maintenance, native planting, haybale placement, boardwalk removal Monitoring: veg surveys, rare plant surveys (2022 only) Community Engagement: school planting days
Molera 2	6	Medium-high cover of natives, medium cover of ice plant	Phase 2- Mid	Restoration: ice plant control, native planting, boardwalk removal
Backdune	70	Medium-high cover of natives, medium cover of ice plant	Phase 2- Low	Restoration: ice plant control, boardwalk removal
Salinas River	10	Medium cover of natives, very low cover of ice plant, lots of bare sand	Phase 1 - SCC	Restoration: ice plant maintenance, Arundo maintenance Monitoring: veg surveys, rare plant surveys (2022 only)

3. RESTORATION ACTIVITIES (TASK 2)

Invasive Species Control

Ice Plant

Herbicide Application

California Reforestation Inc. was hired to conduct the herbicide application on invasive species within the project area. Ice plant control efforts began in 2019 within the Sandholdt focus project area. Herbicide application activities were conducted in late fall and early winter when the natives are dormant and germinating native seedlings are limited. Sprayed ice plant was left in place to act as mulch for new native plants. Spraying occurred approximately 3–9 months prior to revegetation planting efforts to allow enough time for the ice plant to decompose and allow for easier planting.

Herbicide application crew members were trained to properly identify ice plant and native dune species and had proper certifications to use the spray application equipment. A 2% dilution of Roundup (2% glyphosate/1.5% imazapyr mix + surfactant solution) with added tracer die was used. Ice plant was sprayed in linear swaths parallel to the shore by the field crew in a manner that limits dune trampling. Spraying was limited to still and dry days to prevent chemical drift from rain and wind. A second application was completed approximately 3–12 months after the initial application to areas where ice plant remained robust. In many places, native species were intermixed with the ice plant and therefore care was taken to minimize drift or overspray of herbicides on native plants. The foredune areas were sprayed outside of the Snowy Plover nesting season (March–September) to ensure breeding plovers were not impacted.

In late 2020, following the approval of additional project funds, ice plant control efforts were expanded to include unrestored fore and mid-dune areas south of the Potrero access trail (Potrero 2 and Molera 2). Despite these areas having initially robust native cover, the presence of significant ice plant intermixed with the native plants posed a threat to further degrade the dune habitat. Additionally, periodic spot spraying of ice plant was carried out in areas initially restored during Phase 1 of the Coastal Conservancy funded project (Potrero, Molera, and Salinas River). This measure aimed to maintain the ice plant cover in the previously restored dune sections to under 5%.

In May 2022, with remaining project funds redirected for ice plant eradication, State Parks and the project team identified the opportunity to extend ice plant control efforts to an additional 50 acres of back dune habitat east of the Horse Trail, linking the Potrero and Molera access points. This particular area has exhibited a substantial ice plant

cover and has been earmarked in the updated SRSB Dune Restoration and Management Plan (2021) as a restoration priority following the treatment of other key areas. Active invasion of ice plant from this area into adjacent restored areas was noted. In October 2022, the initial phase of ice plant treatment in the backdune region was conducted, followed by a second treatment in October 2023. Concurrently, in 2022, State Parks was provided funding through the USFWS Coastal Program to support supplementary ice plant treatment along the back dune with an additional 20-acre area.

Hand Pulling

Throughout the project duration, CCR, CCWG and the California Conservation Corps (CCC) hand-pulled ice plant around native plants where the herbicide applicators left a no-spray buffer. Crews also hand pulled ice plant in areas where small ice plant patches were missed, where new recruits from seed were found, and in areas where sensitive plants were present. Additionally, CCR and CCWG organized annual staff ice plant pulling events, with a specific focus on the Sandholdt and Potrero sections of the dunes. Any discovered resprouts were collected in buckets and strategically piled for drying and efficient spot spraying, effectively preventing further establishment. Long-term ice plant maintenance will benefit from continued annual pulling events.

CCWG and CCR staff pulling sprouts of ice plant during staff dune walk/ice plant pulling days

European beach grass

European dune grass *(Ammophila arenaria)* is present in several locations within the Sandholdt section of dunes. Herbicide was applied to the *Ammophila* using a 2% glyphosate/1.5% imazapyr mix + surfactant solution during two application periods over the project term. Although the patches have been reduced in size, due to the persistent nature of *Ammophila*, these patches will need additional treatment and hand removal if possible.

Giant Reed

Giant reed *(Arundo donax)* is present within the project area near the Salinas River mouth and efforts were made to eliminate the species from the river mouth area. The *Arundo* was cut by mechanical means and the cut stump was treated with a 50–100% solution of Roundup.

Native Seed Collection and Propagation

Seed Collection

Beginning in 2019, native seed was collected each year for propagation and hand-broadcast seeding. Seed collection focused on species that were known to be common and easily established at the site, as well as species that were less common in order to increase diversity of the dune plant community. Restoration crew members collected seeds of native species (listed in Table 2) from within the SRSB dunes complex to ensure local genetic diversity was supported. To ensure maximum genetic diversity, seed was collected from un-restored sections of the dunes, and from as many different plants of the same species as possible. No more than 10% of the produced seed was collected from any one plant. Some of this seed was shared with State Parks to aid in their own propagation efforts, where volunteers at the Asilomar State Park greenhouse grew a portion of the plants for the project as match.

Table 2. Seed collected at SRSB for plant propagation and broadcast seeding within the project area.

Species	Common Name
Abronia latifolia	yellow sand verbena
Abronia umbellata	pink sand verbena
Ambrosia chamissonis	beach bur
Armeria maritima	sea thrift
Artemisia pycnocephala	beach sagewort
Atriplex leucophylla	beach saltbush
Baccharis pilularis	coyote brush
Calystegia solanella	beach morning glory
Camissoniopsis cheiranthifolia	beach primrose
Carex pansa	sand dune sedge
Cardionema ramosissimum	sand mat
Castilleja latifolia	Seaside painted cup
Corethrogyne filaginifolia	California aster
Dudleya caespitosa	coast dudleya
Elymus mollis	American dune grass
Ericameria ericoides	mock heather
Eriogonum latifolium	coast buckwheat
Eriophyllum staechadifolium	lizard tail
Echscholzia californica	beach poppy
Extriplex californica	California salt bush
Lathyrus littoralis	beach pea
Lupinus chamissonis	dune bush lupine
Lupinus albifrons	silver lupine
Lupinus arboreus	yellow bush lupine
Phacelia ramossissima	branching phacelia

Native Dune Grass Rhizome Collection

Native dune grass (*Elymus mollis*) planting is most successful using small plugs generated from segmenting adult plants. Local dune grass was collected in small numbers and planted in the greenhouse to generate an adult population from which to establish rhizome plugs for out planting.

Dune Plant Propagation

Quantities of individual plants of each species were grown in numbers to reestablish the expected diversity and density. The use of perlite soil amendment for seed propagation helped reduce soil compaction, and mimicked low water retention and high permeability found within the soil type of coastal dunes. Depending on the species, propagation began between winter and spring to allow for seedlings to grow large enough to be out planted in late fall (Nov/Dec) prior to first rains. Consistent watering, thinning to one seedling per cell, and the prevention of herbivory were all essential for the survival and health of the dune seedlings.

- From seed: Seeds were propagated in 3” deep trays with a mixture of perlite and top soil or potting soil. Once seedlings germinated, they were transplanted into 2” pots or cones within a soil/sand mix and grown out.

- From plant material (rhizomes): *Elymus mollis* was propagated/divided from parent material/cuttings taken from approved locations within the project site. Cuttings were planted in 2” pots.

In 2021, CCR and CCWG updated the plant palette for the 2021/2022 planting season to focus on native dune grass and some of the less abundant species found at the dunes.

State Parks had originally intended to propagate around 5,000 plants for the dune restoration project spanning two years. However, due to the COVID-19 pandemic, their greenhouse operations were temporarily halted and only resumed in the spring of 2022. As a result, they were able to propagate only half of the initially planned number of plants.

Native dune plants being grown for the project

Native Planting

Initial native planting was planned for late 2020, however due to the lack of steady rain, planting began in January 2021. The first year of planting was focused within the Sandholdt section, in areas where large mats of ice plant had been sprayed and very few native plants occurred.

Decomposed ice plant material was left in place after the application of herbicide (approximately 3-9 months after initial application). The decomposed ice plant layer acts as a mulch and helps provide insulation from extreme soil temperature fluctuations, retains dune moisture, and inhibits weed growth. Plants were planted within the mulch layer

either by using a spade to cut through the dead ice plant, or by removing ice plant by hand, to clear a small area for the young plant to be installed. Planting density was dependent by species and locations within the dune.

CCR staff focused planting efforts within large mats of dead ice plant

Some native plants were planted within the bare sand in the foredune to help aid in the capture of sand. In these areas, plants were planted within small mounds (3" high) above the base elevation to reduce burial. Plant spacing in this area was determined in consultation with State Parks and Point Blue to ensure that snowy plover breeding habitat was not negatively impacted by planting density.

In total, the CCR restoration crew with help from the CCC, planted over 12,500 plants between January 2020 and February 2023 within the project area. The majority of the plants were planted in the Sandholdt section where ice plant cover was originally dense and native cover sparse.

Table 3 lists the number of plants by species out-planted during each season of the project.

Thanks to both the plantings and growth from the native seed bank, a diverse array of native plants is now well-established throughout the restoration areas (Figure 4).

Figure 4. A sample of the native plant species becoming well established at SRSB: from left to right: Lathyrus littoralis Castilleja latifolia, Abronia umbellate, Camissoniopsis cheiranthifolia (photos taken Spring 2023).

Table 3. Plants planted at SRSB between January 2021 and December 2023

Species	Common Name	Planting Season			Total
		2020/2021	***2021/2022***	***2022/2023***	
Abronia latifolia	yellow sand verbena	-	98	31	129
Abronia umbellata	pink sand verbena	-	24	23	47
Ambrosia chamissonis	beach bur	409	40	71	520
Armeria maritima	sea thrift	-	0	64	64
Artemisia pycnocephala	beach sagewort	1404	244	813	2461
Atriplex leucophylla	beach saltbush	-	-	90	90
Baccharis pilularis	coyote brush	-	-	5	5
Camissoniopsis cheiranthifolia	beach primrose	50	129	477	656
Carex pansa	sand dune sedge	-	185	63	248
Castilleja latifolia	seaside painted cup	-	-	7	7
Corethrogyne filaginifolia	California aster	16	76	104	196
Dudleya caespitosa	coast dudleya	-	128	250	378
Elymus mollis	American dune grass	396	1,009	1,851	3,256
Ericameria ericoides	mock heather	92	9	163	264
Eriogonum latifolium	coast buckwheat	83	498	820	1401
Eriophyllum staechadifolium	lizard tail	278	5	627	910
Echscholzia californica	beach poppy	-	-	200	200
Extriplex californica	California salt bush	189	119	288	596
Lathyrus littoralis	beach pea	-	0	64	64
Lupinus chamissonis	dune bush lupine	-	7	719	726
Lupinus albifrons	silver lupine	83	-	-	83
Lupinus arboreus	yellow bush lupine	-	6	29	35
Phacelia ramossissima	branching phacelia	-	21	240	261
Total		**3,000**	**2,598**	**6,999**	**12,597**

Hand Broadcast Seeding

Two seed mixes were created, representing the species diversity of the foredune and mid-dune areas (Table 4) and hand broadcast during the late fall and early winter months. Broadcast seeding is an effective way to help revegetate unsanctioned pathways and other bare areas of the foredune. Seed was spread by hand onto the sand or within fully decomposed ice plant litter and raked lightly. The crew began spreading native seed in late 2020, throughout the Sandholdt focus area.

Table 4. Example SRSB seed mixes for hand broadcast seeding

Location for seed mix	Species in seed mix
Foredune	*Ambrosia chamissonis, Armeria maritima, Artemisia pycnocephala, Atriplex leucophylla, Eriogonum latifolium, Eschscholzia californica maritima, Lathyrus littoralis*
Mid-dune	*Abronia umbellata, Armeria maritima, Artemisia pycnocephala, Calystegia solanella, Cardionema ramosissimum, Castilleja latifolia, Dudleya caespitosa, Ericameria ericoides, Eriogonum latifolium, Eriophyllum staechadifolium, Eschscholzia californica maritima, ssp. arenaria, Phacelia ramosissima*

Boardwalk Removal and Trail Revegetation Efforts at Molera Access

The Molera beach access trail consists of two paths that branch from the parking lot and lead to the beach. However, the boardwalk on one of these paths had deteriorated and posed safety concerns. State Parks initiated the process of decommissioning this trail, and the first step was to remove the boardwalk, which was completed in October 2022 (Figure 5).

In February 2023, the project team, along with help from the State Parks natural resources crew, placed haybales along the recently decommissioned trail at the Molera access (Figure 6). The haybales are intended to serve multiple purposes, including deterring trail use, providing a windbreak for plants, and capturing sand on the dunes. This use of haybales aims to provide a greater chance of success in revegetating and restoring the trail area.

During the school planting days in February 2023 (see Chapter 5), approximately 500 plants, which were provided by State Parks as a match, were planted along the trail and around the haybales to help revegetate the area where the boardwalk was removed. Staff from the Habitat Stewardship Project at CSUMB, CCR, and CCWG were present to assist the students in the planting process, ensuring that the plants were properly positioned in the ground for optimal growth.

Figure 5. left: trail with boardwalk, center: trail in the process of boardwalk removal, right: trail with boardwalk removed.

Figure 6. Haybales were placed along the Molera access trail to deter trail use, help capture sand, and provide wind barriers for newly planted plants.

Haybales and Driftwood Placement

Restoration activities included strategic placement of hay bales and locally sourced drift wood along select locations of the foredune in order to help capture sand, build dunes, and increase foredune resiliency. In late January 2021, CCR, CCWG, and State Parks placed 40 haybales and locally derived driftwood that had washed up on the beach along the Sandholdt section of foredune (Figure 7). Haybales were placed on their sides and buried about 1/3 into the sand so they wouldn't be able to be moved by beach visitors. Placement location of driftwood and haybales was determined in coordination with State Parks and Pont Blue staff. Installation of drift wood and hay bales along the foredune helped capture sand and increased dune roughness. After a few months the hay bales slowly decomposed

while continuing to help capture sand and add to foredune roughness. Dune grass was planted on the foredune around the haybales and driftwood to enhance foredune resilience (Figure 8).

Figure 7. Haybales and drift wood places along toe of foredune and buried ~1/3 of the way into the sand

Figure 8. Native dune grass helps capture sand in the foredune.

4. MONITORING ACTIVITIES (TASK 3)

Monitoring Overview

CCWG and its partners conducted vegetation surveys and high-resolution dune mapping to document the success of restoration efforts. Additional monitoring focused on special status species. These activities serve to assess the achievement of restoration objectives, explore best practices, pinpoint locations of sensitive plant species, and identify areas requiring adaptive management. While the focus of monitoring was directed at the Sandholdt dune section, vegetation surveys spanned the entire project area.

Point-Intercept Vegetation Surveys

Purpose

Line-point intercept vegetation surveys were used to characterize the vegetation community located within the restoration areas and to document vegetation changes over the course of the project. Information collected during surveys included percent cover of native and non-native or invasive plants, and abiotic features. Presence of ice plant during monitoring was noted for spraying or hand removal. The results of these surveys help provide information on the success of restoration activities.

Methods

In November 2019, CCWG staff conducted pre-restoration vegetation surveys within the Sandholdt project focus area. Eight transect locations were established, with six being within the restoration area and two within the Private parcel, which was used as a no action control area. Each of the eight locations included three transects: 1) a 75m transect perpendicular to beach and 2) two 50m transects parallel to beach, one along the fore-dune and one along the mid-dune (Figure 9). Along the perpendicular transects, it was also noted where the transect transitioned from foredune to mid-dune. Line-Point Intercept method was used along transects to quantify cover of specific species, native and non-native cover, and species diversity. At every meter on the transect line, a pin flag was used to determine cover type, based on the plant or abiotic feature that it intersected first. Native and non-native plants were identified to the species level whereas abiotic cover was defined as bare sand, litter, dead ice plant, or trash. Litter was defined as loose material, whereas dead ice plant was defined as ice plant material that was dead or in the process of dying, but still rooted.

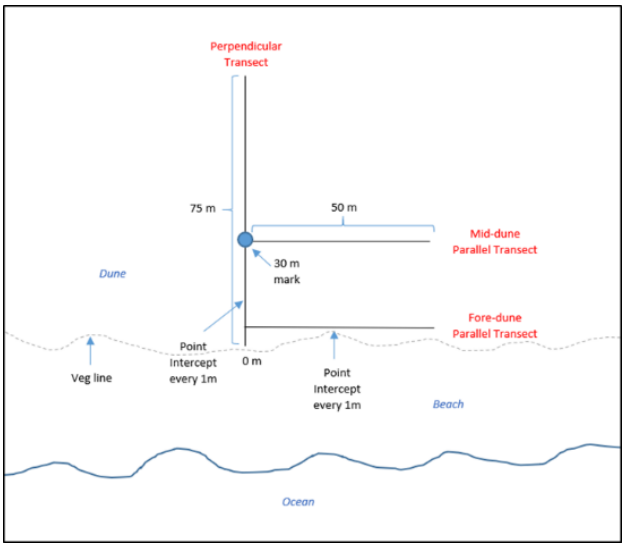

Figure 9. Vegetation transect layout

Beginning in February 2020 (after the initial pre-restoration survey), vegetation surveys were conducted twice-annually throughout each project year to track changes in the vegetation community over the project's duration. These surveys typically occurred in February and October or November, strategically scheduled on either side of the snowy plover nesting season (March-September) to avoid any disturbance to nesting snowy plovers or chicks.

In October 2020, an additional five transects were established and conducted within a new restoration expansion area south of the Potrero Rd access (named Potrero 2/Potrero-Molera). Starting in 2020, surveys were also conducted along select vegetation transects within the Potrero 1, Molera 1, and Salinas River dune sections, that were established in 2016 as part of the previous Phase 1 restoration project. Only perpendicular transects were surveyed in these locations. Transect locations by dune section are shown in Figure 10 and summarized in Table 5.

Percent cover was determined based on the number of noted occurrences of the species relative to the total number of points measured. Diversity values were calculated using the Shannon-Weiner Diversity Index.

CCWG staff using line-point intercept method along a transect in the Sandholdt Restoration dune section

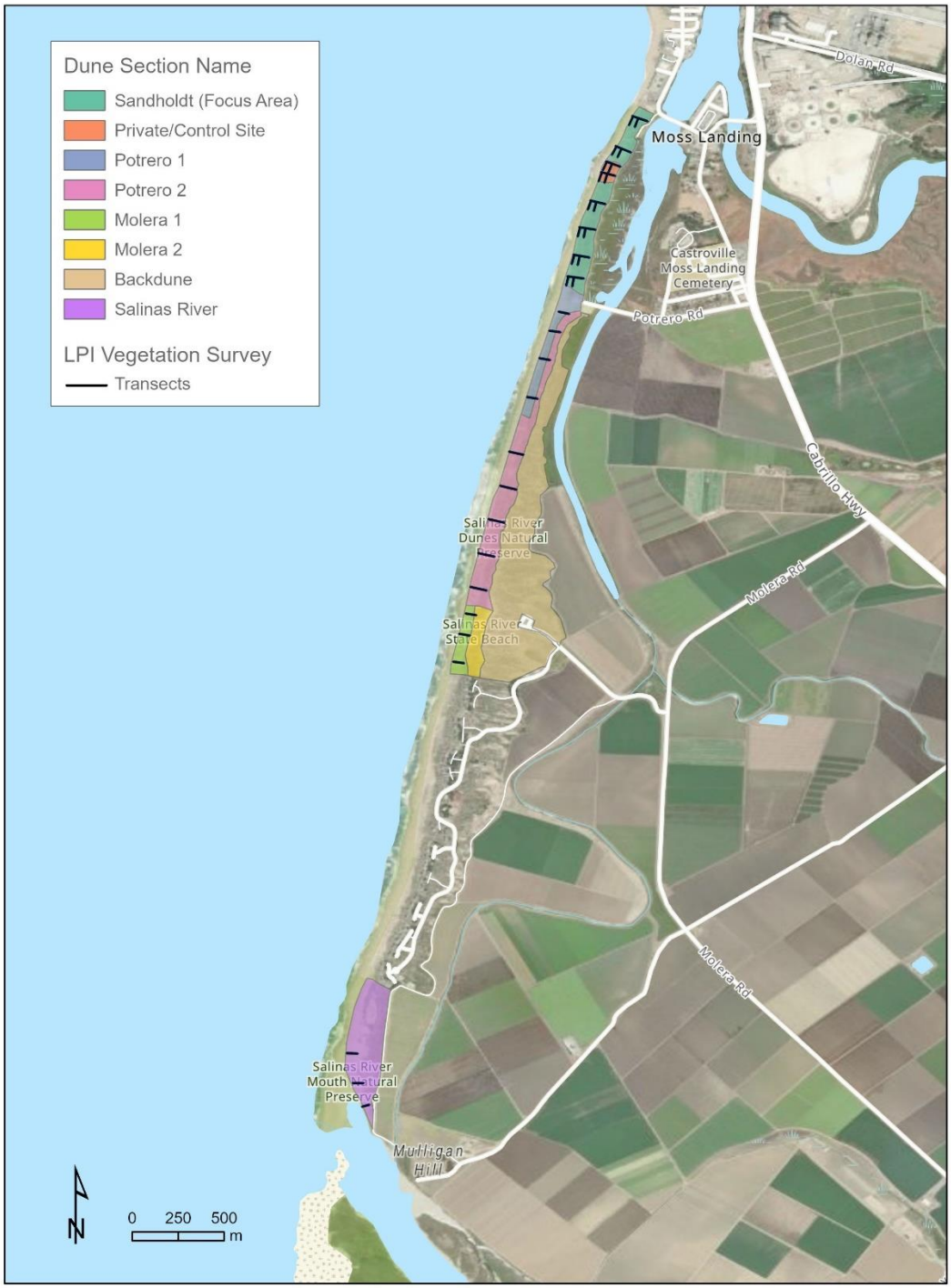

Figure 10. Locations of vegetation transects within the project area. Vegetation transects within Phase 1 dune sections (Potrero 1, Molera 1, and Salinas River were established in 2016. Vegetation transects within Phase 2 restoration areas were established in 2019 (Sandholdt) and 2020 (Potrero 2). The orange area on the Northern portion of the restoration area is a private inholding and has not been treated or restored, however it was used as a control area for surveys. Vegetation transects were established there in 2019.

Table 5. Summary of vegetation surveys at each dune section.

Dune Section	Survey Locations within Section	# Transects at Each Location during Phase 2	Transect position during Phase 2	Survey Years during Phase 2
Sandholdt-Restoration	6	3	Perpendicular Parallel along foredune Parallel along mid dune	Fall 2019- Fall 2023
Sandholdt Control	2	3	Perpendicular Parallel along foredune Parallel along mid dune	Fall 2019- Fall 2023
Potrero 1	4	1	Perpendicular	Fall 2020- Winter 2023
Potrero 2 (Potrero-Molera)	5	1	Perpendicular	Fall 2020- Winter 2023
Molera 1	3	1	Perpendicular	Fall 2020- Winter 2023
Molera 2	0	0	None	N/A
Salinas	3	1	Perpendicular	Fall 2020- Winter 2023
Backdune	0	0	None	N/A

Results

Vegetation survey results for the Sandholdt dune sections (Sandholdt and Control) as well as the Potrero 2/Potrero-Molera dune section are discussed below. These are the two dune sections that were initiated in Phase 2 with corresponding vegetation monitoring. Surveys were not conducted on the Phase 2 backdune expansion areas (Molera 2 and Backdune) due to limitations in funding for monitoring and the large number of acres that would need to be covered. For a summary of results of the previously restored Phase 1 sections (Potrero 1, Molera 1, and Salinas River) please see Appendix A.

Percent Cover/Abundance

The following graphs show average percent cover for native plants, live ice plant, dead ice plant, litter, bare sand, and other non-native plants across transects for each the Sandholdt and Potrero-Molera sections of dunes. The pre-and-post graphs illustrate the comparison between the initial survey season (Fall 2019 for Sandholdt and Fall 2020 for Potrero-Molera) and the final survey season (Fall 2023 for Sandholdt and Winter 2023 for Potrero-Molera). Graphs depicting Winter versus Fall are organized by season and year. Graphs contrasting foredune versus mid-dune present averaged seasonal survey data for each year for the fore and mid dune locations.

Sandholdt and Control - Pre and Post: The Sandholdt restoration area decreased in invasive ice plant cover from 49% to 0% and increased in native cover from 35% to 62% between the pre-restoration survey in 2019 to the most

recent October 2023 survey. The Sandholdt Control area, where no restoration activities have taken place, saw a slight decrease in native cover from 23% to 19% and ice plant cover from 67% to 61% between the pre-restoration survey in Fall 2019 to the most recent Fall 2023 survey (Figure 11).

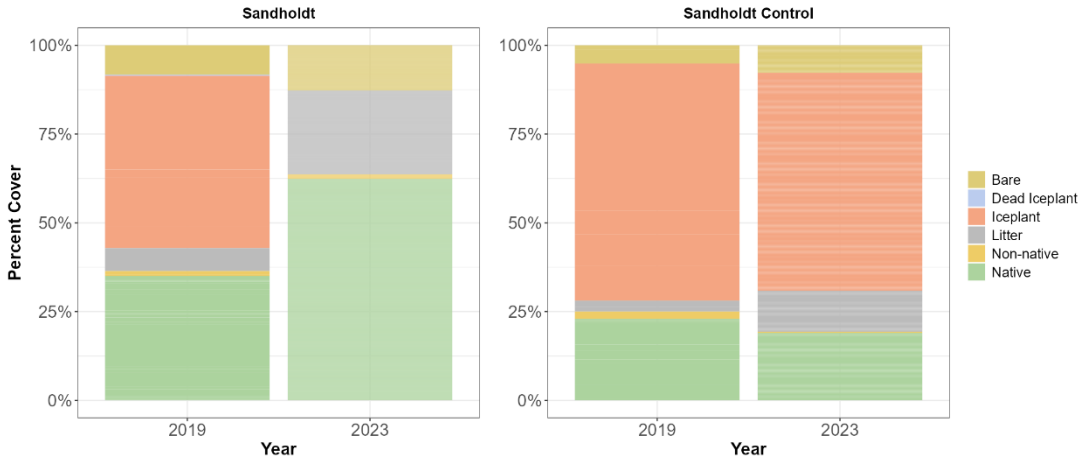

Figure 11. Vegetation survey results comparing pre-restoration (Fall 2019) to post-restoration (Fall 2023) for the Sandholdt Restoration and Sandholdt Control.

Sandholdt Restoration - Winter vs Fall: Results show that surveys conducted in Winter generally had lower percent cover of native vegetation and slightly higher percent cover of bare sand than the Fall surveys (Figure 12).

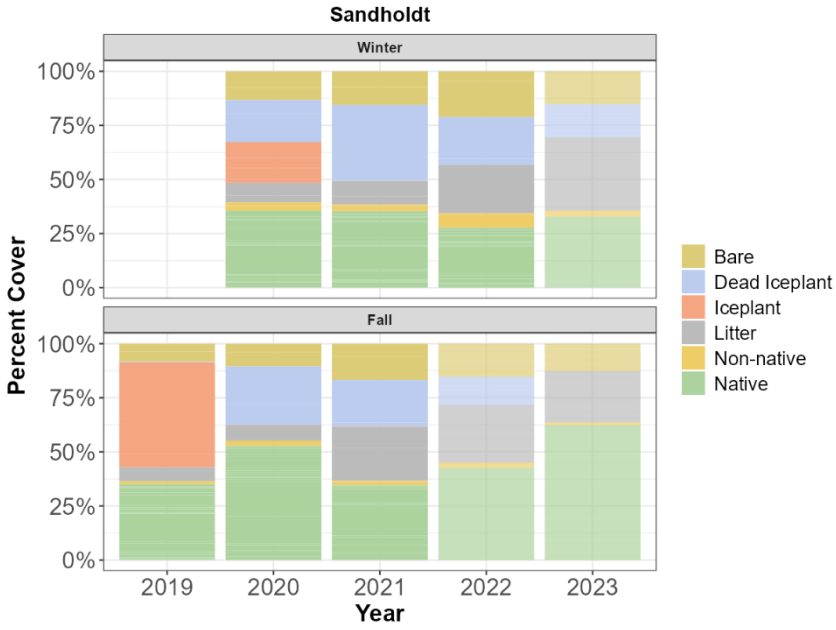

Figure 12. Vegetation survey results comparing Winter vs Fall for the Sandholdt Restoration area.

Sandholdt Restoration - Foredune vs Mid Dune: Results show that the Sandholdt foredune overall has lower cover of native vegetation and higher cover of bare sand throughout the project period than the mid-backdune area. However the foredune also had higher cover of ice plant (at project initiation compared to the mid-backdune area (Figure 13).

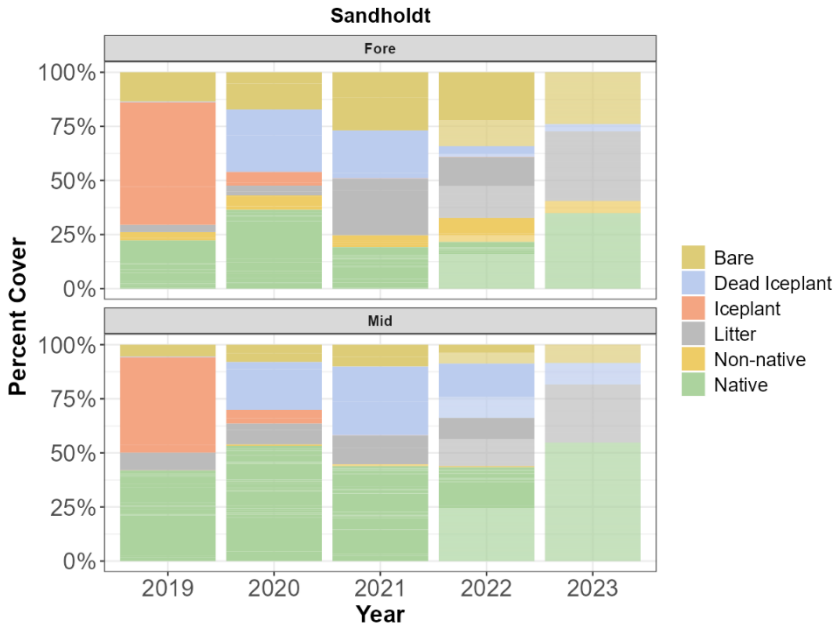

Figure 13. Vegetation survey results comparing Foredune to Middune for the Sandholdt Restoration area.

Potrero-Molera Pre and Post: The Potrero-Molera restoration area is showing an overall significant decrease in invasive ice plant cover from 32% to 0%, and a slight decrease in native cover from 47% to 44% between Fall 2020 and February (Winter) 2023 (Figure 14).

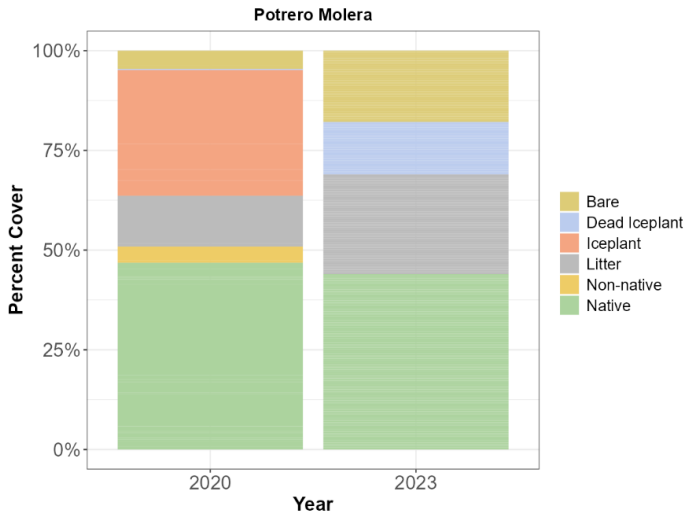

Figure 14. Vegetation survey results comparing pre-restoration (Fall 2020) to post-restoration (Winter 2023) for the Potrero-Molera area.

Potrero-Molera Winter vs Fall: Results show that at the Potrero-Molera site, percent cover of natives does not vary greatly between Winter and Fall surveys. (Figure 15).

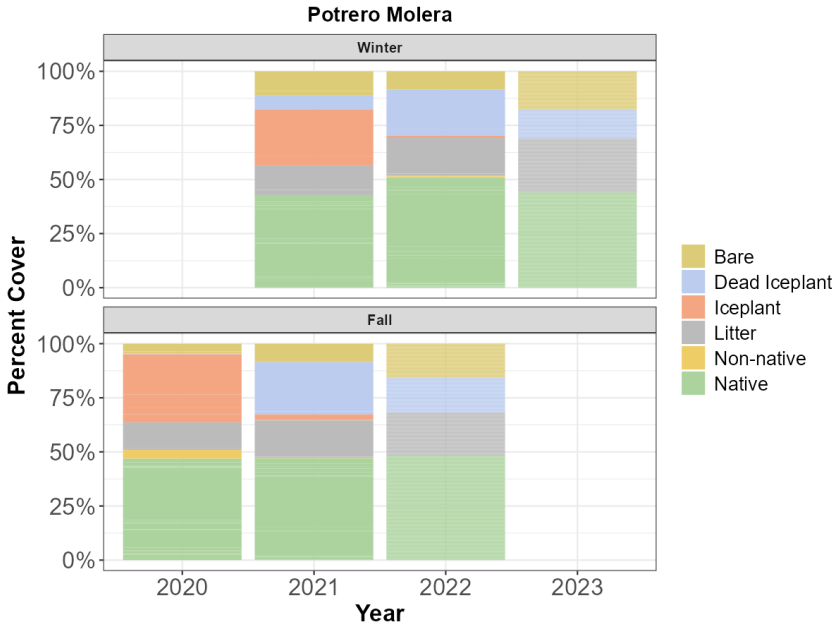

Figure 15. Vegetation survey results compare Winter vs Fall for the Potrero-Molera area.

Potrero-Molera Foredune vs Mid Dune: Results show that the Potrero-Molera foredune has lower cover of native vegetation and higher cover of bare sand in the foredune throughout the project period than the mid-backdune area. However the foredune also had higher cover of ice plant at project initiation compared to the mid-backdune area (Figure 16). Steep/thin foredune area along this segment, and data collection methods (no parallel transect completed) are likely driving the low native plant cover estimates.

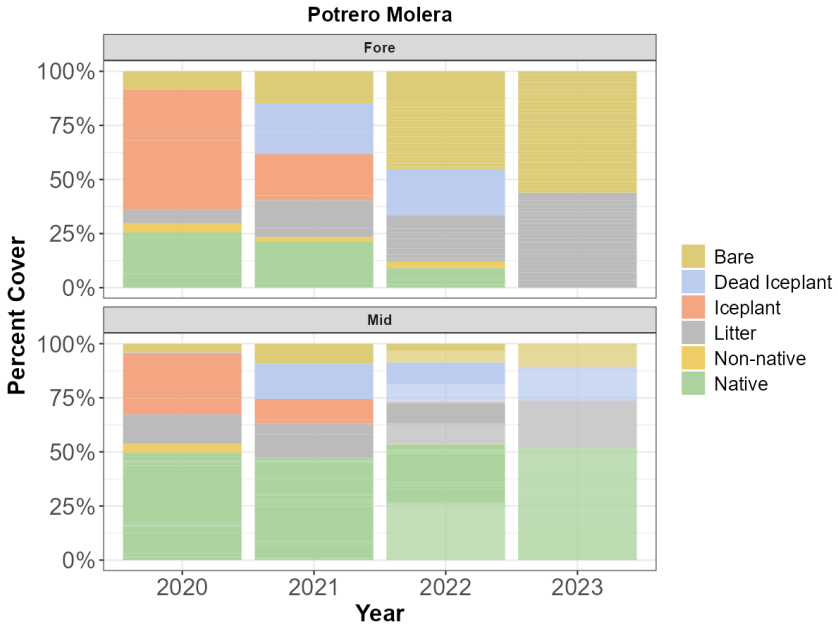

Figure 16. Vegetation transect results compare Foredune to Middune for the Potrero-Molera Restoration area.

Plant Diversity

Results of plant diversity are shown in Figure 17 for the Sandholdt Restoration and Control areas. The diversity index decreased during the Winter surveys and fluctuated during the Fall surveys, with the index from the final Fall 2023 survey at the Sandholdt Restoration area being slightly higher than the Fall 2019 survey. The diversity index was consistently lower in the Control area.

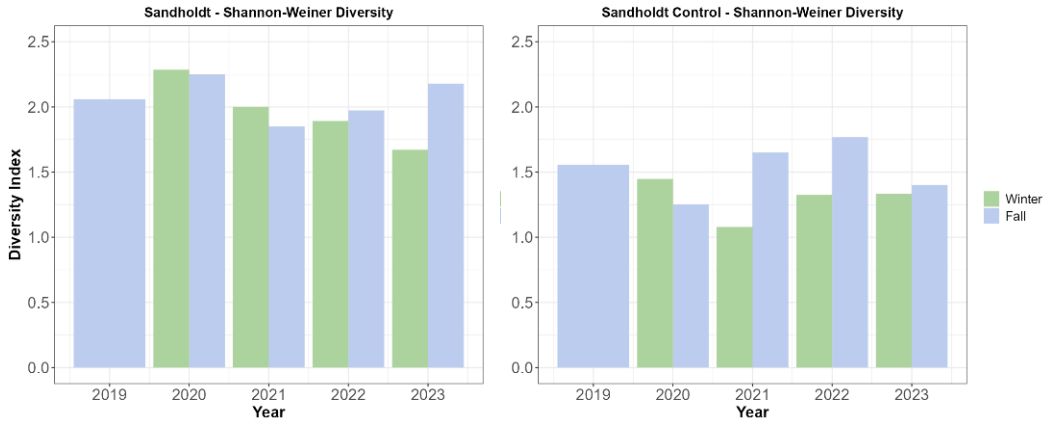

Figure 17. Diversity index of Sandholdt Restoration area compared to Sandholdt Control

Discussion

The vegetation surveys documented a significant decrease in ice plant cover at all restoration sites between pre- and post-restoration surveys. Native cover increased in restoration sites with initially low native cover, such as the Sandholdt Restoration site. However within the Potrero-Molera site, despite pre-restoration cover having over 25% ice plant cover, native vegetation cover remained about 50%, with ice plant cover transitioning to litter and bare ground, instead of native vegetation. The post-restoration 2023 vegetation surveys at Potrero-Molera occurred in the Winter, instead of Fall, after many plants had senesced. Therefore, post-restoration results may be slightly higher in the future if surveys are conducted during fall periods.

The foot trail dividing the Sandholdt Restoration area (left) and the Control area (right).

On average the Sandholdt Restoration section of dunes initially had higher cover of natives and lower cover of ice plant than the Sandholdt Control section of dunes. It should be noted that within the Sandholdt Restoration section of dunes, the native and ice plant cover varies between the six transect locations, with some transects having high ice plant cover and low native cover similar to the Control section, and other transect locations having higher initial native cover and less ice plant cover.

Among all sites, ice plant cover in the foredune was greater than cover of natives. After treatment, foredune vegetation showed the highest variability in cover, most likely due to seasonal fluctuations in sand movement and wave impacts. Native plant cover fluctuated between the Winter and Fall surveys, with higher cover in Fall (October/November) and lower in Winter (late February). Due to access limitations to the study site during Western snowy plover breeding season (March-September), vegetation surveys were not conducted on the foredune during Spring early growing season. The seasonal increase in cover in the Fall likely represents seasonal growth of the vegetation through Fall and then plant senescence and dormancy documented in the Winter surveys.

Other studies have found that when ice plant is removed, invasive grasses recruit to open areas. This did not occur within this study. Cover of non-natives, including invasive species other than ice plant, did not increase during the project period. While open area on the dunes did increase slightly, much of the areas where ice plant was eliminated transitioned to dead ice plant, litter, or native plant cover categories, likely limiting the recruitment potential of invasive grasses. Non-natives noted during transects were primarily sea rocket and New Zealand spinach, neither of which are seen as invasive species of concern at SRSB.

The presence of *Ammophila* and *Arundo* was also reduced within the treatment areas and the project team will work with State Parks to track regrowth and support future spraying and removal of remnant populations. Similarly, ice plant was found to recruit through regrowth of sprayed plants and through seed dispersal by birds. When plants are small, removal and thus maintenance of ice plant free dune habitat, is a low effort nondestructive activity. If plants are allowed to regrow into large patches, additional spraying or mechanical removal are needed which have greater

impacts on the dunes and costs to execute. Therefore, the restoration team recommends (and will work with State Parks to establish) an annual dune walk, aimed at removing any small recruits of ice plant and noting any large patches that will require mechanical or chemical removal.

Despite efforts through native planting and seeding, results from the vegetation surveys within the Sandholdt restoration area, show on average there was no significant increase in native species richness and diversity. Line-point intercept surveys, employed in this study, are limited in capturing less common species. To better understand changes and accurately determine species richness and diversity, a larger sample size or alternative sampling methods, such as quadrat sampling, would be more effective.

GIS Analysis of Vegetation Cover

Purpose

Orthomosaic images generated from UAV surveys during multiple seasonal flights were compared with on-the-ground plant surveys to test the efficacy of this sampling method. Orthomosaic images offer a comprehensive aerial perspective, facilitating efficient monitoring of large areas and identifying spatial patterns not easily captured in ground surveys alone. The primary goal of this effort was to assess the reliability of GIS analysis compared to on-the-ground results as a vegetation survey method.

Methods

A GIS analysis was carried out using the image classification toolset in ArcGIS Pro to compare cover data from high resolution orthomosaic images with cover estimates from the UAV surveys (see Topographic Surveys) in order to determine change in ice plant and native cover within the Sandholdt focus area from the start to the end of the project. Cover classes for native, live ice plant, litter (including dead ice plant), and bare sand were created using the Training Samples Manager tool. Polygons were drawn on the orthomosaic image around known samples of the different cover types in the image. The tool then processes the entire orthomosaic and creates a new layer that contains the designated cover classes. For each UAV flight, abundance was calculated for each cover class using the new classified layers. The results of the analysis were used to compare changes in vegetation at the unrestored control area and the restoration focus area. Results were then compared to the on the ground point-intercept vegetation survey results collected within the same areas. To properly compare the two methods, the on-the-ground survey data from February 2020 was chosen to ensure alignment with the initial February 2020 UAV survey.

Results

The map in Figure 18 displays the results of the image classification. A comparison of results between the GIS image classification and on-the-ground survey are presented in Figure 19 and Table 6.

Figure 18. A) Aerial analysis of UAV photography in February 2020 prior to herbicide spraying and B) November 2023 after several years of ice plant removal efforts.

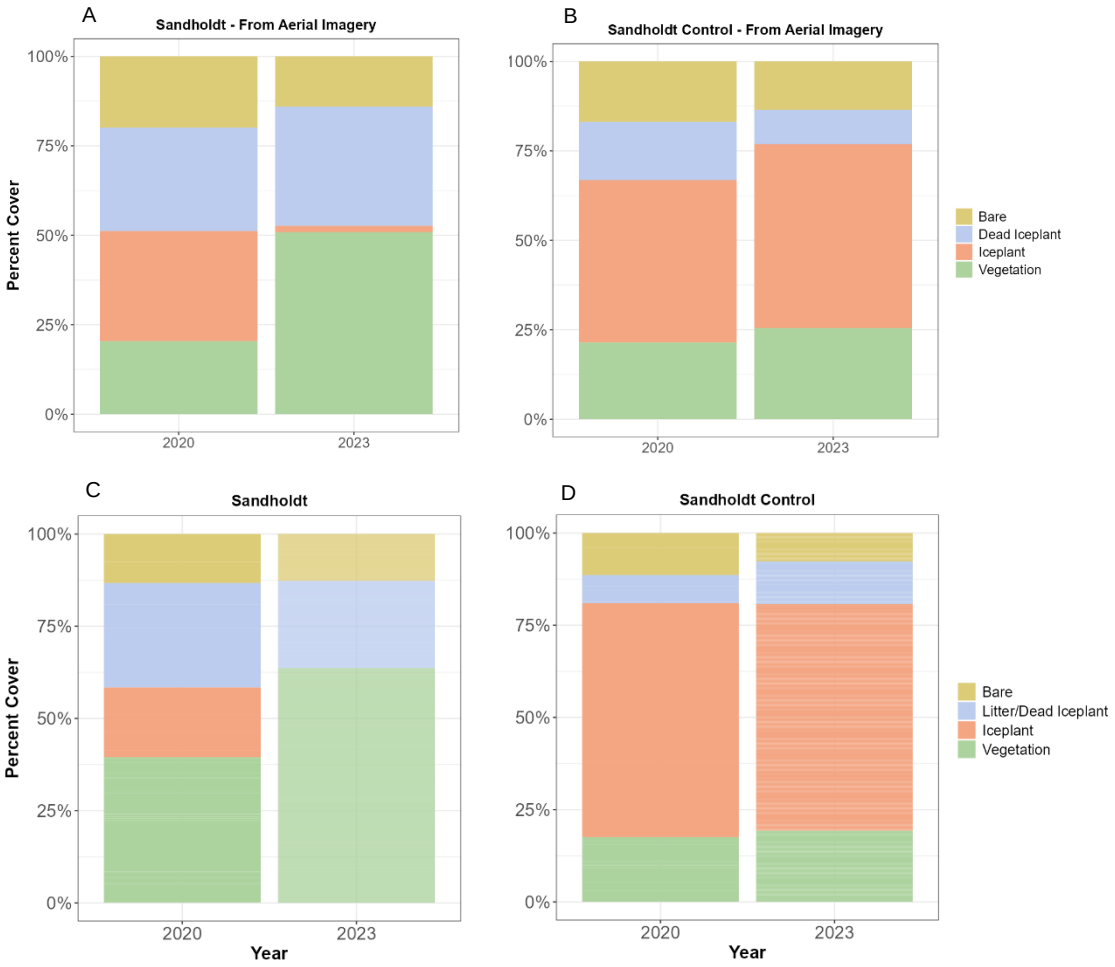

Figure 19. Percent cover of various cover types classified for 2020 and 2023 for restoration and control areas, quantified through aerial imagery analysis (A&B) and field transects (C&D).

Table 6. Image analysis compared to on the ground surveys within the Sandholdt Restoration and Control areas, for Winter 2020 and Fall 2023

Dune Section	Cover	Winter 2020		Fall 2023	
		Orthomosaic	***Ground***	***Orthomosaic***	***Ground***
Sandholdt Restoration	Bare	21%	13%	16%	13%
	Litter/Dead Ice plant	30%	28%	31%	24%
	Ice plant	25%	19%	2%	0%
	Vegetation	24%	39%	51%	64%
Sandholdt Control	Bare	17%	11%	14%	8%
	Litter/Dead Ice plant	16%	8%	10%	12%
	Ice plant	45%	63%	51%	61%
	Vegetation	21%	18%	25%	19%

The percent cover estimates for various classes were generally comparable between the ground surveys and image classification method. There were however some notable differences. The image analysis estimated higher bare ground cover in both restoration and control areas compared to field surveys. Field surveys reported greater native vegetation cover in the restored areas and lower native vegetation cover in the control area compared to the image analysis. Conversely, the image analysis estimated greater ice plant cover in the restored area than field surveys, while estimating less ice plant cover in the control area. Specifically, aerial imagery recorded a 2% cover of ice plant in the restored areas, contrasting with field surveys that documented no presence of ice plant. A statistical analysis using ANOVA showed there was no significant difference between the two methods ($p>0.98$, $n=4$).

Discussion

While, the cover estimate results from both on-the-ground surveys and drone aerial imagery (orthomosaics) are similar, there are limitations associated with using either technique. It is difficult to accurately capture the fine scale of litter and small native plants using the aerial image classification toolset, and the wide spectrum of colors displayed by ice plant (ranging from red to green) pose a challenge for accurate classification of other native vegetation that may share similar colors. Additionally, drone surveys conducted during Winter and Fall pose difficulties as native vegetation tends to exhibit a more muted, grey color during these seasons, making it more challenging to differentiate between native plants and litter or dead ice plant in the imagery. Consequently, there is a potential for over or under-quantification of different cover classes sharing similar color characteristics within the orthomosaics. Utilizing a multispectral drone camera could offer a more effective solution, allowing for better differentiation between ice plant, other plant species, and abiotic features such as bare sand or litter.

Despite some of the limitations of the aerial image data analysis, the use of drones has emerged as a valuable tool in assessing vegetation cover during restoration projects. The aerial perspective provided by drones allows for a comprehensive view of large project areas, enabling efficient monitoring of changes in vegetation cover over time and identifying spatial patterns that may be challenging to capture during ground surveys alone. Additionally, drone surveys can be conducted more frequently and with relative ease compared to intensive ground surveys. This frequency enables timely detection of changes, facilitating proactive decision-making in the context of vegetation management and restoration efforts. For example, drone surveys can contribute to identifying persistent areas of ice plant within the restoration project area, offering specific locations requiring targeted invasive control. If drones are flown at a high enough altitude to not disturb nesting birds, surveys could also be conducted during Spring and Summer growing months.

The combination of drone imagery and ground surveys provides a multi-dimensional understanding of vegetation dynamics. While drone surveys offer a broad overview, on-the-ground surveys offer detailed, species-specific data needed for tracking diversity and species richness. Integrating the use of both these datasets allows for a more robust analysis, improving the accuracy of data collection and vegetation change assessments. Overall, the integration of orthomosaic images from drone surveys with on-the-ground surveys enhances the comprehensiveness and effectiveness of vegetation change analyses. Both techniques documented our successful attainment of ice plant cover objectives of less than 5%.

Photo Monitoring

Methods

Photo monitoring was conducted in conjunction with vegetation surveys along each perpendicular vegetation transect. Photos were taken at the start of the transect on the foredune and at the 30m mid-dune point. At each point, photos were taken looking North, East, South, and West. Photos were used to aid plant identification and provide visual information regarding changes in cover types.

Results

Figure 20 shows pre and post restoration photos from a mid-dune transect within the Sandholdt Restoration dune section. See Appendix B for photos from more transects.

Figure 20. Sandholdt Transect 5 photo monitoring: November 2019 (left) and November 2023 (right). Photo taken on the middune facing North.

Discussion

Photo monitoring along vegetation transects offers a helpful visual way to observe the outcomes of restoration work alongside traditional survey methods. The photos provide a dynamic and time-sensitive view of vegetation changes, helping to track long-term trends and inform adaptive management strategies for ecological restoration.

Rare Plant Surveys

Purpose

SRSB provides critical habitat for special status plant species including Monterey Spineflower (*Chorizanthe pungens* var. *pungens*) and Monterey gilia (*Gilia tenuiflora* ssp. *arenaria*). Both species are herbaceous annuals. Spineflower is in the buckwheat family that prefers openings on sandy soils in fore to mid dune areas in addition to other maritime plant communities (Pereksta & Fish, n.d.). This plant is federally listed as “threatened” and state listed as “moderately threatened” in California (CNPS rare plant rank 1B.2), which means there is a threat to 20-80% of all plant occurrences largely due to invasive species and habitat degradation. Additionally, Monterey gilia is in the phlox family and is federally listed as “endangered”. The dune areas at SRSB provide “the physical or biological features (I)

essential to the conservation of the species and (II) which may require special management considerations or protection" (Endangered Species Act - 16 U.S.C. Sections 1531-1544, n.d.) as defined by the 1972 Endangered Species Act. If these species are to persist, then management strategies can address habitat degradation through eradicating stressors such as ice plant. Annual Spring surveys were conducted to document distribution and abundance of Monterey gilia and Monterey spineflower over several years of the project.

Monterey gilia found during rare plant surveys at SRSB in May 2021

Methods

Surveyors conducted rare plant surveys within the Sandholdt Restoration and Control sections of dunes in 2021, 2022, and 2023 in order to count and map locations where Monterey gilia and Monterey spineflower were present. During each survey, the surveyors walked back and forth along the dunes in a mowing-the-lawn-pattern, with about 5m between adjacent passes until a target plant occurrence was encountered. Target plant species were recorded with the ArcGIS Field Maps cellular phone application with an external GPS unit. Monterey gilia were recorded using points combined with counts of individual plants recorded at each location. For Monterey spineflower, locations were recorded as points for individual plants and small patches, and as polygons for large dense patches. For locations identified with points that contained multiple plants, patch size was estimated to the nearest 0.25 meter^2. Patch size for large areas mapped as polygons was estimated using ArcGIS Pro functions. During all surveys, areas west of the foredune dune crest were not surveyed, to avoid disturbing nesting Western snowy plovers.

Surveys for target species were timed, when possible, to coincide with peak bloom period of target plant species allowing accurate identification of each species. The bloom period for Monterey Gilia is April-June (Calflora, 2024) and for Monterey spineflower the bloom period is April through July (Calfora, 2024). In 2021 and 2022, surveys were initiated in mid-May. In 2023, surveys were initiated in April and focused solely on Monterey gilia. During the 2022 survey the surveyors were able to survey the whole dune complex extending from the Sandholdt Road in the north to the northern edge of the Monterey Dunes Colony complex, and from the southern edge of the Monterey Dunes Colony complex to the Salinas River lagoon. Results from the whole dune survey are presented in Appendix C.

Results

Monterey Spineflower

In 2021, Monterey spineflower plants and small patches were identified at 128 locations within the Sandholdt dune area and the total number of plants observed was estimated to be 1,094. In 2022, the survey methodology was modified to account for large dense patches of Monterey spineflower, where along with the point locations, large patches were mapped as polygons by walking the perimeter of the patch and recording a polygon feature. In 2022, Monterey spineflower was identified at 127 locations and the number of plants was estimated to exceed 1,300. There were also a number of large patches with a combined area occupied in excess of 1,500 m^2 (Figure 21 and Table 7).

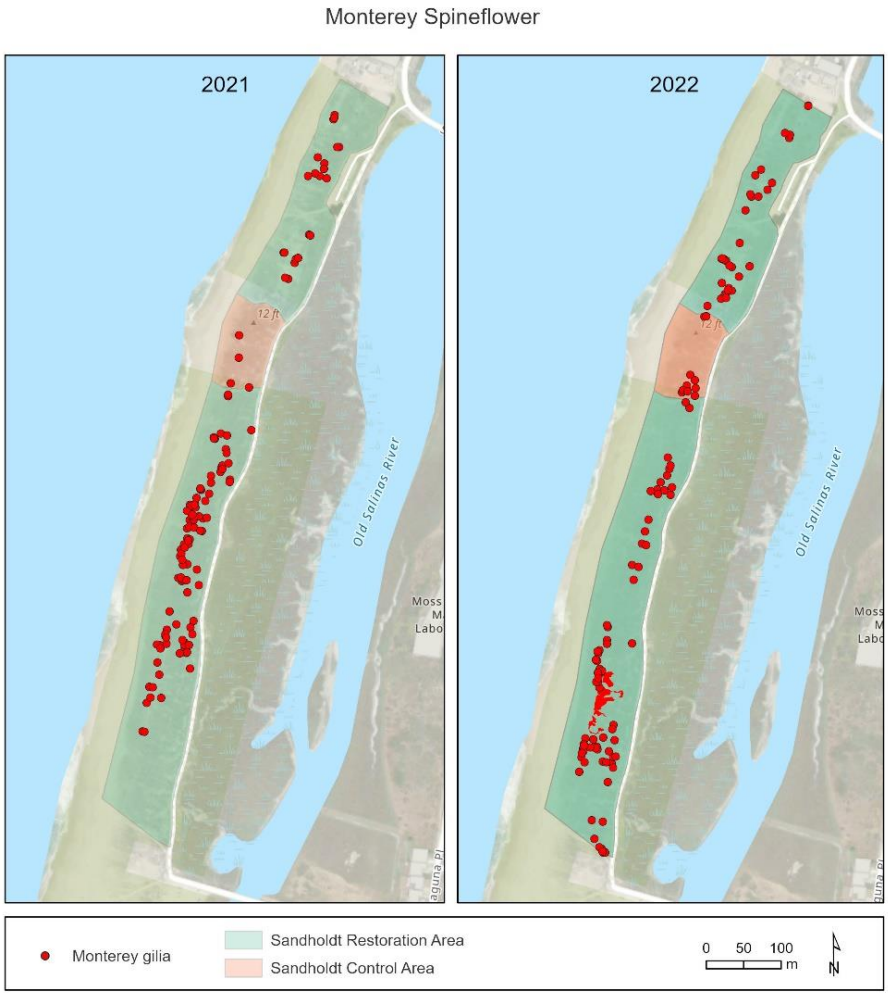

Figure 21. Locations of Monterey spineflower during 2021 and 2022 Spring rare plant surveys.

Table 7. Monterey spineflower observed within the Sandholdt dune area.

Monterey Spineflower	**2021**	**2022**
Number of Locations	128	127
Estimated Number of Plants	1,094	1,322
Estimated Area Occupied	-	1,550 m^2

Monterey Gilia

In 2021, Monterey gilia was found at 9 locations with a count of 23 individual plants within the Sandholdt section of dunes. The following year Monterey gilia was identified at 10 locations with a count of 19 individual plants. In 2023, Monterey gilia was found at 36 locations with an estimate of 107 individual plants (Figure 22 and Table 8). No gilia plants were found within the unrestored Control section.

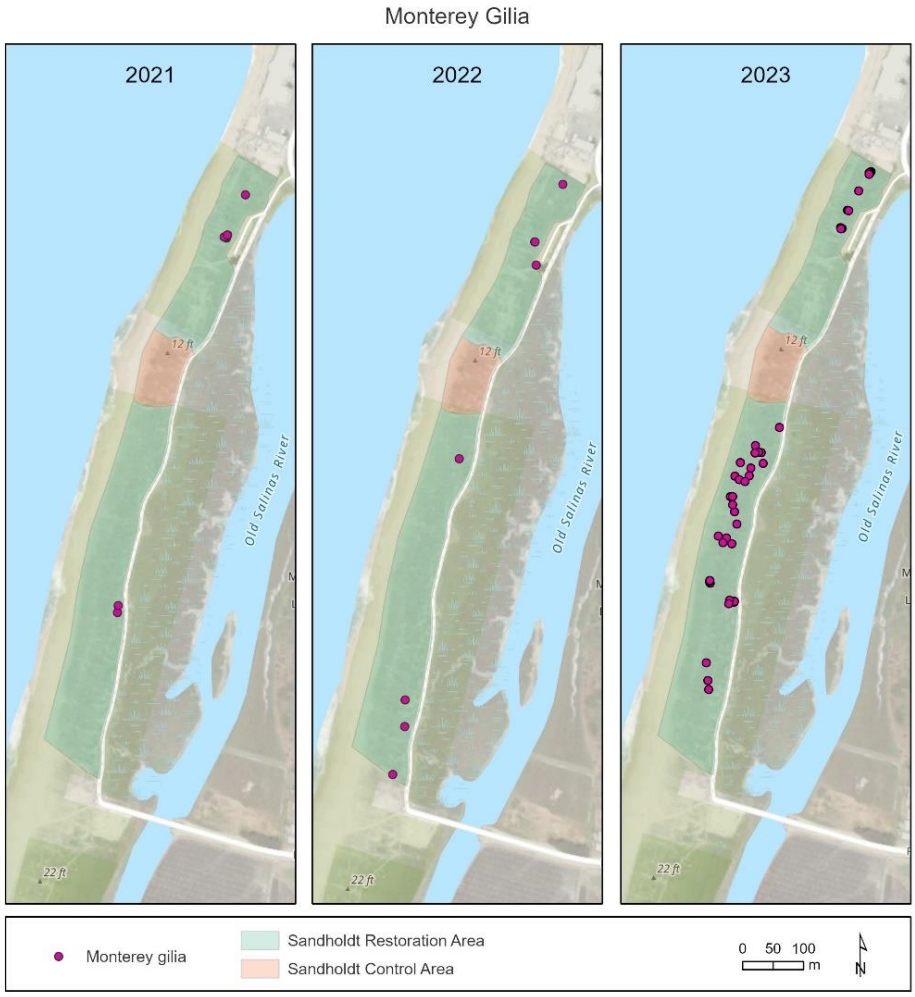

Figure 22. Locations of Monterey gilia during 2021, 2022, and 2023 Spring rare plant surveys.

Table 8. Monterey gilia observed within the Sandholdt restoration focus area.

Monterey Gilia	**2021**	**2022**	**2023**
Number of Locations	9	10	36
Estimated Number of Plants	23	19	107

Discussion

The rare plant surveys conducted over the last few years provide insight into the distribution and abundance of Monterey spineflower and Monterey gilia relative to areas where restoration activities have occurred. Between 2021 and 2022 Monterey spineflower individuals increased by 20%. This increase in plants found may be due to reduction in ice plant cover over time or due to the changes in monitoring methodology in 2022 to better account for large dense patches. This adjustment in methodology better documented Monterey spineflower distribution and emphasized the existence of large patches within the dune complex. Similarly, the number of Monterey gilia plants documented increased threefold between the 2021 and 2023 survey. Notably, no gilia plants were found during any of the three surveys within the unrestored Control section, underscoring the impact of ice plant invasion on the distribution and population size of this rare species.

The timing of surveys also plays an important role in documenting these two species. The surveys initiated in May were well into the bloom period. For Monterey gilia, it is likely that some of the earlier blooming plants were not recognizable at the time of the survey. Monterey spineflower plants, however, are more easily identifiable even as dried specimens.

These findings highlight the value of invasive species removal within dune systems to increase the population size of these threatened species and the importance of ongoing monitoring and adaptive management strategies for their conservation.

Legless Lizard Surveys

Purpose

This study was designed to document the distribution of Northern legless lizards (*Anniela pulchra*) and presence of the black legless lizard subspecies (*Anniela pulchra nigra*) within the SRSB dune restoration area. Northern legless lizards are a California Species of Special Concern (CNDDB, 2024). The primary objective of these surveys was to evaluate legless lizard habitat use in response to restoration of native coastal dune plant communities.

Methods

Surveys for Northern legless lizards were conducting with the use of coverboards. In April 2021, forty-one (60 cm x 60 cm) coverboards were distributed throughout the Sandholdt restoration and Control sections of dunes as well as part of the Potrero dune area, at a density of approximate 5 coverboards per hectare. Coverboards were surveyed throughout the Spring and Summer months in 2021, and opportunistically during rare plant surveys in 2022 and 2023. In 2021, surveys were conducted under optimal conditions which require some level of sunlight during the day and sand surface temperatures exceeding 35° C. Sand temperatures were measured at each coverboard location with an infrared thermometer. At each location the coverboard was quietly lifted and

Figure 23. Quietly removing a coverboard during a legless lizard survey.

set aside (Figure 23). The sand was then gently raked with fingers, multiple times in each direction. This typically reveals if a legless lizard is present within the first 5-8 cm of the surface. When a legless lizard was found, the raking stopped to allow it to return under the sand surface. The coverboard was then gently returned to its location and partially covered with sand.

Results

A total of nine Northern legless lizards were found, eight of which were found under coverboards with one additional found incidentally during a restoration planting (Figure 24 and Table 9). In 2021, surveyors found six legless lizards, with two of the coverboards having two separate observations on different dates. During the opportunistic surveys in 2022 and 2023, there were two observations in 2022 and one and in 2023. No legless lizards were found under coverboards placed in the unrestored Control section of dunes.

Figure 24. Detections of legless lizards at coverboards during 2021, 2022, and 2023 surveys.

Table 9. Northern legless lizards observed during surveys conducted 2021 through 2023

Observation	Description	Location	Date
1	Silver phase - found during planting	Incidental	7/1/2021
2	Mid-range dark back color	C14	7/23/2021
3	Black phase	C17	7/23/2021
4	Silver phase - found during planting	B5	7/24/2021
5	Silver to medium dark	C14	8/18/2021
6	Black phase	C17	8/18/2021
7	Dark olive phase - older tail re-growth	C8	5/17/2022
8	Dark olive phase	A5	5/20/2022
9	Silver phase	E2	4/14/2023

Discussion

Coverboards can be an effective and non-intrusive survey method, and although this survey method may have less impact on the habitat than more active time-constrained search methods, the detection rate tends to be relatively low compared to the actual population size. In one study, Kuhnz et al. (2005) reported detecting 100 Northern Legless lizards during 1,292 searches of 38 coverboards over a 37-month period. These coverboard surveys were conducted within an area from which 3,582 Northern legless lizards were subsequently relocated from a construction site to restored adjacent dune habitats indicating that even when substantial individuals are known to be present, detection rate can be relatively low. The survey results from the Sandholdt survey are indicative of relative abundance of local Northern legless lizard populations within habitats dominated by predominately native versus invasive plants.

Dune Topography

Purpose

The surveys were carried out to assess the geomorphologic characteristics and variability of the different habitats associated with the dunes with focus on the windward slope (the side of the dune facing the ocean), the foredune and the transition with the adjacent beach habitats including runnel and beach berm. High-resolution (<~2cm) dune mapping was conducted before and after project implementation using a combination of survey tools including differential GPS equipment and Unmanned Aerial Vehicles (UAV).

Methods

Beginning in 2020 the SRSB dunes were surveyed twice a year using a UAV flown over an area of 0.12 km^2 (about 0.18 km wide and 1.2 km long), extending from the Moss Landing Marine Laboratories (MLML) Shore Lab at the north end of the project area, to the parking lot at Potrero Road at the south end of the project focus area. Preliminary 2D/3D surveys were conducted on 1/13/2020 to test the best UAV flying conditions, and to create the first

photomosaic to use as baseline to both visually assess the treated areas as well as to find the best locations for the Ground Control Points (GCPs) for future surveys. Based on the results of the preliminary surveys in January 2020, the photogrammetric surveys with the UAV were carried out to manage resolution quality and flight time. For optimal results, the study area was broken into two separate survey areas of similar size, outlined by the red and the green colors in Figure 25. The survey extents overlap to ensure a seamless integration of survey results.

Before the start of the February 2020 survey, 20 Ground Control Points were distributed throughout the survey areas (Figure 25). The GCPs were created by driving a 3 feet-long rebar in the ground and letting the top stick out from the ground a few cm. The tip of the rebar is too small to be able to be seen on the aerial photographs and a relatively large surface is required for the parallax correction. Before the UAV flight, the tops of the rebar rods were covered with 30 x 30 cm brightly colored bucket lids, so they could be clearly visible and identifiable on the aerial photos and can be matched with the software coordinates of each GCP.

Figure 25. UAV Study area. The colored polygons outline the two separate survey areas. The label identifies the GCPs used for the surveys.

The first survey was conducted at the beginning of February 2020 and twice a year there after, with the exception of a Fall 2022 survey that was canceled due to weather. The flight path for each survey area followed 5 transects parallel to shore and 25 cross-shore transects, all photographed from 50 m altitude. The 50 m altitude ensures an image resolution of 2.5 cm per pixel, while also limiting wildlife disturbance.

The images captured by the UAV were post-processed using Pix4D software, which georeferenced the images and associates them with a ground control point with a known elevation to calculate the elevation of the survey area. The products of this processing include a digital surface model (DSM) and an orthomosaic which are imported to ArcGIS Pro. The DSMs are used to analyze sand accretion and erosion throughout the project duration. To conduct elevation analysis, transects perpendicular to the ocean were drawn over the DSMs at 50m intervals and the Surface Profile tool was then used to generate elevation graphs for each transect for every drone flight, quantifying dune elevation change over time.

Left: Bucket lids being put on ground control points before the UAV /survey. Right: UAV departing Moss Landing Marine Labs for survey at SRSB

Results

Digital Surface Model Raster Subtraction

DSM elevation maps were compared between Fall 2020 pre-restoration period and Fall 2023 after restoration activities were completed. Positive and negative changes in dune elevation were mapped to highlight areas of change (Figure 26). Greatest changes in dune elevation (positive and negative) occurred in the beach and foredune areas, confirming that this is a dynamic environment with significant temporal change. Inland areas of change may be a result of changes in vegetation cover/height resulting from ice plant removal and native planting efforts. The southern mapped section shows a positive elevation change in the fore and mid-dune. This area is located in the Potrero 1 dune section, where restoration was initiated in 2016 during Phase 1.

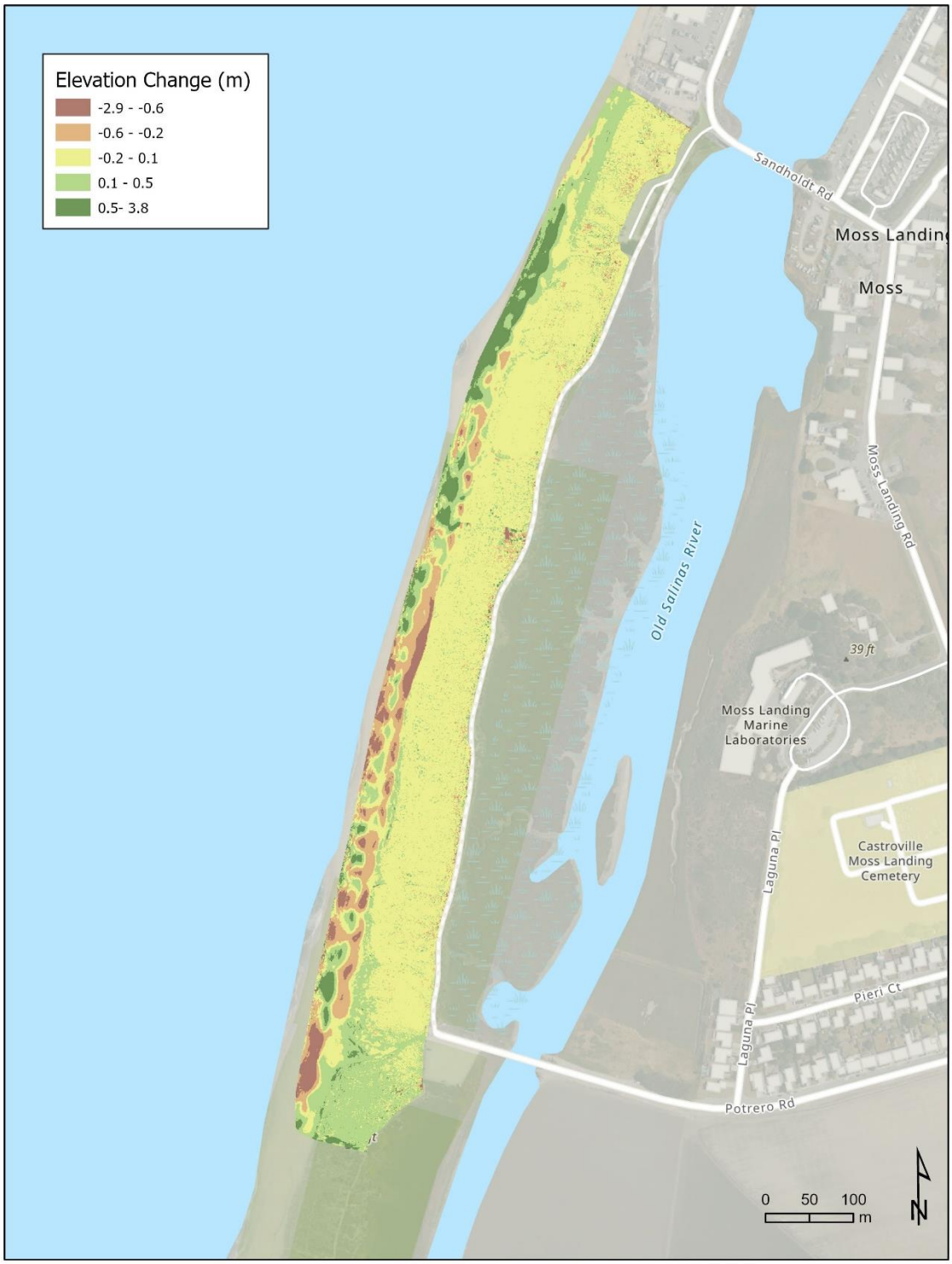

Figure 26. DSM raster subtraction map showing elevation change between Fall 2020 and Fall 2023

Cross Sections

Dune elevation cross sections were generated for each survey at each transect location (Figure 27). Cross sections graphs correspond with labeled cross section locations on the map. Representative cross sections were chosen from within the Control section (unrestored), the Sandholdt section where restoration was initiated three years ago, and within the Potrero 1 section where restoration was initiated six years ago during Phase 1. Cross sections were then divided into beach, foredune, mid dune, and back dune areas to better visualize local change (Figure 28).

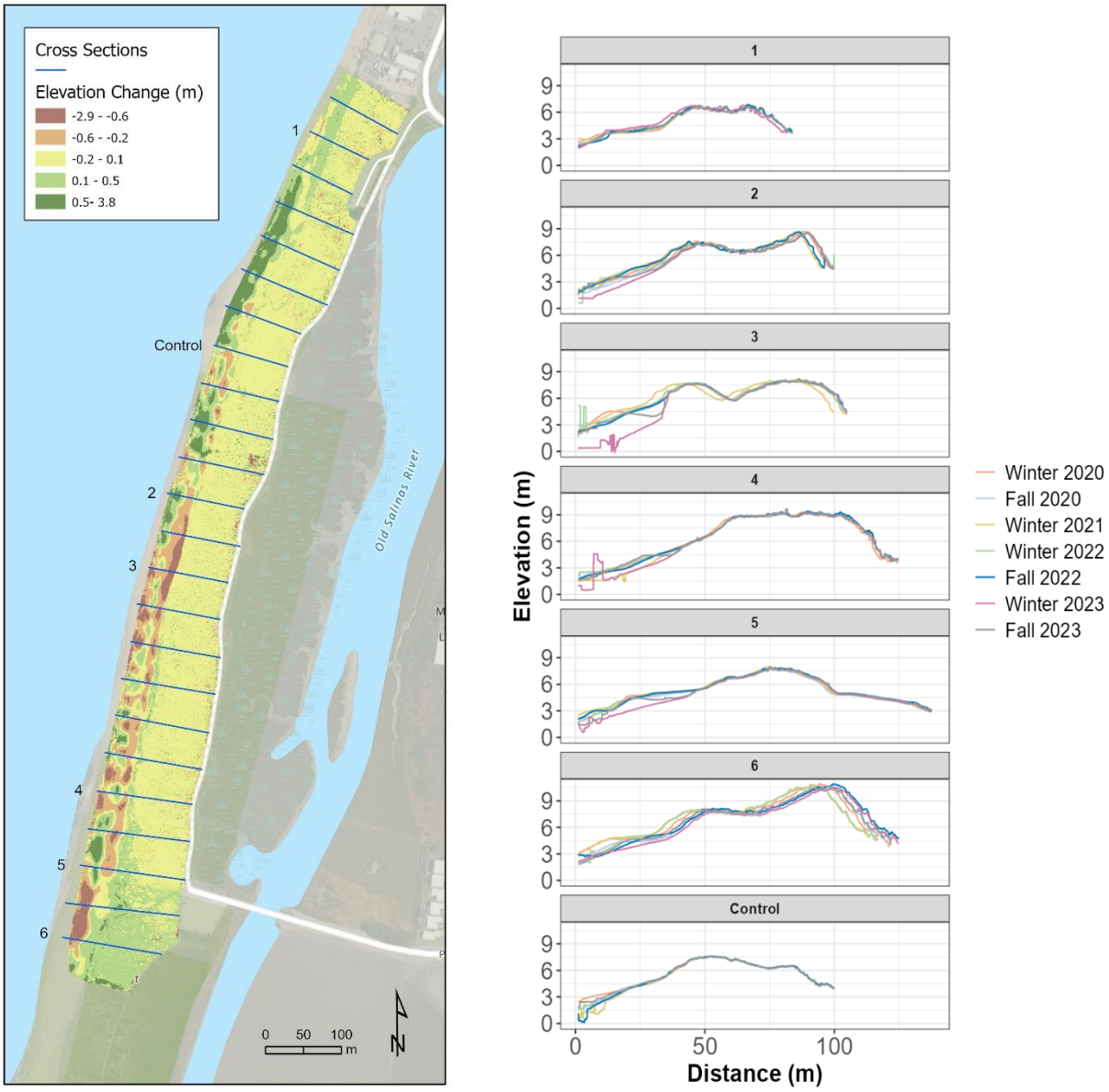

Figure 27. Digital Surface Elevation map depicting raster changes in elevation associated elevation cross sections showing fluctuations in dune height.

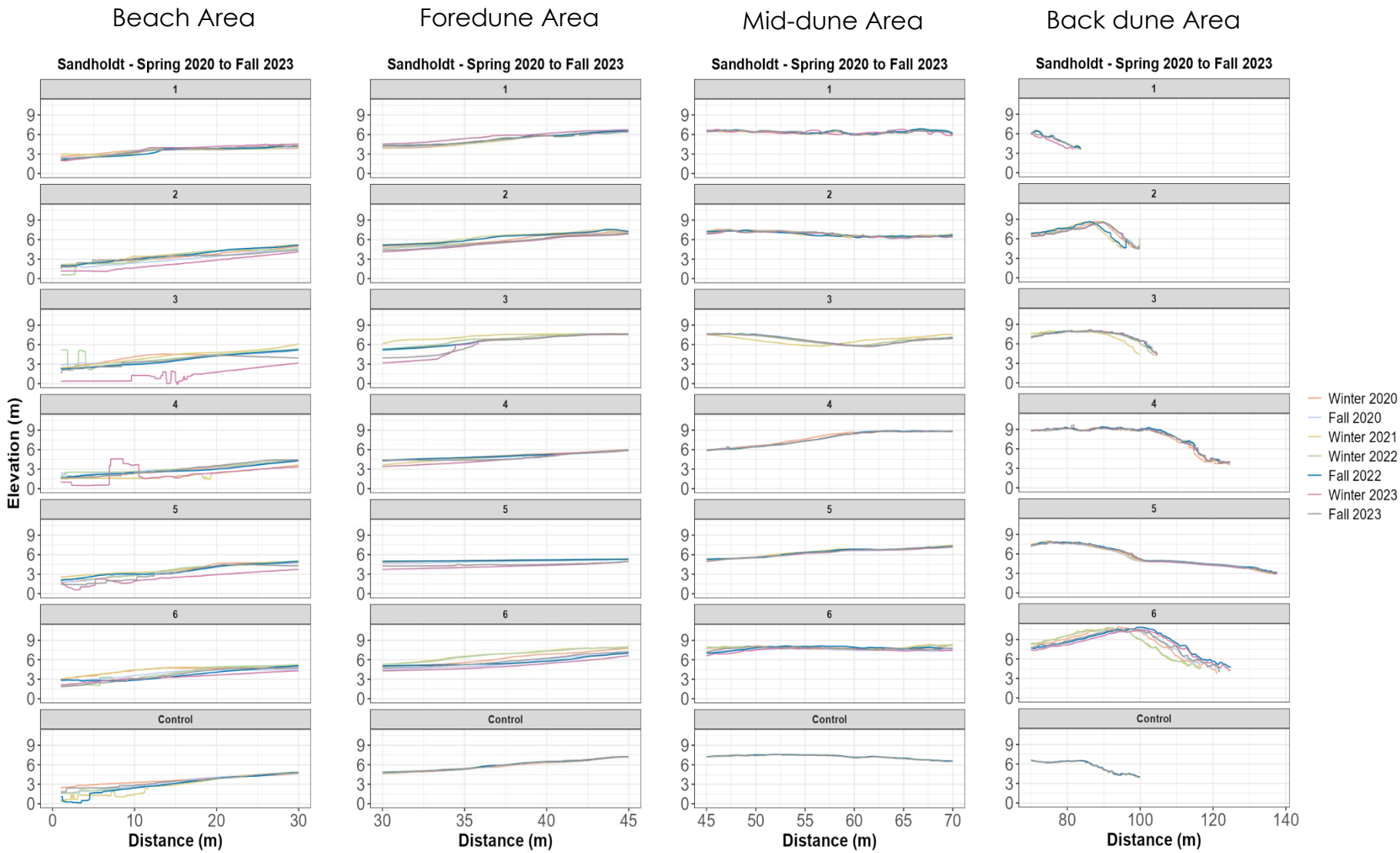

Figure 28. Cross sectional elevation changes for 6 linear transects and a control transect within each dune zone area

Discussion

Dune topography monitoring that occurs solely during a project period (typically 3-5 years) will most likely only pick up seasonal changes in topography (i.e erosion due to winter storms), but can provide a baseline for future studies. Long-term dune topography data collection is needed to be able to better understand how restoration efforts (removal of ice plant, planting of natives, and strategic placement of natural materials) affects longer term dune erosion and accretion processes. Cross-sectional elevations demonstrate the variability in beach and foredune areas among sample dates. Temporal change in dune elevation were greatest in the foredune and back dune areas with mid dune and control areas showing little change in elevation. The positive elevation change documented on the dunes in the Potrero 1 dune section (where restoration began in 2016) suggests the potential for sand accretion over an extended restoration timeframe.

Snowy Plover and Restoration Study

In 2021, CCWG partnered with a CSUMB Masters student (in fulfillment of a 400-hour internship) and Point Blue to develop a methodology to investigate if there is a relationship between Western snowy plover (*Charadrius nivosus nivosus*) nesting sites and restoration activities. Snowy plovers, a federally threatened species, are experiencing habitat degradation and loss impacting nesting success. Invasive plants such as *Carpobrotus edulis* and *Carpobrotus chilensis* are hypothesized to reduce plover preferred habitat of relatively flat, open, sparsely vegetated habitats. This study aimed to relate snowy plover nest locations with changes in foredune habitat complexity resulting from the SRSB Dune Restoration Project. Hypotheses included:

- Snowy plovers will select nesting sites in areas with higher restoration effort
- Secondary: Snowy plovers will select nesting sites in areas with a low foredune slope.

CCGW staff and the CSUMB intern conducted field surveys in September at the ten Snowy plover nest locations observed by Point Blue at SRSB during the 2021 nesting season. An additional ten “control” sites were generated and surveyed in potential snowy plover habitat. Surveys were conducted after the nesting season (so as not to disturb nesting birds), but before the winter storms when the beach morphology typically changes. At each nest site, four 50-meter transects were laid out in the cardinal directions and four 20-meter transects in the ordinal directions (Figure 29). Along each transect, line-point intercept methodology was used to characterize ground cover (native and non-native veg species and abiotic features). Cover was recorded down to the species level at each meter along the transects. Slope measurements (degree and direction) were recorded every 5 meters along each transect to help characterize dune topography surrounding each nest. In total, over 5,600 meters were surveyed at the beach. Study results can be found in the following *Snowy Plover Nest Site Characterization Report* (Heckel, 2022).

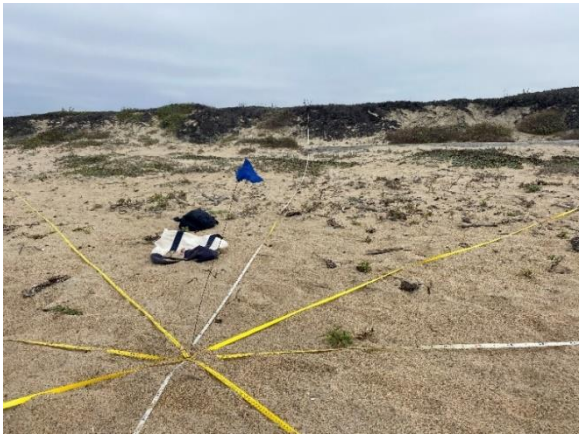

Figure 29. Transects radiating from a known snowy plover nesting location.

5. COMMUNITY ENGAGEMENT (TASK 4)

Introduction

Community outreach and engagement played a significant role in the success of this project. Through activities such as conference presentations, stakeholder workshops, school planting days, and the addition of interpretive signs to the project site, the project team was able to make important connections with the local community, as well as practitioners and researchers working on similar projects. These initiatives not only helped raise awareness about the ecological significance of the dunes at SRSB, but also helped to foster a sense of ownership among community members. This project also represents a positive public climate action activity that helps to empower the community to be a part of climate resiliency efforts in the Monterey Bay. Information shared at conferences and workshops has also helped to advance restoration and monitoring methods. Furthermore, the installation of interpretive signs at the Sandholdt access provide accessible information about the project that enhances public knowledge and appreciation of the restored dune ecosystem.

Workshops and Presentations

Throughout the project duration, the project team showcased various project components at a number of conferences and workshops, as outlined below:

Northern California Botanists Conference: In January 2020, CCWG staff presented the project at the Northern California Botanists Conference. The presentation focused on the current threats to dunes and our efforts to make them more resilient through restoration at Salinas River State Beach. The presentation highlighted the presence of two special status plants at the project site, *Chorizanthe pungens* var*. pungens* and *Gilia tenuiflora* ssp*. Arenaria*.

Dune Science Network Workshop 2021: In December 2021, CCWG put together and presented a video on monitoring strategies at the 2021 2-day virtual Coastal Dunes for Resilience Workshop (https://www.resilientcoastlines.com/2021workshop, hosted by the California Dune Science Network, California Sea Grant, USC Sea Grant, University of California Santa Barbara, The Bay Foundation, and NOAA's Office for Coastal Management). The video was presented as part of a panel and then followed by a Q&A session.

Dune Science Network Workshop 2022: In November 2022, CCWG participated in the Coastal Dune Resilience Workshop at UC Santa Barbara. The workshop brought together a diverse group of interdisciplinary scientists from California to collaboratively define how dune ecosystem functions and services contribute to coastal resilience and discuss indicators that can be measured to evaluate resilience over time. CCWG shared valuable lessons learned from the SRSB dune project. The group also explored the idea of developing a dune resilience evaluation method, including functions and indicators of resilience.

Planning with Nature Workshop: In September 2023, CCWG staff attended the Planning with Nature workshop in Petaluma, CA hosted by Point Blue Conservation and Science and the Elkhorn Slough Estuarine Research Reserve Coastal Training Program. This workshop brought together practitioners, researchers, and managers working on coastal resilience projects to discuss projects and share lessons learned. Goals of the workshops included:

- discuss various nature-based adaptations, including how to link options to specific site characteristics and needs;
- articulate the benefits of nature-based solutions for climate-related adaptation; &
- create a plan for their own adaptation development process, including identifying needed expertise/collaborators

Project staff shared methodologies and lessons learned from the SRSB project.

School Field Trips and Planting Days

In February 2022, CCWG organized an educational field trip for a small group of 1st through 5th grade students and their parents. During the trip, students participated in various activities such as planting native species, conducting vegetation transects using the line-point intercept method, and comparing data from restored areas to unrestored areas. In addition, they went on a fun scavenger hunt and learned about the significance of dune habitats. Figure 30 showcases some of the moments from the field trip.

Figure 30. Students conducting a point-intercept vegetation survey and then graphing their data

In February 2023, in collaboration with the Habitat Stewardship Project Monterey Bay, two school planting days were held at SRSB. More than 120 5th grade students from Marina and Seaside elementary schools participated in the events. The students learned about the dune system and the goals of the restoration project. They were then divided into two groups and rotated through two different stations. At the first station, the students were shown a planting demonstration and then each planted a few native plants along the decommissioned trail at the Molera access. At the second station, the students did a nature walk and journaling activity (Figure 31).

Figure 31. Students planting natives (left) and nature journaling (right) during February 2023 planting days at SRSB

Interpretive Signage

Three new interpretive signs were designed and installed at the SRSB Sandholdt parking lot (Figure 32). One sign focuses on the special status species that inhabit the SRSB dunes, including the Western snowy plover, California legless lizard, Monterey gilia, and Monterey spineflower. A second sign features a timeline of significant events for SRSB. The third sign is a Land Acknowledgment for SRSB which was developed in collaboration with State Parks, the Amah Mutsun, and members of the Ohlone Rumsen and Mutsun communities. The signs were installed at the Sandholdt parking lot in September 2023 (Figure 33).

Figure 32. Final interpretive sign designs for the Sandholdt Rd access parking lot at SRSB.

Figure 33. Final interpretive signs installed at the beach access trail at the SRSB Sandholdt Rd parking lot.

6. NEXT STEPS

Restoration activities undertaken as part of this grant funded project have led to an increase in habitat condition and complexity. Although coastal resilience enhancements have yet to be fully quantified, early results suggest that changes in foredune plant communities shifting from ice plant dominated to native species dominated allow for a more adaptive dune system, helping to increase wave impact resiliency.

To retain current environmental benefits and maintain a positive habitat condition trajectory, long term management of this area is needed. CCWG and CCR have outlined a series of strategic next steps to ensure the continued success and sustainability of project efforts. These steps take a comprehensive approach, addressing key aspects such as adaptive management, conducting a more thorough analysis using data generated by the project, improving and standardizing monitoring strategies, seeking continued funding for adaptive management and monitoring, and maintaining continued community outreach and engagement. These initiatives are designed to not only protect the dune ecosystem but also to enhance our understanding, replicate successful models, and actively involve the community in the ongoing preservation of these unique and important coastal landscapes.

- **Ice plant Control and Adaptive Management:**
    - Implement ongoing ice plant maintenance activities to prevent reestablishment of ice plant and other invasive species.
    - Conduct annual UAV flights to detect areas where ice plant may be reestablishing and promptly report to State Parks for early treatment. Work with State Parks to ensure resources are available to implement invasive species management activities.
    - Organize annual community ice plant pulling days to ensure continuous efforts in eradicating ice plant.
    - Engage local tribal representatives in the long-term management of the dunes.
    - Propagate and plant native species in areas where greater species diversity is needed.
- **In-Depth Analyses of Existing Data:**
    - Conduct a thorough analysis of existing data to enhance our understanding of dune dynamics, restoration success, and coastal resiliency benefits.

- **Seek Continued Funding for Adaptive Management and Monitoring:**
    - Explore funding opportunities to continue the monitoring and adaptive management of the dune restoration project.
- **Replicate Success Across Monterey Bay and State:**
    - Utilize the gathered data to develop strategies for replicating successful restoration efforts throughout the Monterey Bay area and the broader state.
- **Improve Survey Methods:**
    - Reevaluate the vegetation survey study design to allow for surveys during the growing season.
    - Integrate survey methods that better capture species diversity and richness.
- **Standardize Monitoring Strategies:**
    - Collaborate with dune restoration practitioners and researchers on similar projects to establish standardized monitoring strategies.
    - Collaborate with partners to develop a Dune Rapid Assessment Method (DRAM) to create a cost-effective standardized monitoring strategy for dune restoration projects and ambient surveys.
- **Continued Community Outreach and Education**
    - Continue to engage with local communities through educational programs, workshops, and volunteer opportunities to foster a shared responsibility for the long-term health of the dune ecosystems.
    - Establish an annual volunteer dune walk to remove small sprouts of ice plant and provide education about the importance of dune ecosystems.

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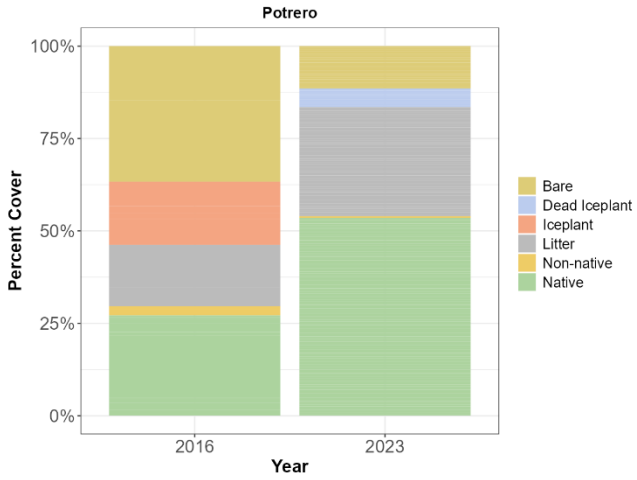
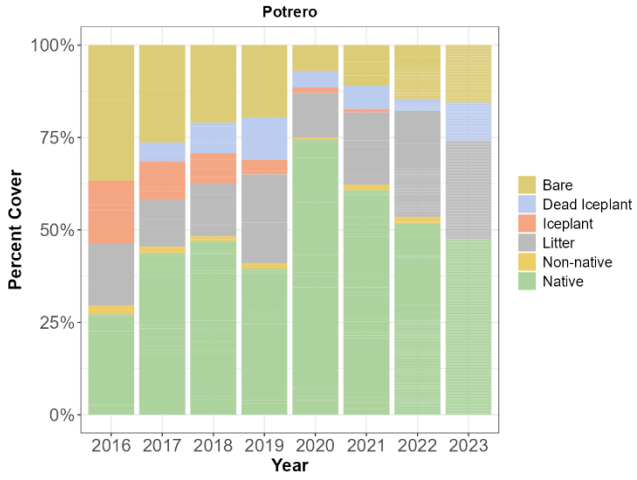
APPENDIX A – Vegetation Graphs for Phase 1 Restoration Areas (2016-2023)

Potrero 1


Potrero
100%
75%
50%
25%
0%
Percent Cover
2016
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native


Potrero
100%
75%
50%
25%
0%
Percent Cover
2016
2017
2018
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2020
2021
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2023
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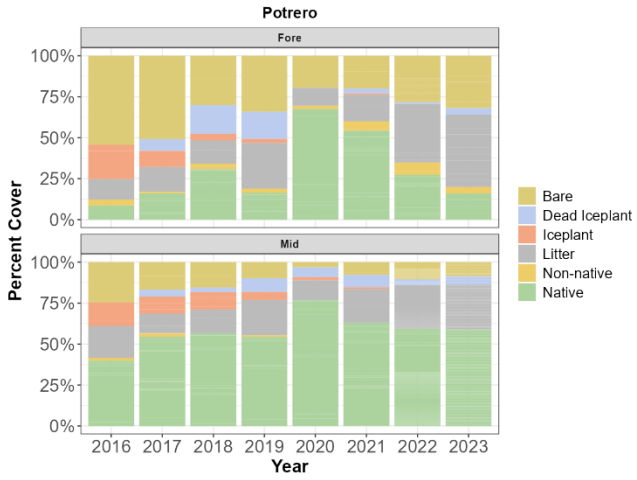
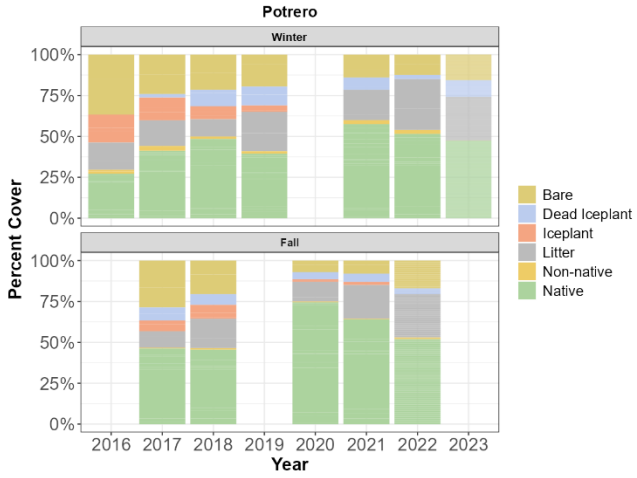
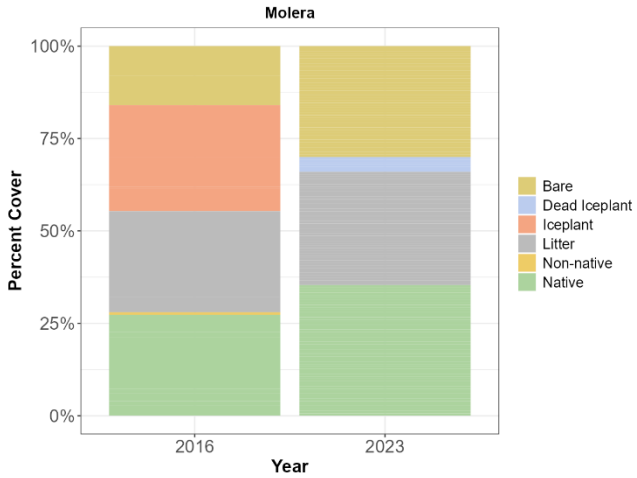
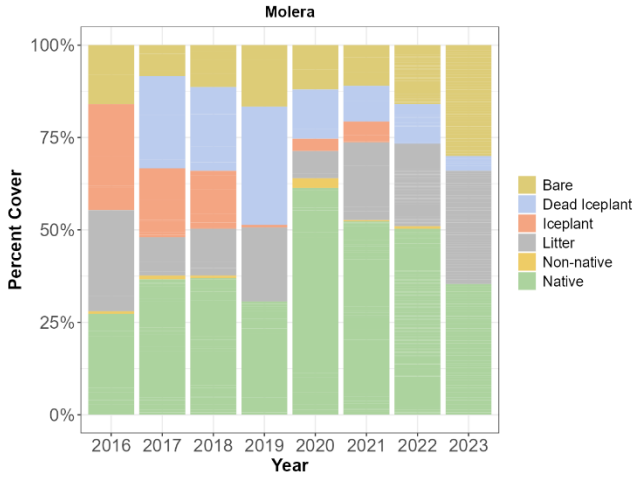
Dead Iceplant
Iceplant
Litter
Non-native
Native


Potrero
Fore
Mid
100%
75%
50%
25%
0%
Percent Cover
2016
2017
2018
2019
2020
2021
2022
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native


Potrero
Winter
Fall
100%
75%
50%
25%
0%
Percent Cover
2016
2017
2018
2019
2020
2021
2022
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native

Molera 1


Molera
100%
75%
50%
25%
0%
Percent Cover
2016
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native


Molera
100%
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Percent Cover
2016
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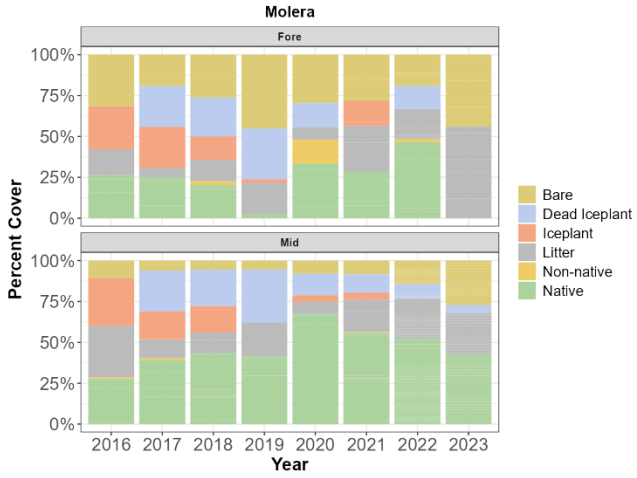
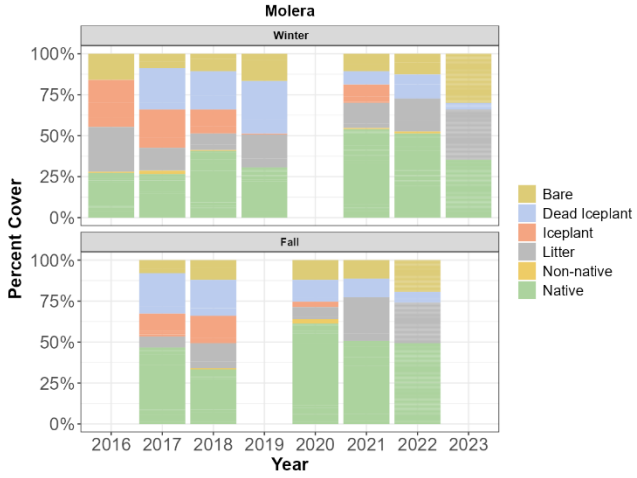
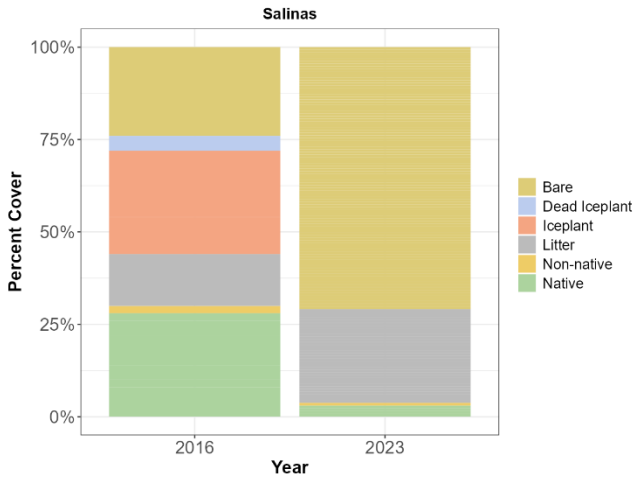
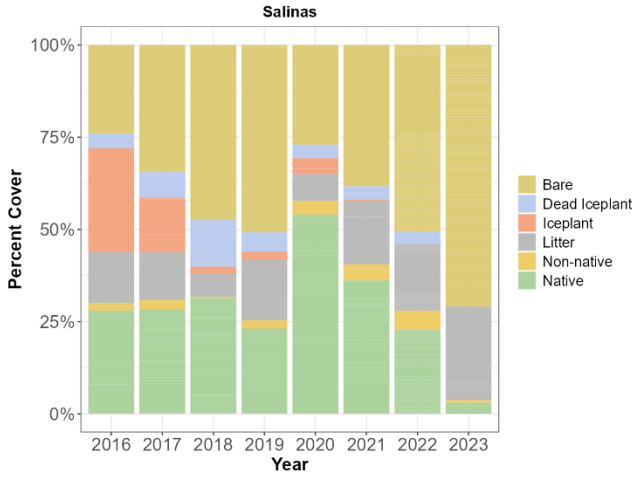
Dead Iceplant
Iceplant
Litter
Non-native
Native

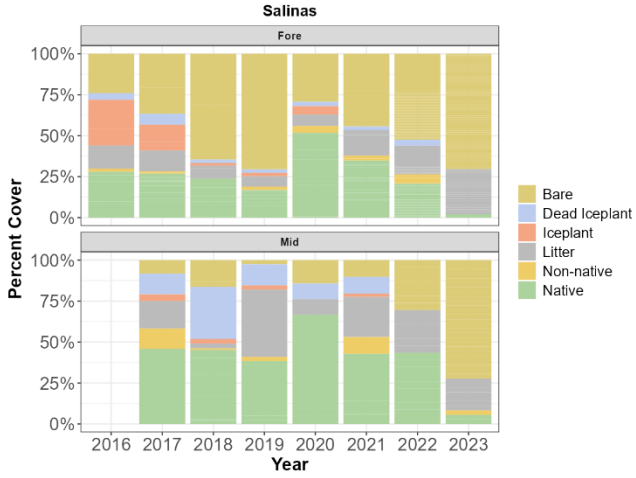


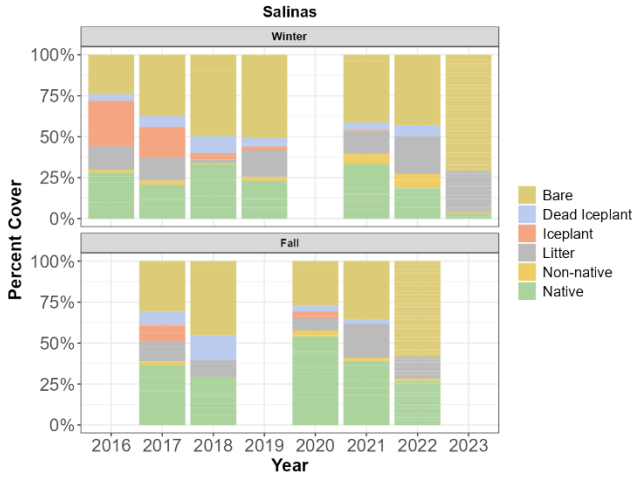


Salinas River




Salinas
100%
75%
50%
25%
0%
Percent Cover
2016
2017
2018
2019
2020
2021
2022
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native


Salinas
Fore
Mid
100%
75%
50%
25%
0%
Percent Cover
2016
2017
2018
2019
2020
2021
2022
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native


Salinas
Winter
Fall
100%
75%
50%
25%
0%
Percent Cover
2016
2017
2018
2019
2020
2021
2022
2023
Year
Bare
Dead Iceplant
Iceplant
Litter
Non-native
Native

APPENDIX B – Photo Monitoring

Sandholdt (Restoration Project Focus Area)

Sandholdt Transect 1: November 2019 (left) and November 2023 (right). Photo taken on the foredune facing North

Sandholdt Transect 2: November 2019 (left) and November 2023. Photo taken on the foredune facing South

Sandholdt Transect 5: November 2019 (left) and November 2023 (right). Photo taken on the middune facing east.

Sandholdt Transect 7: November 2019 (left) and November 2023 (right). Photo taken on the foredune facing north.

Sandholdt Transect 8: November 2019 (left) and November 2023 (right). Photo taken on the middune facing north.

Potrero 2/Potrero-Molera (Restoration Expansion Area)

Potrero-Molera Transect 2: October 2020 (left) and February 2023 (right). Photo taken on the middune facing South.

Potrero-Molera Transect 3: October 2020 (left) and February 2023 (right). Photo taken on the middune facing East.

Potrero-Molera Transect 4: October 2020 (left) and February 2023 (right). Photo taken on the middune facing North.

APPENDIX C – Expanded Rare Plant Survey (2022)

Appendix C: 2022 Expanded Rare Plant survey

Introduction

In 2022, an expanded rare plant survey was conducted, extending from the Northern end of the SRSB boundary through the mid-dunes to the Southern boundary of the SRSB at the Salinas River mouth. The rare plant survey area excluded the foredune due to presence of nesting Western snowy plovers as well as the expansive backdune behind the Potrero and Molera dune sections, due to having limited time to survey, as well as it not being a part of the restoration area at the time of the 2022 Spring survey. The survey began in mid-May and continued through mid-June covering the areas north of the Monterey Dunes Colony complex. Surveys were delayed for the Salinas River mouth area south of the Monterey Dunes Colony complex until September 9th, due to concerns over disturbing nesting Western snowy plovers. The initial start date for the 2022 surveys was well into the bloom period for Monterey spineflower (Apr-Jun; Calflora 2024), and undoubtably some of the earlier blooming plants were not recognizable at the time of the survey.

Monterey Spineflower

The 2022 SRSB expanded rare plant survey resulted in identifying individual Monterey spineflower plants and small patches of plants at 1,715 locations. Surveyors counted 4,336 individual plants, and estimated the area occupied by individual plants to be approximately 1,644 m^2. Additionally 110 large patches of Monterey spineflower were mapped as polygons. When combined, surveyors estimated the mid dune area of Salinas River State Beach occupied by Monterey spineflower to be approximately 8,497 $meter^2$ in 2022 (Figure 1, Table 1).

Monterey Gilia

The 2022 SRSB expanded rare plant survey resulted in identifying Monterey gilia at 27 locations throughout the dunes with a count of 57 individual Monterey gilia plants (Figure 2, Table 2). The Salinas River dune section was surveyed in September of 2022, as essentially a salvage survey focused on at least identifying presence of Monterey gilia. Although a comprehensive survey was not able to be conducted within the Salinas River section, dried specimens of Monterey gilia were identified at two locations.

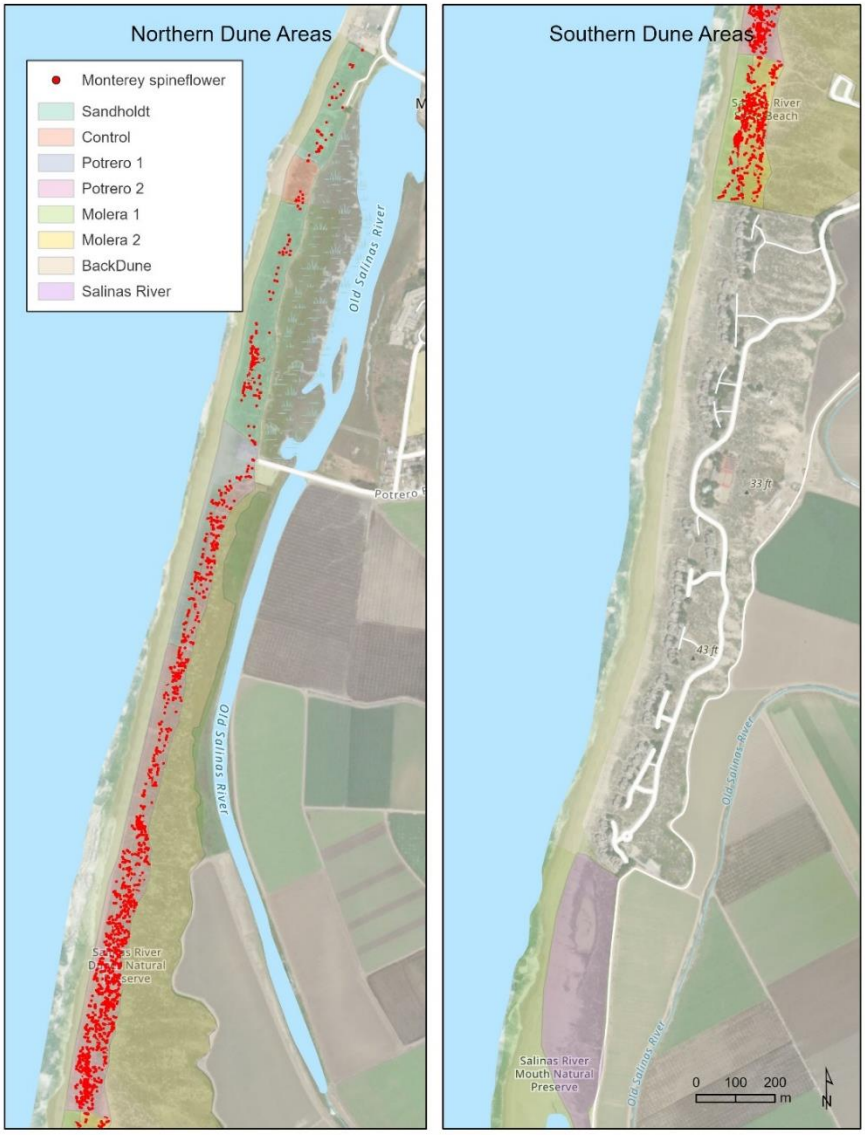


Figure 1. Locations of Monterey spineflower during expanded 2022 rare plant survey

Table 1. Monterey spineflower observed within the mid dune area of Salinas River State Beach.

Monterey Spineflower	**2022**
Number of Locations	1,715
Estimated Number of Plants	4,336
Estimated Area Occupied	8,497

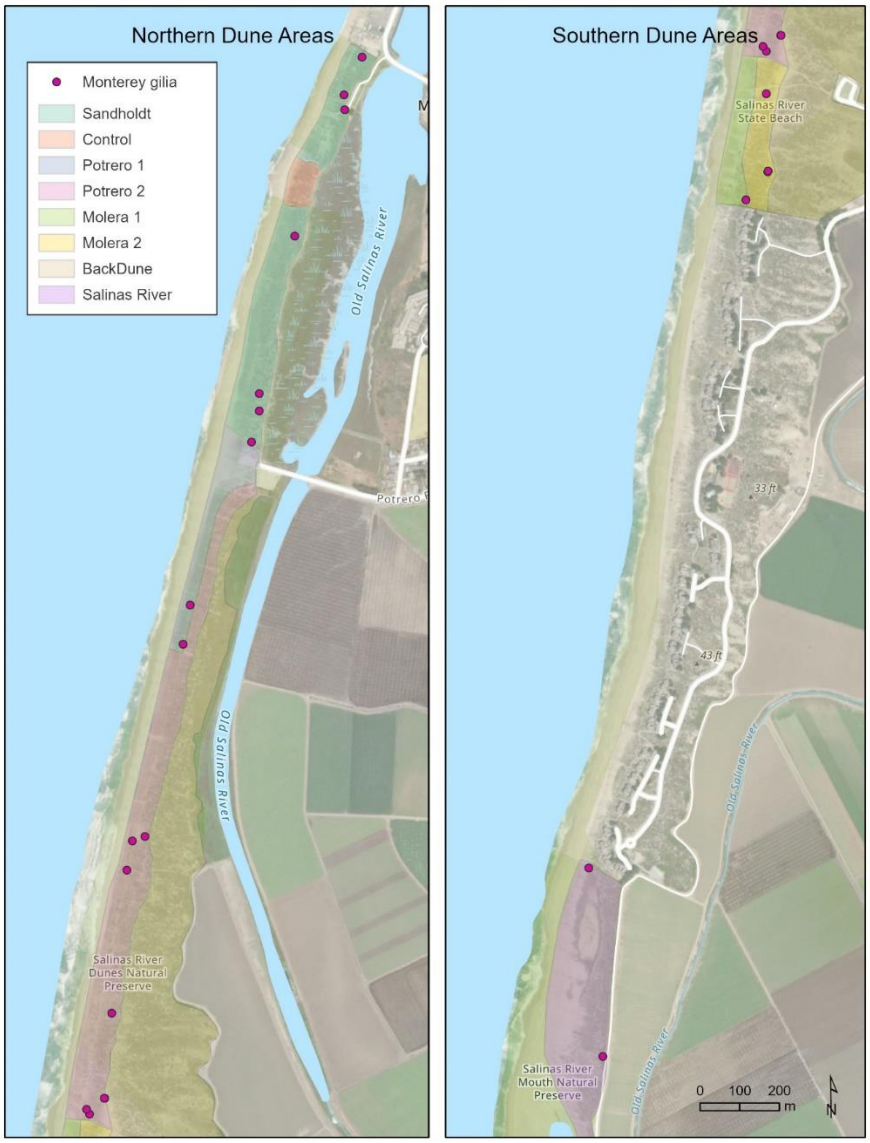


Figure 2. Locations of Monterey gilia during expanded 2022 rare plant survey

Table 2. Monterey gilia observed within the mid dune area of Salinas River State Beach.

Monterey Gilia	**2022**
Number of Locations	27
Estimated Number of Plants	57