North Dunes Restoration Project
Annual Report

Year Four 2019–20
Year Five 2020–21

Prepared for:
City of Carmel-by-the-Sea

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Introduction

The North Dunes of Carmel-by-the-Sea comprise eight acres of environmentally sensitive habitat area (ESHA) rising from Carmel Beach to 100 feet in elevation, bounded to the south by Ocean Avenue and the Del Mar Parking Lot, and to the east by San Antonio Avenue. Designated as open space parkland, the North Dunes provide natural habitat in a busy urban area that attracts many visitors. There is a continuous bloom of native plant species that are well adapted to the exposed conditions of the Carmel shoreline. The deep, complex root structure of native dune species stabilizes the shifting sands into undulating mounds and swales that buffer the coastline during stormy weather. The open sands and coastal vegetation absorb and retain seasonal rainfall that support a flourishing, resilient dune habitat providing food and shelter for a variety of wildlife.

The North Dunes contain the largest remaining dune habitat in the City of Carmel-by-the-Sea, where dune sands once stretched all the way to Camino Real (Ferreira, 2009). Pathways meander through coastal habitats that are unique and valuable remnants of the Monterey coastline. These habitat subtypes include the low-growing, colorful species of the open dune strand, remnants of coastal prairie (native grasses and sedges), central dune scrub (shrubs), oak woodland, and transitional pine forest. The North Dunes contain two special status species; Tidestrom's lupine (*Lupinus tidestromii*), a rare lupine that was state- and federal-listed as endangered in 1992, and the California legless lizard (*Anniella pulchra*), a species of special concern.

The white sands and native vegetation of the North Dunes were significantly impacted over decades by uncontrolled public access and invasive, non-native species, including tree and landscape plantings. The most aggressive non-native species include Sydney golden wattle (*Acacia longifolia*), iceplant (*Carprobrotus species*), narrow leaf iceplant (*Conicosia pugioniformis*), Bermuda butter-cup (*Oxalis pes-caprae*) and weedy grasses, ripgut brome (*Bromus diandrus*), foxtail (*Hordeum murinum*), and panic veldt grass (*Ehrharta erecta*). Dense, rapid growth of invasive iceplant and planted acacia resulted in monocultures that displaced native species and increased the organic debris layer, encouraging the expansion of annual weeds and invasive grasses. Prior to improvements in the stormwater drainage system, it is likely that invasive grass seed and *Oxalis* bulbs washed down city streets and drainages into the North Dunes.

In October 2016, the City of Carmel-by-the-Sea implemented the North Dunes Restoration Program to protect and restore valuable and sensitive dune habitat, under a five-year Coastal Development Permit (CDP) approved by the California Coastal Commission. In August 2021, the Planning Commission of the City of Carmel-by-the-Sea renewed the Coastal Development Permit to continue restoration efforts, weed management and complete the trail system and interpretive signage. To fulfill permit requirements, annual reports are submitted to the City, the California Coastal Commission, and the California Department of Fish and Wildlife.

Restoration activities follow protocol described in the North Dunes and Del Mar Dunes Habitat Restoration Plan (Ferreira, April 2009) and an updated North Dunes Restoration Summary (Dorrell-Canepa, July 2016). Restoration services and on-site management are performed by a contracted dune biologist. Weed control and plantings are assisted by several volunteer groups and student interns that provide enthusiastic labor and stewardship of the dunes. The Carmel Public Works staff provides equipment, labor, and valuable expertise when needed.

The North Dunes Restoration Plan includes the following guidelines:

> THE MISSION of the restoration and management program is to recreate a self-sustaining native dune habitat with thriving populations of the special status species, while providing safe visitor access and enjoyment of the dunes.
>
> The biological objectives are to eliminate all aggressive non-native species, restore the native dune scrub, expand the population of Tidestrom's lupine (*Lupinus tidestromii*), and the quantity and quality of available habitat for the California legless lizard (*Anniella pulchra*).
>
> The visitor-serving objectives are to establish a trail system to provide safe visitor access to the Carmel Dunes, without compromising the dune habitat and its wildlife, and to provide interpretive signage to enhance visitor experience and knowledge of the dunes.

The biological objectives of the dune restoration program are nearly complete, with strong gains in native species cover and diversity. The dune habitat improves steadily due to debris removal, weed management, and exclusionary cabling to protect the sensitive areas and the native plantings. The removal of non-native acacia and iceplant opened large areas for revegetation. Plantings grew rapidly into a diverse assemblage of species that are well-adapted to local climate conditions and periods of little-to-no rainfall. During intermittent drought years, the native dune species have impressive seedling survival and produce ample seed. Species richness is defined as the number of native species in a measured area and is an indicator of habitat diversity. From 2009 to 2021, species richness within the eight-acre North Dunes habitat area increased from 22 to 38 native species, a 73% increase (Ferreira, 2009 baseline survey). Increasing native species diversity and favorable trends in percent cover data suggest an increasingly robust and sustainable North Dunes habitat (Appendices A–C).

The visitor-serving objectives are a high priority for completion within the next two years to adequately protect the unique North Dunes habitat. Dual trash and recycling receptacles and mutt-mitt dispensers were installed during the reporting period, which encourage recycling, litter disposal and dog waste cleanup. Additionally, regulatory signage to remind users that dogs should be kept on leash also helps reduce the impacts of dogs on the North Dunes' habitats. Durable, permanent fencing should define the habitat boundaries along Ocean and San Antonio Avenues. Entrances to the North Dunes should have an aesthetic, cohesive design with interpretive and regulatory signage that is attractive and non-obtrusive. Interpretive signage should highlight the unique native plants,

pollinators and wildlife of the North Dunes and encourage protection and stewardship of this valuable environmentally sensitive habitat area.

In March 2020, Shelter-in-Place guidelines were mandated by the County of Monterey to reduce the spread of the COVID-19 Pandemic. Anticipating reduced tourism and tax revenue, the City eliminated funding for capital projects to ensure funding for essential city services. Funding was temporarily eliminated for the North Dunes Project until another source of funding became available in 2021 (Forest and Beach Commission minutes, 8/13/20). Signage design and installation were deferred due to a reduced North Dunes budget and fiscal uncertainties.

During May - December 2020, supervised volunteer groups resumed weed control efforts following strict COVID-19 protocol. The dune biologist provided voluntary weed services in spring and summer 2020 to reduce significant weed growth following two years of above-average rainfall.

This progress report describes restoration activities completed in Years Four and Five of the North Dunes Project, a five-year program. Restoration tasks include exclusionary cable fencing, tree and acacia removal, weed eradication, and planting. Despite work restrictions and limited budget due to the COVID-19 pandemic, 14,940 pounds of weeds were removed during fiscal years 2019/2020 and 2020/2021. To measure the success and efficacy of restoration efforts, monitoring data from line transects is used to calculate percent cover of native and non-native species over time. The results of annual Tidestrom's lupine surveys are presented, including naturally occurring clusters and 2021 distribution of transplanted Tidestrom's lupine. Monitoring results, trends in native/non-native cover, and progress toward success criteria are discussed and summarized in the Discussion section. Pending restoration and infrastructure tasks are listed and management solutions for current issues are proposed.

Completed Restoration Tasks

See Figure 1. Restoration Completed 2020 and 2021

Guideline Fencing

In March 2020, Public Works staff installed 600 linear feet of guideline fencing (cable and I-rods) north and west of the 4th Avenue boardwalk to discourage trampling by pedestrians and off-leash dogs. In October 2020, existing guideline fencing in the central dunes was expanded 300 feet eastward into the upper central dunes area. The expanded cabling protects high quality, open sand areas for additional plantings of Tidestrom's lupine seedlings to increase the number of separate occurrences across the North Dunes.

In March 2021, Public Works staff installed 300 feet of cable fencing around the acacia removal area at the ocean bluff, where a half-acre of dense acacia shrubbery was removed in January 2018. Cable fencing is important along this well-traveled pathway to delineate and protect the thriving dune shrubs and wildflowers planted in 2018.

In 2018, cable and rope fencing were installed around several small, planted areas adjacent to the bathrooms at the end of Ocean Avenue. Until a defined entrance or boardwalk is constructed, the temporary fencing protects native shrubs and wildflowers that provide pollinator habitat and prevent sand erosion. To the north and south of the volleyball courts, temporary plastic fencing is secured to the cable fencing to repel volleyballs, reducing habitat damage from ball retrieval. It is essential to maintain the temporary screening after periods of stormy weather and to replace the plastic barrier annually.

Tree Removal and Pruning

In March 2018, based on a tree survey and project biologist recommendations (Canepa, 2017) and with input from the Planning Commission and Forest and Beach Commission, the City Council amended the CDP to allow for the removal of live trees necessary for habitat restoration. The amended CDP authorized the removal of up to 21 live trees, including 17 Monterey cypress (*Hesperacyparis macrocarpa*) and 4 Monterey pine (*Pinus radiata*). The City Council also allowed for the removal of up to 10 smaller trees (<8-inch diameter) in areas necessary for dune restoration, if recommended by the biologist and subject to review by the Forest and Beach Commission. The CDP amendment was consistent with the City's General Plan to maintain a tree density of 40-60 trees at the North Dunes. Additionally, Condition #5 of the CDP was amended so that the prescribed height of acacia pruning along the foredune bluff be a height of 6-8 feet instead of 2-3 feet to preserve the base of the acacia for dune stability.

In November 2020 of Year Five (FY 2020-21), forestry staff removed three young Monterey cypress adjacent to the volleyball courts and one dead Monterey pine near the Fourth Avenue boardwalk where four live pines were removed in 2018 due to their proximity to a naturally occurring population cluster of endangered Tidestrom's lupine. Several mature pines remain in the forested area near the Fourth Avenue boardwalk, approximately fifty feet east of the Tidestrom's lupine population cluster. This spacing should allow an adequate buffer between the Tidestrom's lupine and the canopy and root system of the pines.

In October 2020, Public Works staff pruned and shaped aging Monterey cypress and coast live oak in the rear dunes along San Antonio Avenue. The older cypress in this area should not be replaced when they die. Coast live oak can remain under management by the city forester, as the species is an important native component of rear dune vegetation on the Monterey Peninsula.

Acacia Removal

In November 2017, approximately one half-acre of dense non-native acacia shrubbery was cleared from the central dunes, adjacent pine forest, and along the boundary fence northwest of the boardwalk (Figure 1). In January 2018, acacia was removed to the western dune bluff, clearing an additional half-acre for dune revegetation. Based on GPS mapping after removal, the total area was estimated to be at least one acre.

To prevent seed dispersal across the sensitive dune habitat, acacia removal occurred in the winter (December–February) prior to seed pod development. The contracted crew cut, stacked, and removed the acacia carefully to avoid impacts to native plants or the California legless lizard. Acacia removal was completed using a 'skid-steer', a compact track loader that was maneuvered to grab and haul out the acacia piles around sensitive native vegetation. Ripgut brome (*Bromus diandrus*) and panic veldt grass (*Ehrharta erecta*) have expanded in the acacia removal areas, requiring frequent weed control, especially in wet years.

In the removal areas, acacia germinates readily from the seedbank. Volunteers remove the acacia stems while sands are moist (January-March). Although young acacia is not reproductive for several years, it grows aggressively and can be easily overlooked next to fallen logs, or in dune swales that hold moisture. In May 2021, public works staff removed 'errant' acacia and excavated low-lying acacia branches buried by sand from several locations at the North Dunes. To prevent re-sprouting, stumps are cut low and painted with 100% Glyphosate (Roundup) immediately after cutting.

Table 1. Completed restoration tasks, Years 4 and 5

Date	*Task*	*Units*	*Time*	*Completed by*
Exclusionary fencing		**1200**		
	Cable installation, 3 areas	**linear ft**	**5 days**	Public Works staff
FY 2019–20				
Mar 2020	Northwest of boardwalk	600	2 days	
Oct 2020	Expanded central dune section eastward	300	2 days	
FY 2020–21				
Mar 2021	Acacia removal area, foredune ocean bluff	300	1 day	
Tree maintenance				
FY 2020–21	**Pruned cypress, oaks**	6+ trees	2 days	Public Works staff
Oct 2020	Central drainage, rear dune along San Antonio Cut, stack, haul out, chip			
	Cut, removed young cypress	3 trees	1 day	Public Works staff
Nov 2020	Main entrance (2), Volleyball east (1)			
May 2021	**Cut, removed errant acacia and regrowth**		2 days	Public Works staff
	Cut, stack, haul out, chip			
Native plants installed total—		**1115**		
FY 2019–20	**Propagated/planted native plants**	**950**		Native Solutions (950)
Nov 2019– Apr 2020	Site-specific seedlings (5-in cones)	775		
	Grasses, flowers, strawberry (4-in pots)	150		
	American dune grass (gallons)	25		
Mar 2020	MEarth grew sedges/grasses for class field trips	**100**		MEarth (100)
FY 2020–21	**Propagated/planted native plants**	**65**		Native Solutions (65)
Jan–Feb 2021	Site-specific seedlings (assorted species and sizes)	65		*No plant budget* *FY 2020–21*
Contractor weed eradication		**5760 lbs**		**Native Solutions**
FY 2019–20	**Weed eradication—54 bags**	**2160 lbs**	*(in 40# bags)*	
Jul–Dec 2019	*Bromus diandrus, Ehrharta erecta, Conicosia*	360 lbs		
Jan–Jun 2020	*Oxalis, Bromus, Ehrharta, Hordeum, Conicosia*	1800 lbs		
FY 2020–21	**Weed eradication—90 bags**	**3600 lbs**		
Jul–Dec 2020	*Same species as above*	1600 lbs		
Jan–Jun 2021	*Same species as above*	2000 lbs		
FY 2019–20	**Weed eradication—annuals, grasses, iceplant**		**9 days**	
Jan 2020	**Flaming pathways—foxtail** (San Antonio, Ocean Ave)		3 days	
Feb–Apr 2020	**Spray services** (mornings)		6 days	
	Oxalis, Bromus, Ehrharta, Conicosia			
FY 2020–21	**Spray services** (mornings)		**5 days**	
Feb–Mar 2021	*Same species as above*			
May 2021	**Treated acacia stumps** to prevent regrowth		**2 hrs**	

***Completed restoration tasks, Years 4 and 5**, continued*

Date	*Task*	*Units*	*Time*	*Completed by*
Stewardship/Volunteer assistance total		**9180 lbs**	**790hrs**	
FY 2019–20	**Weeded Conicosia, acacia sprouts**	**620 lbs**	**142 hrs**	**MEarth**
Jul 2019	Monterey Peninsula College (Env Sci class)	220 lbs	**1** field trip	16 volunteers
Mar 2020	**Weeded Conicosia, grasses; planted natives**	400 lbs	**3** field trips	55 volunteers
	Big Sur Charter School (5/6th grade class)			
	Monterey Peninsula College (2 classes)			
		3640 lbs	**408 hrs**	**CbtSea Garden Club**
FY 2019–20	**Weed eradication: 47** 40# bags	**1880 lbs**	**248 hrs**	
Sep–Nov 2019	Ehrharta grass, Conicosia, Eucalyptus debris	700 lbs	**4** 2-hr workdays	66 volunteers
Jan–Jun 2020	Oxalis, Conicosia, Bromus diandrus	1180 lbs	**8** 2-hr workdays	58 volunteers
FY 2020–21	**Weed eradication: 44** 40# bags	**1760 lbs**	**160 hrs**	
Oct–Nov 2020	Ehrharta, Conicosia, senescent shrub debris	600 lbs	**2** 2-hr workdays	26 volunteers
Feb–Jun 2021 (no Mar–Apr)	Bromus, Conicosia, Eucalyptus debris	1160 lbs	**8** 2-hr workdays	54 volunteers
	Note: 22 CbtSea GCA members came to multiple workdays			
		25CY 4920 lbs	**240 hrs**	**Pebble Ridge Vineyards**
FY 2019–20	**Weed eradication–annuals** **20** 40# bags	5 CY	**48 hrs**	
May 2020	Foxtail, Bromus, Conicosia	800 lbs	**2** 6-hr workdays	4 men/day
FY 2020–21	**Weed eradication–annuals** **103** 40# bags	20 CY	**192 hrs**	
Nov 2020	Ehrharta, annual grasses (acacia removal area—pruned acacia regrowth	1720 lbs	**2** 6-hr workdays	8 men/day
Dec 2020	Iceplant/Eucalyptus debris (4th Ave gully/boardwalk)	2400 lbs	**2** 6-hr workdays	8 men/day

Comparison of weeds/debris

Weed eradication/removal, Years 2 and 3, Grand total	**17005 lbs**	**110CY**
FY 2017–18 and FY2018–19		
Weed eradication/removal, Years 4 and 5, Grand total	**14940 lbs**	**25CY**
FY 2019–20 and FY2020-21		

Weed Removal

Over two years, July 2019 through June 2021, weed control by volunteer crews and contractors removed 14940 pounds of bagged annual and perennial grasses including ripgut brome (*Bromus diandrus*), foxtail (*Hordeum murinum*) and panic veldt grass (*Ehrharta erecta*). Highly invasive non-native species such as Bermuda buttercup (*Oxalis pes-caprae*) and narrow-leaved iceplant (*Conicosia pugioniformis*) are bagged if bulbs or seed are ripening, and iceplant (*Carpobrotus*) is stacked to desiccate for later removal. During Years Four and Five (FYs 2019/20 and 2020/21), 25 cubic yards of desiccated iceplant (*Carpobrotus* species) was removed, compared to 110 cubic yards of iceplant in Years Two and Three (FYs 2017/18 and 2018/19). The reduced quantities point to successful removal of most of the iceplant at the North Dunes. From December 2019 through 2020, COVID-19 cancellations reduced weed removal by two of the three volunteer groups. There were no student field trips in Year Five (FY2020/21).

During five years of weed removal from the North Dunes Project, the estimated weight of bagged weeds totaled 41,595 pounds (nearly 21 tons) of annual weeds and invasive grasses. Volunteer groups pulled 22,350 pounds (11 tons), approximately 54% of the total weeds bagged. The total weight of volunteer weed removal divided by all volunteer hours combined (2121 hours) indicates that the average volunteer pulls about ten pounds of weeds per hour.

The dune biologist supervises volunteers and workflow onsite and is usually joined by a group leader or outdoor educator(s). The volunteer groups include classes (elementary to junior college) organized and led by MEarth Education staff, and the Pebble Ridge Vineyard crew of experienced viticulture workers whose services are donated by the vineyard owner. The dedicated Carmel-by-the-Sea Garden Club members volunteered their weed services several years before the project began and continue their workdays on a monthly schedule. Student interns assist with monitoring and weeding.

City staff haul out weed bags, dried iceplant piles and other debris when needed. Iceplant is stacked to dry for one to two months before removal. Prior to cable installation and native shrub establishment, iceplant berms were created to delineate planting areas and provide protection from human and canine incursion into newly planted areas.

Ehrharta erecta is a perennial grass that disperses seed year-round and invades rapidly in areas with bare ground, declining vegetation, and downed wood. *Ehrharta* grass clumps form a dense monoculture in shady conditions and require substantial digging to remove, disturbing the soil and stimulating further *Ehrharta* germination. To avoid ground disturbance, each clump is sprayed with Roundup and left in place until late summer, when the dead grass is removed by hand. The dead *Ehrharta* blankets the soil, reducing seed-to-soil contact during peak germination and growth periods in late spring and early summer.

Slender-leaved iceplant (*Conicosia pugioniformis*) and Bermuda buttercup (*Oxalis pes-caprae*) are highly invasive and require immediate, continuous attention prior to seed and bulb development. *Conicosia* flowers produce tens-to-hundreds of seeds. The abundant ground squirrels at the North Dunes eat *Conicosia* fruits, dispersing the seeds contained in each ripening fruit. *Conicosia* plants with seed heads and *Oxalis* plants with developed root bulbils should be gathered into a bucket or bag and handled carefully to prevent dispersal.

Plant Installation

See Table 2. Plants Installed 2016 to 2021 and Proposed Plants for 2022 and 2023

In Year Four, Native Solutions installed 950 seedlings between November 2019 to April 2020 in areas cleared of weeds prior to planting. MEarth students propagated and installed 100 sedges, grasses, and rushes at the North Dunes. Most of the native seedlings were site-specific, and the American dune grass was region-specific (Monterey Bay). There was no plant budget in Year Five and very little rainfall (9 inches). Native Solutions installed 65 native plants from January to February 2021. Plantings included 20 gallons of American dune grass and 45 site-specific seedlings.

Tidestrom's lupine seedlings were grown under permit with the California Department of Fish and Wildlife as a state-and federal-listed endangered species. There were 130 Tidestrom's lupine seedlings transplanted into six quality sand areas during Year Three (January 2019, 100) and Year Four (January 2020, 30). *See Figure 1-Restoration Completed 2020 and 2021*. The transplant areas contain pristine, wind-blown sands and dune strand species similar to other Tidestrom's lupine occurrences on the Monterey Peninsula. The seedlings were monitored and watered periodically over two summers. Thirty Tidestrom's seedlings were caged each year (2019 and 2020) to protect the seedlings from mice, ground squirrels and deer.

Over five years, 5900 native plants were installed at the North Dunes. The proposed plant list for 2022 and 2023 includes several native species that have become scarce in high quality dune areas due to invasive species, recreational activities, and climate variations. These species include California beach aster (*Corethrogyne filaginifolia*), seaside painted cup (*Castilleja latifolia*), bluff lettuce (*Dudleya caespitosa*), and dune bluegrass (*Poa douglasii*). It is important to propagate endemic species (native to our region) from nearby Carmel sources while local seed is still available, and conditions are favorable at the North Dunes. Increasing plant numbers of these unique species improves genetic diversity and increases resilience to climate variations. With improved fencing and interpretive signage, the environmentally sensitive habitat areas at the North Dunes can be protected and stewarded as a diversity hotspot.

Table 2. Plants installed 2016 to 2021 and Proposed Plants for 2022 and 2023

Scientific name	Common name	2016–17	2017–18	2018–19	2019–20	2020–21***	Proposed 2022–2023
Abronia latifolia	yellow sand verbena	5		4	2		5
Abronia umbellata	pink sand verbena	8		1	8		5
Abronia umbellata ssp. unknown	white sand verbena						
*Achillea millefolium**	common yarrow		80				20
Artemisia pycnocephala	dune sagewort	342	350	541	300		48
Atriplex leucophylla	saltbush						
Baccharis pilularis	coyote bush		35				10
Camissoniopsis cheiranthifolia	beach primrose	45	290	86	130		28
*Carex pansa***	dune sedge		400	109	**40**		50
*Carex praegracilis****	field sedge				**40**	20	50
Castilleja latifolia	seaside painted cup	50			5		20
*Ceanothus thrysiflorus** (gallons)	blue blossom		4	5			8
Corethrogyne filaginifolia	California beach aster		2		15		10
*Diplacus auriantiacus (Mimulus)**	monkeyflower		30	11			5
*Diplacus guttatus (Mimulus)**	seep monkeyflower			2			5
Dudleya caespitosa	bluff lettuce						10
Elymus mollis (Leymus) (gallons)	American dune grass	40	90	51	25	20	30
Elymus triticoides (Leymus)	creeping wild rye				40		20
*Elymus condensatus (Leymus)**	giant wild rye						10
Ericameria ericoides	mock heather	60	90	160	20		28
Erigeron glaucus	seaside daisy	60	100	156	20		21
Eriogonum parvifolium	dune buckwheat	255	140	282	140		28
Eriophyllum staechadifolium	lizardtail	115	100	56	130		28
Eschscholzia cal. var. maritima	California beach poppy		92	76	40		60
*Fragaria chiloensis**	beach strawberry			170	40	15	25
*Frangula californica** (gallons)	coffeeberry			13			6
*Iris douglasiana** (gallons)	Douglas iris		10	14			
*Juncus patens****	common rush				**20**	10	8
*Lonicera hispidula**	California honeysuckle			3			2
Lupinus arboreus (lilac/white)	coastal bush lupine	20	85	8			
*Lupinus tidestromii***	Tidestrom's lupine		2	110	20		50
Phacelia ramosissima	branching phacelia				5		
Poa douglasii	dune bluegrass				10		10
*Salix lasiolepis**	arroyo willow			22			
*Sisyrhinchium bellum**	blue-eyed grass			5			
TOTAL PLANTS/YEAR		**1000**	**1900**	**1885**	**1050**	**65**	**600**
TOTAL PLANTED 2016 to 2021						**5900**	

*Species present < 3 mi away, but not onsite **State- and federally-listed endangered species ***No plant budget
****Totals in 2019-20 include 100 plants grown and planted by MEarth Education Program**

Monitoring Methods

See Figure 2. Pending Restoration Tasks 2022 and 2023

The North Dunes Restoration Plan lists the following goal and success criteria to be met by Year Five, July 2020–June 2021:

> "All restoration and maintenance efforts shall be designed and implemented to create a high–quality dune habitat that is self-sustaining in perpetuity. Success criteria will be met when the number of native dune species in the project area is restored to a minimum of 30 species and 50% average native plant cover within 5 years. The average cover of aggressive, non-native species will be reduced to no more than 10% cover within 5 years, with the number of non-native species reduced by at least half, from 30 species to ≤15 species. The endangered population of Tidestrom's lupine shall total 1000+ individuals, with at least ten locations scattered throughout the North Dunes, each supporting a minimum of 100 plants."

During 2020 and 2021, qualitative site monitoring occurred in March through June and assessed plant survival, herbivory and weed control priorities. Periodic inspections of the boardwalk, guideline fencing, and walkways were conducted during routine restoration tasks. Repair needs were communicated to Public Works and completed as time and budget allowed.

Tidestrom's lupine areas were observed bi-weekly for phenological data (timing of vegetative growth, budding, flowering, fruiting, seed dispersal) and to note the density of juvenile seedlings and reproductive plants. Counts of Tidestrom's lupine were completed in May and June 2020 and 2021, adjusting for late season rainfall and germination that prolonged the reproductive window in 2020.

Permanent line transects were monitored at peak vegetative growth during June 2020 and 2021 to determine percent cover of:

- Native species
- Non-native species
- Native debris (cypress, pine, needles, oak leaves)
- Non-native debris (dead iceplant, acacia leaves, eucalyptus leaves/bark)
- Bare sand (clean)
- Dirty sand (sift-able sand with small flecks of debris)

The North Dunes project area measures ~8.6 acres, walking the property boundaries using GPS (Global Positioning System). Permanent transects were used to measure the progress of treatment areas in comparison to baseline areas, which contain more established vegetation. Transect data provide valuable information based on increase/decrease in plant cover regarding the efficacy of restoration activities. Monitoring should occur earlier in dry years to measure vegetation at peak growth, and to

observe Tidestrom's lupine as buds and flowers develop to watch for herbivory.

Figure 2 shows transect locations, approximately one transect for each half acre. Twelve transects were measured in June 2017 (100 ft=30m), prior to acacia and tree removals. Six transects were added in 2019 to observe the effects of cypress and acacia removal on native vegetation and the efficacy of spray treatments for persistent weedy grasses. For 2020 and 2021, calculation of percent cover includes the original twelve transects compared across five years of data (2017-2021). For subsequent reports, analysis of the additional six transects will provide percent cover data for eighteen transects across five years (2019-2023).

The line intercept method is efficient for measuring small scale vegetation change and habitat improvement on restoration sites. This method measures the absolute cover of vegetation that intersects the measuring tape (100ft = 30m line transect), looking vertically downward. After measuring the vertical projection of plant foliage that crosses the tape (by species), percent cover is calculated by summing the totals for each species encountered, divided by the length of the transect, then multiplying by 100 to convert to a percentage. Each plant species, type of vegetative debris, and bare sand are calculated separately. Plant parts that are attached to the plant are measured, dead or alive. Percent cover greater than 100% indicates multilayered vegetation along the transect. Since measurements are taken looking directly downward at the tape, the foliage of two or more species may overlap beneath the tape. An example of multilayered vegetation could be annual grasses germinating beneath a perennial dune shrub.

A site-wide average of percent plant cover (native versus non-native) by year is calculated by dividing the total cover (per species, type of vegetative debris, or bare sand) for all transects by the number of transects. Comparison of plant cover by year (native versus non-native) provides valuable information about plant response to weather variations and indicates progress toward success criteria. Percent cover data for bare sand, thick non-native debris (iceplant, acacia, eucalyptus) and native debris (pine/oak/vegetative duff) provides information about challenging areas and successfully restored areas. For instance, thick debris (native and non-native) suppresses germination of native species and non-native species. Thick debris (pine needles) can be used as mulch in degraded areas to inhibit weed germination until weed control has significantly reduced the standing weeds and seedbank.

Monitoring Results

See *Table and Graph 3. Percent native and non-native cover in 12 transects*

The North Dunes Project follows a fiscal year cycle from July 1–June 30. Rainfall along the central coast falls between October–May, with trace levels of moisture from fog drip between June and August (NOAA Online Weather Data). Water year records are calculated from October–September, reflecting the rainfall that most influences plant germination, growth and reproduction in our area. Water year totals from Carmel were used to analyze trends in percent cover for this report (rainfall data, D. Fish personal communication 2019-2021).

In Table 3 and the accompanying graph, monitoring results from five years are compared and progress toward success criteria is quantified. Challenges and possible solutions are described in the Discussion section if trends are unfavorable, or success criteria are not met.

Year Five (2020–21) data show that percent native cover increased 7% over Year Four (2019–20), from 70% to 77% native cover. There was a 23% decline in cover during Year Four (2019-20) for non-native species, from 31% to 8% in Year Five (2020-21) due to low annual rainfall of 9 inches. The success criteria threshold of 50% native cover was exceeded by 1% in Year Two (2017-18) and by a wide margin (over 20%) in Years Three-Five (2018-2021). Non-native cover was close to the goal of ≤10% weed cover in the drier weather of Year Two (13% cover, 12 inches rainfall, 2017-18) and was below the threshold in Year Five (8% cover, 9 inches rainfall, 2020-21). In between the dry years, percent non-native cover spiked significantly during the wet years. During Years Three (25 inches, 2018-19) and Four (23 inches, 2019-20), weed cover increased to 37% and 31% cover respectively, 27% and 21% above the desired ≤10% threshold for non-native species.

The survival of plantings was assessed during routine weeding across the site. Seedling germination and survival were robust in FY 2019-2020 with 23 inches of rain. The driest rain year during the project was Year Five (2020-2021) when 8.9 inches of rain fell, mostly in January and March, with a dry February. Native germination was lower than usual, and native seedlings exhibited higher mortality in the late spring, summer, and fall. Some native species like dune buckwheat (*Eriogonum parvifolium*) never blossomed fully, adjusting their blooming period to conserve water and were only in partial flower throughout the summer and fall. Low rainfall resulted in a substantial reduction in non-native cover (8.4% average cover across 12 transects in Year Five, compared to 29% average weed cover in Year Four). The native species increased by 7%, from 70% in Year Four to 77% in Year Five. Low rainfall and diligent weeding in Year Five contributed to reaching success criteria for non-native cover in Year Five, with an average weed cover of 8%, 2% below the success threshold of <10%.

The cabled area at the corner of Ocean and San Antonio Avenues was restored in 2012–2015 by members of the Carmel-by-the-Sea Garden Club prior to the beginning of the North Dunes Restoration Project in 2016. The project was named the "Centennial Tree Project" for a picturesque cypress tree at the site. The area was covered with ripgut brome (*Bromus diandrus*) and iceplant (*Carpobrotus* sp.) prior to the restoration. A permanent line transect crosses a drainage that bisects the area. Five years of transect data (2017-2021) show the dedication of the members toward their goal of restoring diverse native vegetation to the site. Transect data for 2016-2021 shows that percent native cover ranged from 97% to 151% and percent non-native cover was maintained at an average of 7% cover. The Centennial Tree Project area is stewarded by Garden Club members during regular workdays. Despite high germination of weedy species, the area is usually cleared of all weeds by May.

Several species did not fare well after planting. Planted amongst Monterey pine, beach strawberry (*Fragaria chiloensis)* and California coffeeberry (*Frangula californica*) did not thrive in the dry forest soils even after rains began. The shallow roots and high-water use of Monterey pine appears to outcompete new plantings of dune scrub shrubs and forest understory. Seaside daisy (*Erigeron glaucus*), beach strawberry (*Fragaria chiloensis*) and sticky monkey flower (*Diplacus auriantiacus*) were successful when planted next to decomposing logs in the forest areas.

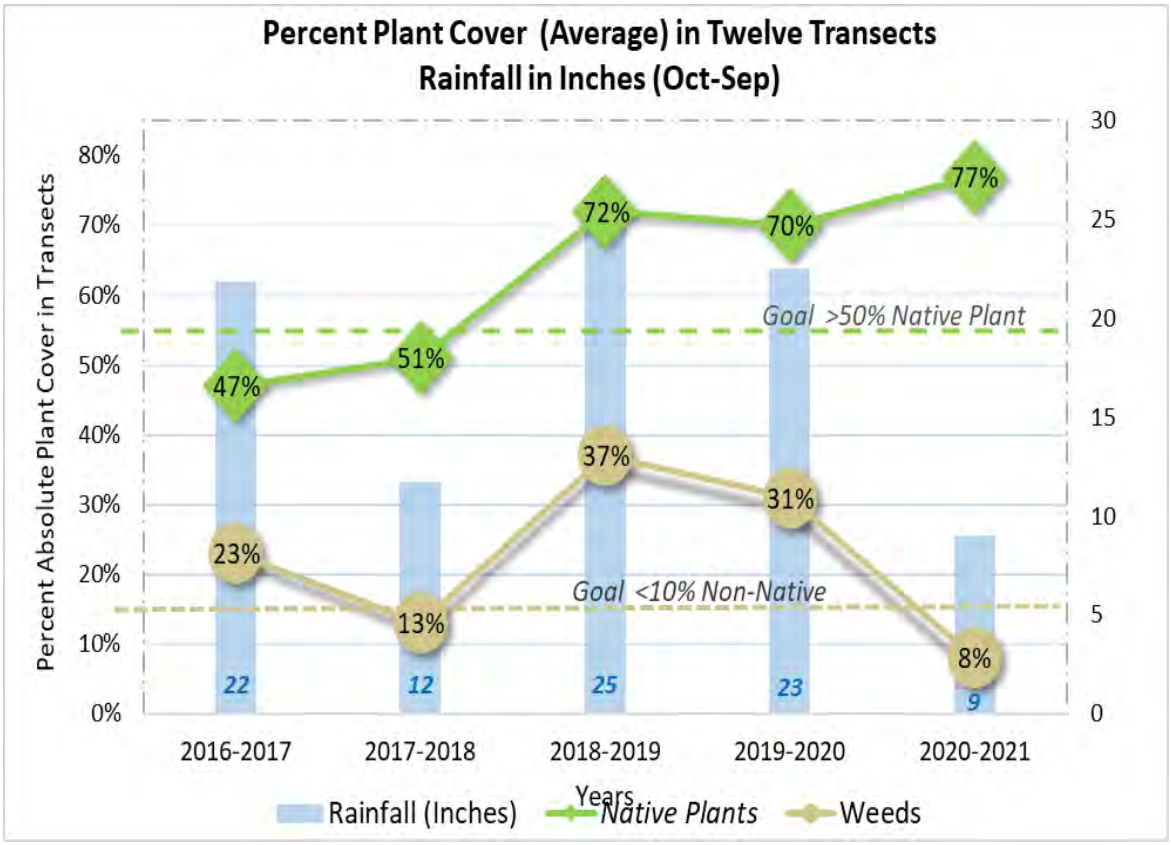
Herbivory was minimal for most native seedlings, except the Tidestrom's lupine. Transplanted lupine seedlings struggled to survive with reduced rainfall. Herbivory was observed on naturally occurring Tidestrom's lupine under six inches in diameter, which were grazed heavily and reduced to a woolly nub that did not generate new leaves. Squirrels were observed nibbling flowers and seed pods, including anything that extended outside the Tidestrom's lupine cages. Signs of deer herbivory on understory plants in the forested area suggests that deer likely graze the Tidestrom's lupine when the plant is in flower or developing seed pods, similar to squirrel herbivory. Squirrels leave clean nipped stems devoid of buds and flowers and munch brazenly in the open. Deer have no upper incisors, and their grazing scrapes the lupine stems unevenly and pulls at the plant. Deer leave scat in the area, indicating their presence. The Tidestrom's lupine has a clever adaptation for herbivory. Developing seed pods are heavy and often buried by blowing sand. Beneath the sand, the seed pods can ripen and dehisce, awaiting rainfall the following winter. Lupine seed has a hard seed coat and is usually viable for many years, if not discovered by mice.

Table 3. Percent absolute native and non-native cover (average) in 12 transects

Year	2016–2017	2017–2018	2018–2019	2019–2020	2020–2021
Native plant cover *should be greater than—*					
	50%	*50%*	*50%*	*50%*	*50%*
Percent cover native plants	**47%**	**51%**	**72%**	**70%**	**77%**
Success criteria met?					
(%) under/**over**	3% under	**1% over**	**22% over**	**20% over**	**27% over**
Non-native cover *should be less than—*					
	10%	*10%*	*10%*	*10%*	*10%*
Percent cover non-native	**23%**	**13%**	**37%**	**31%**	**8%**
Success criteria met?					
(%) **under**/over	13% over	3% over	27% over	21% over	**2% under**
Rainfall (inches) *October–September, Carmel*					
	22	**12**	**25**	**23**	**9**

Rainfall data courtesy of Diana Fish

Graphic representation of Table 3



Species diversity increased from twenty-two native species onsite (2009, J. Ferreira, botanist) to thirty-eight native species (2021, Appendix A). In 2015, the species below were identified from one to three plants in the project area. Now these species are flourishing across the site:

- Common deerweed (*Acmispon glaber*)
- Heermann's lotus (*Acmispon heermannii)*
- Santa Barbara sedge (*Carex barbarae*)
- Dune buckwheat (*Eriogonum parvifolium*)
- California beach poppy (*Eschscholzia californica ssp. maritima*)

Higher than average rainfall stimulated the sand verbena species to colorful abundance. The North Dunes sand verbena is known for an array of unique colors from *Abronia* subspecies. Flower colors include white, salmon, and lavender in addition to the characteristic yellow (*Abronia latifolia*) and pink (*Abronia umbellata*) blooms. Leaves of the color variants are intermediate between the two verbena species common to the Monterey area (A. *latifolia,* A *umbellata*). The verbena flowering season is nearly year-round, and seed production is prolific in areas where gophers do not undermine the plants. The dispersed seed will enrich the North Dunes plant palette for many years.

Before (2010) and After (2019) Views of Restoration Area

Photos courtesy of Carmel-by-the-Sea Garden Club

Center cypress in top photo is in the far left of bottom photo

View from San Antonio Avenue before restoration (2010)

Non-native species include—

iceplant
Carpobrotus spp.

ripgut brome
Bromus diandrus

View from San Antonio Avenue after restoration (2019)

Native species include—

yellow sand verbena
Abronia latifolia

beach sagewort
Artemisia pcynocephala

beach primrose
Camissoniopsis cheiranthifolia

mock heather
Ericameria ericoides

seaside daisy
Erigeron glaucus

Special Status Species

Goal: to eliminate all aggressive non-native species, restore the native dune scrub, and expand the population of Tidestrom's lupine (Lupinus tidestromii), and the quantity and quality of available habitat for the California legless lizard.

Tidestrom's Lupine (*Lupinus tidestromii*)

Success Criteria: *Tidestrom's lupine numbers shall total 1000+, with at least 10 locations scattered throughout the North Dunes, each supporting a minimum of 100 plants.*

Tidestrom's lupine seedling <4 in. (<10 cm)

Tidestrom's lupine in flower > 8 in. (20 cm+)

Naturally occurring Tidestrom's lupine areas

See Figure 1 for naturally occurring Tidestrom's lupine clusters and transplant areas

In 2021, there were three clusters of naturally occurring Tidestrom's lupine at the North Dunes, all protected by guideline fencing. These clusters are named for their location at the habitat, ie. NatW= Naturally occurring West cluster. Two of the clusters contain a substantial number of plants, greater than 100 individuals (NatW, NatN). NatW cluster is the largest naturally occurring cluster of Tidestrom's lupine on the site (1300 Tidestrom's lupine, 2019). Plants in the NatS cluster have never been observed in reproductive stage, indicating that herbivory (or other disturbance) may be a concern. The fourth cluster of naturally occurring Tidestrom's lupine (NatE) contained no live plants in 2019. A lone plant survived for several years and finally senesced in 2018. This cluster was shaded by scrub oak at the top of a long dune slope, close to the NW San Antonio entrance. Winds and herbivory are high, and there is no natural seed dispersal to the area. The area surrounding the NatE cluster has ideal soil conditions for Tidestrom's lupine transplantation and plantings were successful in 2019.

Table 4a. Number of naturally occurring Tidestrom's lupine at Carmel North Dunes, 1995–2021

Lupinus tidestromii is state- and federal-listed as endangered.

See *Figure 1, Restoration completed 2020 and 2021 and Special Status Species* for locations of *L. tidestromii* clusters (naturally occurring and transplanted)

Year	Plant stage, counts: Seedlings *<4 in <10 cm*	Juvenile *4–8 in 10–20 cm*	Mature reproductive *8 in+, 20 cm*	Total individuals	Number of clusters	Source
1995		168	112	**280**	**4**	Jones & Stokes
2008		124	216	**340**	**2**	Jean Ferreira
2009		n/a	n/a	**296**	n/a	Jean Ferreira
FY 2015–16	103	60	318	**481**	**3**	JD-Canepa
FY 2016–17	190	95	116	**401**	**4**	JD-Canepa
FY 2017–18	629	72	186	**887**	**3**	JD-Canepa
FY 2018–19	1146	33	121	**1300**	**1 of 3 clusters counted**	JD-Canepa
FY 2019–20	*No budget for surveys*			n/a	**2**	JD-Canepa
FY 2020–21	463	235	216	**914**	**2**	JD-Canepa Laura Overett

Success criteria: *Tidestrom's lupine population shall number 1000 individuals, in 10 different clusters.*
FY 2018–2019 total is underestimated. Not all clusters could be surveyed due to budget constraints.

Naturally Occurring Tidestrom's lupine (2020, 2021)

There was no budget for surveys of Tidestrom's lupine in 2020. The number of naturally occurring Tidestrom's lupine counted in May 2021 was 914 individuals in two separate clusters (844 individuals NatW , 70 individuals NatN). NatS no longer has naturally occurring Tidestrom's lupine. Of the 914 plants, 463 were seedlings <4 in, 235 were non-reproductive juveniles 4-8 in, and 216 were mature, reproductive plants 8 in+ in diameter. In 2021, a low rainfall year of 9 inches, the reproductive plants did have flowers and seed pods but the drought stress was apparent. The small seedlings were dried out and many did not live. Juvenile plants were grazed early in the season and never looked robust. It was difficult to collect seed because the temperatures were hot early in the season and seeds dehisced earlier than usual.

Tidestrom's lupine numbers in June 2019 (1300 individuals, mostly seedlings) showed a 324% increase over 2017 numbers (401 individuals) and a 47% increase over 2018 numbers (887). There were no Tidestrom's lupine surveys in May–June 2020 due to budget cuts related to the Covid-19 Pandemic. In May–June 2021, rainfall was very low (8.9 in), yet Tidestrom's lupine

numbers were still robust with a total of 914 individuals comprised of 463 seedlings, 235 nonreproductive juveniles, and 216 mature reproductive plants.

The number of Tidestrom's lupine individuals at Carmel North Dunes surpassed 1000, but only two clusters support more than 100 individuals (NatW, NatN). The substantial increase in the NorthDunes Tidestrom's lupine numbers are primarily seedlings that germinated from very robust seed dispersal in 2017, a year with below-average rainfall (12 in) preceded by above-average rainfall (22 in, FY 2016-17)

Table 4b. Number of Tidestrom's lupine planted in new areas 2018–2021

Carmel North Dunes

Lupinus tidestromii is state- and federal-listed as endangered.

Transplant area name and *location notes*	FY2018–19 Planting #1	Caged % Y/N	FY2019–20 Survival	FY2019–20 *Mortality*	FY2019–20 Reason	FY2019–20 Planting #2	Caged % Y/N	FY2020–21 Survival	FY2020–21 *Mortality*	FY2020–21 Reason	Notes
All areas cabled						*Transplants **must** be caged*				84% of FY2019–20 mortality in uncaged plants	FY2020–21 very dry year—9 inches
Transplant North *Sand & Sea*	**20**	**N**	**15**	***5***	hot/dry, exposed area	**4** *(+15) survivors*	**Y**	**4**	***15***	herbivory	grazers chewed uncaged seedlings to nub in 2021
Transplant East *Oak Island*	**20**	50/50	**3**	***17***	gone—birds? dog digging	**8** *(+3) survivors*	**Y**	**9**	***2***	herbivory, dog disturbance	many cones & plants gone, plant loss higher near oaks
Transplant CGClub *Centennial Tree corner*	**12**	50/50	**4**	***8***	tree shade—cooler sands	**4** *(+4) survivors*	**Y**	**1**	***7***	herbivory	area mossy, dense vegetation, plants grazed immediately
Transplant VBall East *50ft east of VBall courts*	**20**	50/50	**10**	***10***	nibbled stems& buds	**10** *(+10) survivors*	**Y**	**9**	***11***	Herbivory, dog/human wind? knocked over cages,	good sand conditions, consistent footpath thru cabled area,
Transplant South *Central dune*	**23**	**N**	**8**	***15***	seedlings grazed to nubs	**2** *(+8) survivors*	**Y**	**0**	***10***	herbivory	good sand conditions, dense sagewort likely shelters grazers
Transplant West *North of naturally occurring cluster*	**5**	60/40	**3**	***2***	hot/ dry area	**2** *(+3) survivors*	**Y**	**0**	***5***	pine needles	planted in shade of pines (now removed)
Total	**100**		**43**	***57***		**30**		**23**	**50**		**TOTAL = 130**
			43%	**57%**		*(+43)*		**32%**	**68%**		TOTAL survivors=23
		Percent survivors		Percent dead			Percent survivors		Percent dead		(18%)

(18%)

Rainfall

FY2018–19	FY 2019–20	FY 2020–21
25 inches	23 inches	9 inches

Rainfall average—18.98 inches per year in Carmel-by-the-Sea

Success criteria Tidestrom's lupine population shall number 1000 individuals in 10 different clusters of 100 plants each.

In early 2019, 100 Tidestrom's seedlings were transplanted into five transplant areas in pristine sands and with associated vegetation typical of Tidestrom's lupine occurrences in Pebble Beach and Pacific Grove. Twenty-nine of the seedlings were caged and the remainder were "camouflaged" in various ways to prevent herbivory. This was the first year that there were enough propagated seedlings to transplant into the North Dunes.

Transplanted seedlings survived well through a stormy and wet winter. Herbivory (chewed to a nub) was noted in two of five transplant areas and appeared more extensive near beach sagewort (*Artemisia pcynocephala*), and coast live oak shrubs with abundant leaf litter. Deer, squirrels and mice are known to graze on Tidestrom's lupine.

Based on Tidestrom's lupine observations over the past five years and the observed stressors on the species, herbivory in particular, it is unlikely that the goal of 1000 individual plants in 10 different areas of the North Dunes will be reached. We anticipate that restoring viable Tidestrom's lupine clusters in 3 to 5 areas of the North Dunes with a total number of individual plants of at least 1000 is a more reachable target.

California legless lizard (*Anniella pulchra*)

Goal: to eliminate all aggressive non-native species, restore the native dune scrub, expand the quantity and quality of available habitat for the California legless lizard

Before dune restoration work begins**,** crews and volunteers are oriented about legless lizard habits and protocol regarding this species of special concern. To minimize possible contact with a lizard, sharp tools are not used, and digging is slowed. California lizards are harmless but are not handled unless relocation is necessary.

Juvenile legless lizard

California legless lizards are usually observed during the winter months, when they migrate toward the surface seeking warmth from the sun. Planting seedlings, pulling weeds and iceplant may result in finding a slow-moving lizard at the bottom of a hole. Native shrub mulch and piles of dead iceplant are attractive to legless lizards because of insect activity beneath the decomposing material.

Table 5. California legless lizard occurrences

Anniella pulchra Species of Special Concern
See Figure 1. Restoration Completed 2020 and 2021, Special Status Species

Year	Relocated within 5m	Remained in place	Total occurrences
2017	7	14	**21**
2018	2	6	**8**
2019		5	**5**
2020	1	2	**3**
2021		3	**3**
Total	**10**	**30**	**40**

Anniella pulchra, California legless lizard, Rank G3/S3
California Department of Fish and Wildlife, California
California Natural Diversity Database (CNDDB)

Species Level Rank

Rank G3 **Vulnerable** At moderate risk of extinction due to restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

State Rank S3 **Vulnerable** to extirpation from the state for same reasons.

A total of forty California legless lizards were encountered during restoration work at the North Dunes between 2017–2021. Legless lizard occurrences were much more frequent in the first year of work when over 9600 pounds of weeds and debris were stacked and removed from the North Dunes. Rainfall was consistent in winter FY2017-18 and sands were moist. Most volunteers were able to see at least one legless lizard during their workday or fieldtrip, while digging weeds or removing debris piles. Most of the lizards were observed during January–March beneath the following native species: *Ericameria ericoides* (mock heather), *Carex pansa* (dune sedge), *Camissoniopsis cheiranthifolia* (beach primrose), and two non-native species, *Oxalis pes-caprae* (Bermuda buttercup) and *Ehrharta erecta* (panic veldt grass). Ten legless lizards were relocated out of harm's way into soft sands beneath native vegetation, within five meters of the occurrence. During subsequent years, thirty lizards were accidentally unearthed, observed briefly, then allowed to burrow back into their sandy homes, sheltered by native vegetation. Legless lizards are stressed by handling and can be harmed if they are young (small) or have recently molted (bluish color).

Restoration efforts enhance dune habitat and benefit the CA legless lizard population by reducing invasive weeds and increasing native plant numbers and species diversity. More than a thousand native plants per year were installed at the North Dunes, including 330 *Ericameria ericoides* (mock heather), a species preferred by the lizards. Five years of weed eradication has improved all vegetated areas of the North Dunes by removing over 8000 pounds per year of weedy grasses, annual weeds and iceplant. Weed control and native plantings have substantially improved all the available habitat for the California legless lizard. We have observed fewer legless lizards than we observed during early restoration work. There is much less ground disturbance from tree and acacia removal, fence installation and planting than in the early years of restoration work. The lizards have 5000 more native grasses, sedges and shrubs under which they can seek shelter and food. There has likely been a similar increase lizard food as numbers and diversity of insects and their larval stages has likely increased with the native plant numbers.

Table 6. Completed tasks under Coastal Development Permit 16–315, 2016–2021

Restoration Tasks	FY 2016–2017 Year 1	FY 2017–2018 Year 2	FY 2018–2019 Year 3	FY 2019–2020 Year 4	FY 2020–2021 Year 5	5-year totals
Protective fencing installation						
Cable fencing	1100 ft		1400 ft	900 ft	300 ft	3700 ft
Rope/stake fencing	550 ft		200 ft			770 ft
Weed removal—annual/perennial						
Total weed removal (lbs)	**9650**	**9815**	**7190**	**5460**	**9480**	**41595 lbs**
Weed control—Native Solutions	6200	2025	2760	2160	3600	**16745 lbs**
Weed control—Hired Contractor		2500				**2500 lbs**
Weed control—Volunteer total (lbs)	3450	5290	4430	3300	5880	**22350 lbs**
CbtSea Garden Club	*n/a*	*840*	*1320*	*1880*	*1760*	*5800 lbs*
MEarth Education Program	*2200*	*880*	*1040*	*620*	*no fieldtrips*	*4740 lbs*
Pebble Ridge Vineyard Volunteers	*1250*	*3570*	*2070*	*800*	*4120*	*11810 lbs*
Weed control—Volunteer total (hrs)	n/a	661	670	438	352	**2121 hrs**
Iceplant removal (cubic yards)	*40 CY*	*58 CY*	*52 CY*	*5 CY*	*20 CY*	***175 CY***
Tree removal and pruning						
Dead tree removal	11	1	1		1	**14**
Live tree removal	1		21		3	**25**
Stump removal/grinding	X	X	X			
Acacia removal	X	1 acre	X	X	central dunes	
Acacia pruning		viewing platform			foredune bluff	
Tree pruning (Cypress—Central Drainage, Reardune)				6		
Native plant installation						
Site- and region-specific, all sizes	1000	1900	1885	1050	65	**5900**
Other tasks						
Coastal Development Permit (CDP)	Oct 2016				Aug 2021	
Volleyball court relocation		Feb 2018				

Discussion and Pending Restoration Tasks

See Figure 2. Pending Restoration Tasks 2022–2023

Ample rainfall during three of five years enhanced restoration efforts at the North Dunes Project. The removal of dead iceplant piles and large quantities of non-native weeds opened new areas for recovery and germination of the native seedbank. In early 2020, there were high numbers of germinating seedlings under established native species, followed by a robust flowering season. Windblown seed from established native plants is a simple, cost-effective method of restoring dune habitat. Plentiful native seed dispersal and germination are strong indicators of recovering native habitat on the path to sustainability.

Figure 2 provides a visual representation of pending tasks for the next two years. Nearly fifty percent of the North Dunes is relatively pristine or has been successfully restored by removal of non-native species, followed by successful plantings and periodic weeding that has reduced weed cover to a controllable level (less than 5-10%). In the remaining areas of the habitat, weed control may require three to five more years to meet the success criteria of less than 10% average weed cover across 12 transects.

To ensure that success criteria are met, “weed sweeps” are recommended in highly impacted areas, depending on rainfall. These “challenged” weedy zones are shaded yellow in Figure 2 to emphasize periodic weeding through the year, prioritized by the biologist. Degraded by years of disturbance and non-native cover, successful habitat rehabilitation in these areas requires careful weed pulling around the native species, and timely removal prior to seed dispersal.

After five years of planting (2016-2021), a total of 5900 native seedlings have been planted at the North Dunes. An additional 600 native dune strand, coastal scrub and forest understory species are scheduled for installation in 2022 and 2023. These later plantings are in areas where invasive weed cover is improving, or trees and debris have been removed that will allow plantings to be more successful.

Success Criteria

Transect measurements from five years indicate a steady increase in percent cover of native plant vegetation from 47% (2017) and 51% (2018) to a range of 70-77% in the last three years (2019-2021). Sitewide assessments showed a steady progression in native species diversity across 8.6 acres, from twenty-six species in 2017 to thirty-five native species in 2018 and thirty-eight native species in 2021.

The number of native species at the North Dunes reached the five-year minimum success criteria of 30 species and 50% average percent cover by Year Two (2018) and continued the upward trend through the last three years with percent native cover values in the 70% range.

The percent cover of non-native species was unfavorably high in 2017, 2019 and 2020 due to above average rainfall, and cleared habitat areas that became fertile ground for weed germination.
The large increase in non-native plant cover in 2019 was primarily due to the rapid expansion of ripgut brome (*Bromus diandrus*) in cleared iceplant and acacia areas. Average percent cover of ripgut brome in 12 transects increased over four years of monitoring, then dropped in the fifth year (2017-2021: 4%, 6%. 28%. 17%. 5%). Because acacia and cypress removal occurred prior to Years Three and Four opening up bare ground, high levels of weedy grasses were to be expected.

The number of non-native species did not drop below 19 species, with the five-year success criteria set at <15 non-native species. The success criteria states that the average cover of aggressive, non-native species will be reduced to no more than 10% cover within 5 years, with the number of non-native species reduced by at least half, from 30 species to ≤15 species. The five most aggressive non-native species are: *Conicosia pugioniformis*, *Bromus diandrus, Ehrharta erecta, Hordeum murinum*, and *Carpobrotus* species. According to transect data, all of these species (except *Carpobrotus*) increased during Years Three and Four and have been declining since that time. Of the 19 non-native species, many are found in the 4th Avenue gully adjacent to the boardwalk which will undergo restoration in 2022. The non-native species are not dispersing seed to the remainder of the North Dunes because of the topography and isolation of the gully.

Improved strategies to reduce annual grasses and other weeds include monthly weed sweeps in all highly impacted areas (February–June). We will remove stacked iceplant debris within four to six weeks to reduce conversion of the white sands to nutrient rich sands that stimulate higher weed growth. Non-native species shall be removed prior to seed dispersal under close supervision so that bagging weeds for removal and dune travel to the city trucks does not spread invasive seed.

Iceplant and annual weed control, followed by native plantings as needed, will continue to be the primary restoration activities through 2022 and 2023. Focused weeding, debris removal, and planting in treatment areas should maintain the increase of native plant cover and increase species diversity. Restoration in the acacia removal areas and the forest management area (northwest corner of the site) where the non-native seedbank is prolific will require time to rebuild quality native habitat. Designated pathways and recent installation of guideline fencing helps to protect these habitat areas so that the native species can establish successfully.

During winter/early spring 2022 and 2023, additional coastal strand and central dune scrub species will be planted in unvegetated dune areas, with dune sedges and understory species added to the forested areas. The northwest boundary fence and boardwalk area will receive extra weed control and plantings in 2022 and 2023, including the Fourth Avenue coastal access corridor. Weeds and non-native landscaping plants will be removed up to the City's property line at Sand & Sea and replaced with native shrubs whenever possible to replace several invasive landscape species. The Sand & Sea property line needs adequate delineation between homes and environmentally sensitive habitat area. There are trails and dog paths crossing highly sensitive habitat.

Acacia, cypress and iceplant removal at the North Dunes allowed beach poppies, pink and yellow sand verbena, beach primrose, and coastal bush lupine to establish and thrive in sunny expanses of white sand that were once shaded and challenged by competition from tree and shrub species planted outside of their natural habitat. These colorful dune strand and coastal scrub species provide valuable shelter and sustenance for native bees, bumble bees, butterflies and other pollinating insects. The flower and shrub diversity provides an abundance of seed and insects that inhabit native coastal dune strand and dune scrub providing essential food and shelter for birds and local wildlife.

There are several robust stands of coastal bush lupine (*Lupinus arboreus*) colonizing open areas throughout the North Dunes. Dense multi-year stands of robust coastal bush lupine can die out suddenly. Root damage by caterpillars of the ghost moth *Hepialus californicus* (Lepidoptera, Hepialidae) are a major cause of individual bush death and a probable cause of die-off of stands of lupine (Strong et al, 1995). In areas of the North Dunes where Monterey cypress, acacia or iceplant were removed, the native coastal bush lupine seedbank germinates densely, producing abundant seed for one to two years, then senesces quickly. Because coastal bush lupine seed is very prolific these lupine stands usually reappear in an adjacent open area of the North Dunes.

Tidestrom's Lupine

The endangered Tidestrom's lupine met the success criteria of 1000+ individuals, however the majority of the lupine was in one occurrence cluster. Two naturally occurring clusters of the species have at least 100 individuals, so seed distribution from eight other occurrences are required to meet the Fish and Wildlife goal of 1000 Tidestrom's lupine in ten separate occurrences of at least 100 individuals. (currently at <20% of goal). Based on Tidestrom's lupine observations over the past five years and the observed stressors on the species, herbivory in particular, it is unlikely that the goal of 1000 individual plants in 10 different areas of the North Dunes will be reached. We anticipate that restoring viable Tidestrom's lupine clusters in 3 to 5 areas of the North Dunes with a total number of individual plants of at least 1000 is a more reachable target.

Tidestrom's lupine seedlings germinated very densely in early 2019, and the population clusters expanded in all directions. Seedling numbers were so high in the largest naturally occurring Tidestrom's lupine cluster (NatW) that we had to create new methods of estimation, since walking through the area without impact was very difficult. This area near the boardwalk was fully counted from numerous angles to avoid disturbing the seedlings. There were 1300 seedlings and mature plants in the cluster, with seedlings far outnumbering reproductive plants. Another location cluster below the Sand & Sea homes contained at least 100 plants, estimated during weed control efforts.

In Year Four, rainfall was 23 inches from November 2019 to March 2020, which was 21% higher than the seasonal average of 19 inches and extended the planting season. Rainfall was 47% of normal in Year Five, when it rained only 8.9 inches, mostly in January and March with long dry periods in between rains (Fish, 2021).

The wet–dry–wet pattern of annual rainfall 2017–2019 appeared to create good conditions for native species recruitment and establishment. Native species thrive with early winter rainfall; seedlings germinate early and become robust, producing bountiful seed in summer. Early and consistent rainfall provides an important competitive advantage for native species, as non-native (annual) species usually germinate and grow quickly once temperatures warm in the spring. Native seed production was robust in 2018 (a low rainfall year) for the endangered Tidestrom's lupine, and the yellow and pink sand verbenas (*Abronia latifolia, A umbellata*). Perhaps prolific rainfall prior to reduced rainfall provides strongly rooted native species with "deep water" that augments the ability to seed prolifically under dry conditions. The removal of the acacia shrubbery near the Tidestrom's lupine cluster in 2017-2018 removed habitat and shelter for deer. The surge in seed production and dispersal for the Tidestrom's lupine may have been temporary while the deer moved away to find shelter. According to residents, deer are frequenting the forested areas once again

Future plans- Adaptive Management

Future improvements should prioritize improving the visitor experience while continuing to reduce the impacts of visitors on the sensitive habitats of the North Dunes. The installation of cable fencing and regulatory signage has significantly reduced trampling impacts at the North Dunes while providing more clearly defined trails for access.

Additional cable fencing and directional signage along clearly defined pathways is essential to preserve the environmentally sensitive habitat area (ESHA) from unnecessary trampling. Dogs-on-leash signs were installed in 2020 and many dog owners comply with the signs. However, evidence of dog prints throughout the protected cabled areas indicates that some dogs are allowed off leash to run in fragile dune areas. Educational and regulatory signage should further highlight the unique dune ESHA and define the rules for public access and city laws at entrances, bathrooms, and along major pathways.

Future grant funding may assist with developing access improvements to accommodate visitors with limited mobility while reducing impacts of visitors on the sensitive habitats of the North Dunes. A boardwalk could be installed to connect the Del Mar parking lot with the 4th Ave boardwalk. There is space for dune stabilizing vegetation such as American dune grass to buffer recreational areas around the historic cypress trees and below the volleyball courts. With well-designed, sturdy construction, this boardwalk and associated vegetation restoration could reduce irreparable sand loss downslope and allow for stabilizing plant recovery on sections of the broad ocean-facing slope to the beach. Access and boardwalk improvements, as well as erosion mitigation, will require significant design work and public input prior to implementation.

Accolades

Dedicated work by city staff and contractors completed many of the skilled restoration tasks at the North Dunes Project between 2016-2021. In addition volunteer groups, donated crews and students of all ages cleared most of the dense iceplant cover, non-native debris, and annual weed clutter from the North Dunes, a truly monumental task. Volunteers made the eight-acre dune restoration project possible with their dedication and stewardship. To put numbers to the magnitude of the work, there was a grand total of 20.8 tons (41,595 pounds) of invasive weeds removed over five years. Volunteers contributed 54% of the weed removal effort (2121 hours) while the contractor(s) completed 46% of the work. The value of the volunteer weed removal efforts at the North Dunes is over $60,500 at the current volunteer rate of $28.54 for 2021 (Independent Sector, Do-Good Institute).

Of note, are the long-term efforts of the Carmel-by-the-Sea Garden Club members, who designed and implemented the Centennial Tree Project, the first segment of the North Dunes habitat restoration project at the corner of Ocean and San Antonio Avenues. They collaborated and helped implement the original coastal development permit for the southeast corner of the project and fundraised for cable installation, planting design plans, and the installation of 1200 dune seedlings between 2012–2015. The Garden Club installed interpretive signage and sitting benches that provide a scenic view of the ocean and the North Dunes while providing a welcome respite for visitors. The Garden Club was recently granted permission to expand their original project area an additional 4000 feet northward, for a total of 20,000 square feet under their stewardship. The total amount of bagged weeds that Garden Club members pulled between 2017-2021 was 5800 pounds (2.9 tons).

Pebble Ridge Vineyards generously supports the North Dunes Project with a skilled team of five to eight men who assist with restoration tasks several times per year. The capable supervisor and crew have been indispensable to restoration success in all areas of the North Dunes. Between 2017-2021 the Pebble Ridge Vineyard Volunteer Crew bagged 11,810 pounds (nearly 6 tons) of weeds and pulled tarp loads of iceplant, assisting city staff with hauling out the heavy material. The vineyard workers are very efficient weeders and expert pruners who enjoy 'shaping up' the native coastal bush lupine (*Lupinus arboreous*) in the late fall to encourage a robust spring bloom. The Pebble Ridge Crew keeps the dead lupine from becoming a nexus for weedy grass invasion. During April-May, a walk to the 4th Avenue boardwalk captures the beauty and delightful scent of the purple/white lupine blossoms of this endemic species.

The MEarth Environmental Sustainability Program provides education that inspires youth and adults to be better stewards of our communities and environment with engaging fieldtrips and high-quality outdoor curriculum. Between 2017-2021, MEarth staff, student, and family weeding efforts totaled 4740 pounds (2.7 tons) of annual weeds and countless tarps of pulled iceplant. MEarth's ethic of nature stewardship and environmental sustainability is exemplary and ripples throughout the community and beyond.

Pending Dune Restoration Tasks
Year 6, 2021–2022, Year 7, 2022–2023

1) Train and supervise volunteer groups; manage productive workdays during appropriate season
2) Remove all non-native species, dried iceplant piles and debris in high-quality sand areas
3) Remove annual weeds prior to seed dispersal (assess and weed monthly January-July)
4) Continue plantings of Tidestrom's lupine until numbers and dispersal meet success criteria
5) With eucalyptus gone, remove non-native species in 4th Ave swale N of boardwalk/forest area
6) Plant native grasses, sedges, dune scrub, and forest understory near boardwalk in forest area
7) Within North Dunes boundaries, replace landscaping with natives south of Sand & Sea homes
8) Maintain and augment native plantings at entrances, along sidewalks, newly cabled areas
9) Monitor—Plant survival, Tidestrom's lupine (Feb–May), Transects (May–June)
10) Reports—Jan 31 (CA. Dept. Fish & Wildlife), Sep 30 (Annual Report, Years Six, Seven 2021–23)

Pending Maintenance, Infrastructure Tasks, Signage, and Planning (Public Works)
Year 6, 2021–2022, Year 7, 2022–2023

1) Annual maintenance—tighten cable fencing, replace rusted cable and decomposing corner posts (one or two sections per year as budget allows)
2) Inspect and repair boardwalk hazards
3) Replace plastic barrier sheeting north and south of volleyball courts after winter storms abate
4) Inspect mature trees—remove hazards, prune trees per city forester recommendations
5) Trim back encroaching acacia at the foredune bluff every two years (completed 2018, 2021)
6) Design and install regulatory signage (2021-2022), directional and interpretive signage (2022-2023)
7) Design and install attractive, permanent, and durable perimeter fencing (San Antonio, Ocean Ave.)

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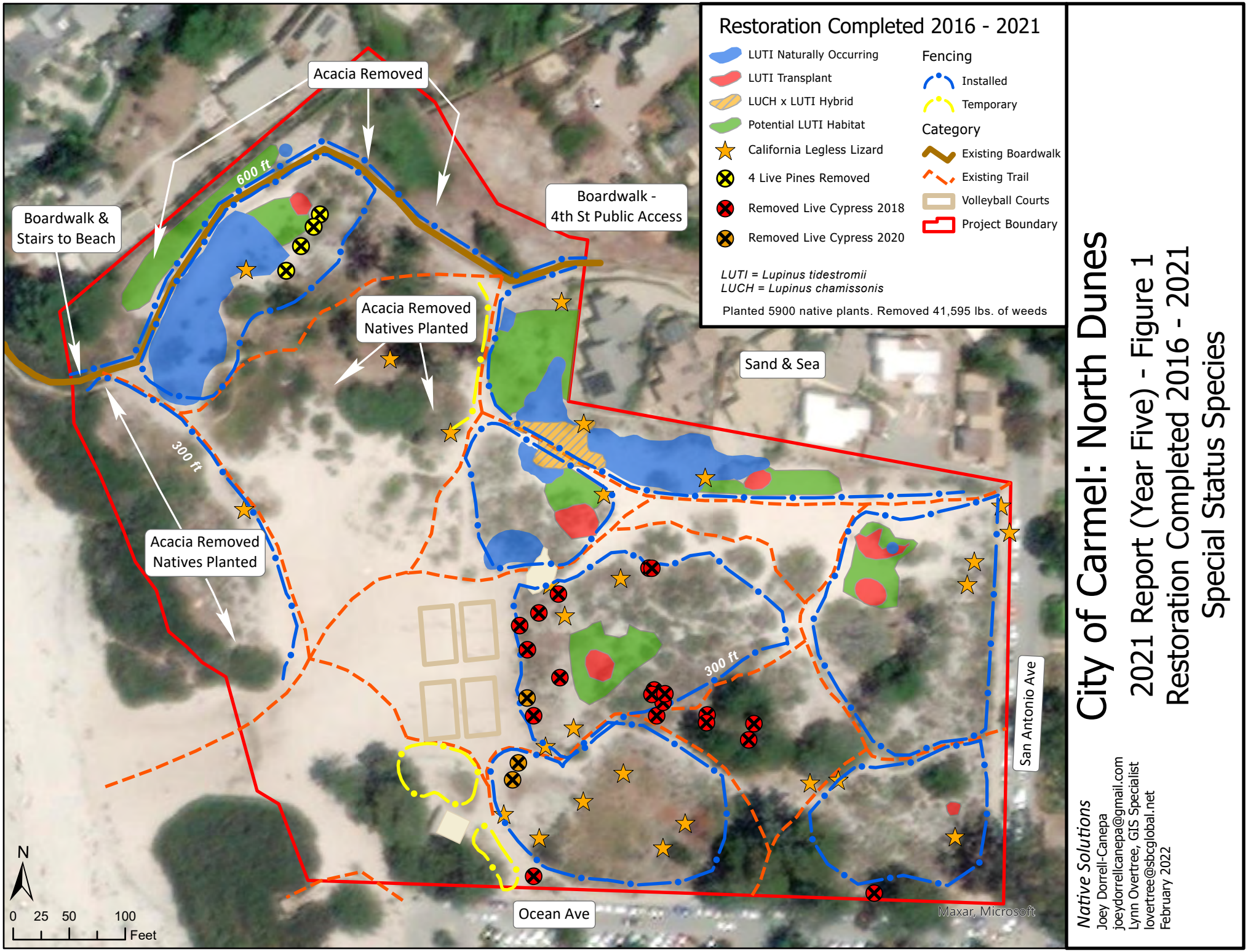
FIGURES



City of Carmel: North Dunes

2021 Report (Year Five) - Figure 1
Restoration Completed 2016 - 2021
Special Status Species

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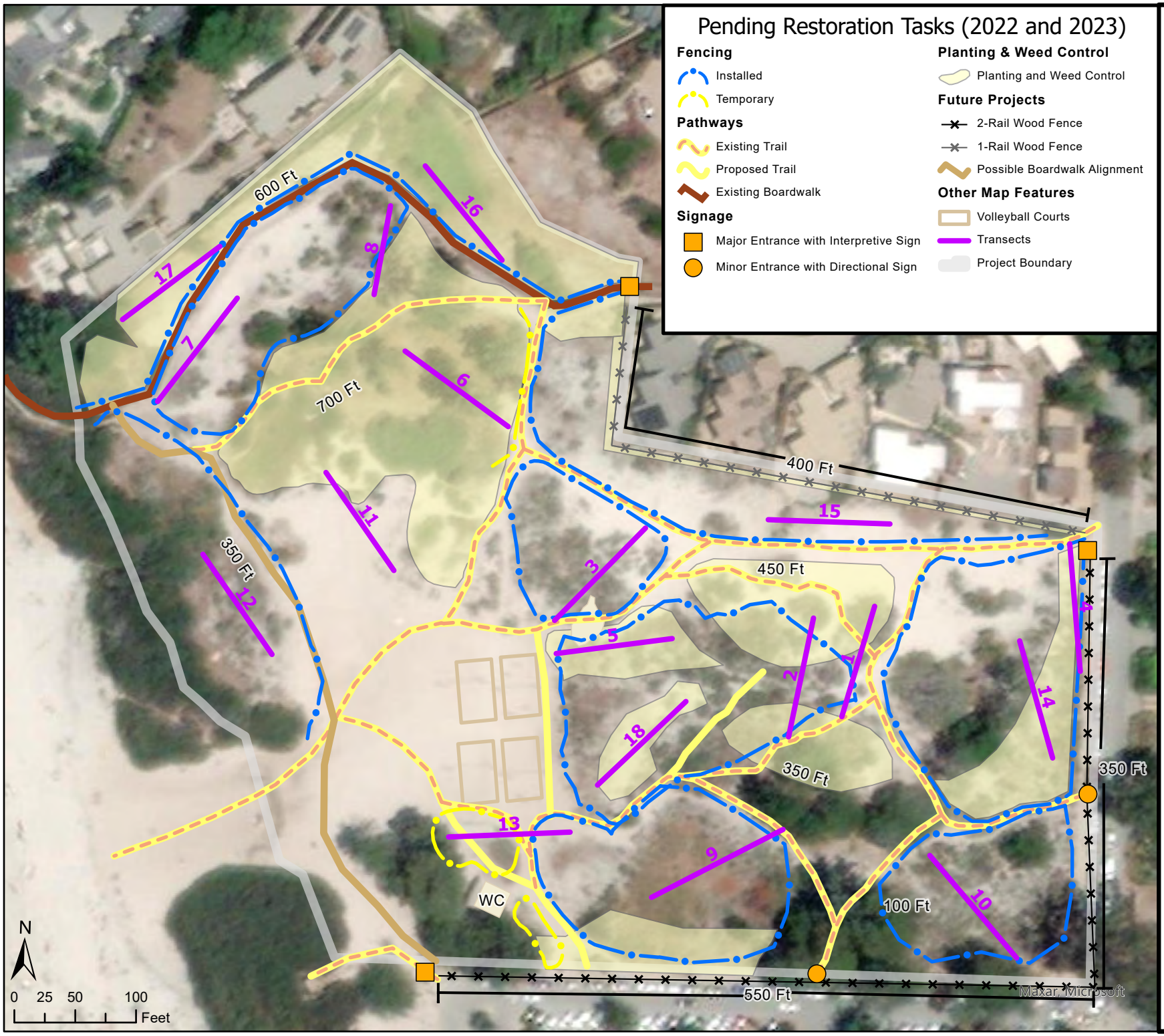
February 2022



City of Carmel: North Dunes

2021 Report - Figure 2
Pending Restoration Tasks 2022 and 2023

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February 2022

APPENDIX A

Appendix A. Native Plant Species of the North Dunes, Carmel-by-the-Sea, California

Success criteria are met when the number of native dune species in the project area is restored to a minimum of 30 species.

Initial Survey Date: May 13, 2008 (J. Ferreira)
Updated Surveys: May – June 2016, 2017, 2018, 2019, 2020, 2021 (JD Canepa)

Family	Botanical Name	Common Name	
Asteraceae	*Achillea millefolium*	common yarrow	1
Asteraceae	*Ambrosia chamissonis*	beach bur	2
Asteraceae	*Artemesia pynocephala*	beach sagewort	3
Asteraceae	*Baccharis pilularis ssp. consanguinea*	coyote bush	4
Asteraceae	*Baccharis salicifolia*	mule fat	5
Asteraceae	*Corethrogyne filaginifolia*	CA. sand aster	6
Asteraceae	*Ericameria ericoides*	mock heather	7
Asteraceae	*Erigeron glaucus*	seaside daisy	8
Asteraceae	*Eriophyllum staechadifolium*	lizard tail	9
Asteraceae	*Pseudognaphalium stramineum*	cotton batting plant	10
Anacardiaceae	*Toxicodendron diversilobum*	poison oak	11
Brassicaceae	*Cakile maritima**	sea rocket*	
Chenopodiaceae	*Atriplex leucophylla (on beach)*	saltbush	12
Crassulaceae	*Dudleya caespitosa*	liveforever	13
Cucurbitaceae	*Marah fabaceus*	wild cucumber	14
Cupressaceae	*Hesperacyparis macrocarpa*	Monterey Cypress	
Cyperaceae	*Carex barbarae*	Santa Barbara sedge	15
Cyperaceae	*Carex pansa*	dune sedge	16
Cyperaceae	*Carex praegracilis*	freeway sedge	17
Dennstaedtiaceae	*Pteridium aquilinum*	bracken fern	18
Euphorbiaceae	*Croton californica (last observed 2012)*	CA. croton	19
Fabaceae	*Acmispon glaber*	deerweed	20
Fabaceae	*Acmispon heermanii var. orbicularis*	woolly lotus	21
Fabaceae	*Lupinus arboreus*	bush lupine	22
Fabaceae	*L. chamissonis x L. tidestromii*	HYBRID (remove from site)	
Fabaceae	*Lupinus chamissonis*	REMOVE from site if found	
Fabaceae	*Lupinus tidestromii **	Tidestrom's lupine**	23
Fagaceae	*Quercus agrifolia*	coast live oak	24
Hydrophyllaceae	*Phacelia ramosissima*	branching phacelia	25
Juncaceae	*Juncus patens*	spreading rush	26
Lamiaceae	*Stachys bullata*	wood mint	27
Nyctaginaceae	*Abronia latifolia*	yellow sand verbena	28
Nyctaginaceae	*Abronia latifolia X umbellata* (last observed 2019)	white sand verbena	ID
Nyctaginaceae	*Abronia umbellata X sp.* (last observed 2019)	salmon colored verbena	ID
Nyctaginaceae	*Abronia umbellata*	pink sand verbena	29
Orobanchaceae	*Castilleja latifolia*	seaside painted cup	31
Papaveraceae	*Eschscholzia californica var. maritima*	beach poppy	32
Pinaceae	*Pinus radiata*	Monterey Pine	33
Poaceae	*Distichlis spicata*	Salt grass	34
Poaceae	*Elymus mollis (Leymus)*	American dune grass	35
Poaceae	*Elymus triticoides*	creeping wild rye	36
Poaceae	*Poa douglasii*	dune bluegrass	37
Polygonaceae	*Eriogonum parvifolium*	dune buckwheat	38
~~Rosaceae~~	~~*Rubus ursinus****~~	~~CA. blackberry****~~	~~39~~

*non-native: useful dune-building plant in barren areas, non-invasive in this area

**special status species, state-and federal-listed as endangered

***species mis-ID'd, accurate ID is *R. armeniacus*-Himalayan blackberry see *Appendix B. Non-Native Species*

APPENDIX B

Appendix B. Non-Native Species of the North Dunes, Carmel-by-the-Sea, California

Success Criteria: The average cover of aggressive, non-native species will be reduced to no more than 10% cover within 5 years, with the number of non- native species reduced by at least half, from 30 species to ≤15 species.

Initial Survey Date: May 13, 2008 (J. Ferreira)
Updated Surveys: May – June 2016, 2017, 2018, 2019, 2020, 2021 (JD Canepa)

Family	Species	Common Name	Number
Aizoaceae	*Carpobrotus species*	iceplant	1
Aizoaceae	*Conicosia pugioniformis*	conicosia	2
Asteraceae	*Delairea odorata*	Cape Ivy	3
Asteraceae	*Sonchus oleraceus*	sow thistle	4
Fabaceae	*Paraserianthes lophantha*	Cape wattle	5
Fabaceae	*Acacia longifolia*	Sydney golden wattle	6
Fabaceae	*Genista monspessulana*	French broom	7
Malvaceae	*Malva parviflora*	Cheeseweed	8
Oxalidaceae	*Oxalis pes-caprae*	Bermuda buttercup	9
Poaceae	*Avena fatua*	wild oat	10
Poaceae	*Briza major*	rattlesnake grass	11
Poaceae	*Bromus diandrus*	ripgut brome	12
Poaceae	*Ehrharta erecta*	panic veldt grass	13
Poaceae	*Festuca myuros (Vulpia)*	rattail fescue	14
Poaceae	*Hordeum murinum*	hare barley	15
Poaceae	*Phalaris sp.*	canary grass	16
Poaceae	*Poa annua*	annual blue grass	17
~~Polygonaceae~~	~~*Rumex acetosella*~~	~~sheep sorrel~~	not seen
Rosaceae	Rubus armeniacus	Himalayan blackberry	18
Solanaceae	Solanum nigrum	black nightshade	19

Non-Native Species from Landscaped Areas

Agave	1
Allium	2
Australian tea tree (anchors North Dunes entrance at Sand & Sea)	3
Bermuda Grass	4
English Ivy (Hedera helix)	5
Flowering plum	6
Fountain grass (*Pennisetum setaceum*)	7
Mexican Feather Grass (*Nassella or Stipa tenuissima*)	8
Honeysuckle	9
Nasturtium	10
Passion Vine	11
Pride of Madera (*Echium candicans*)	12
Rosemary	13

APPENDIX C

Appendix C. Percent Absolute Cover of Native and Non-Native Species by Year – 2020, 2021

PERCENT Absolute COVER																2021
SUCCESS CRITERIA	transect #	1	2	3	4	5	6	7	8	9	10	11	12		SUM	# TRNs	AVG Percent Cover 12 Transects
Percent cover native species GOAL >50%	NATIVE	57	77	81	117	72	71	32	49	91	127	41	105		920	12	77%
Percent cover non-native spp. GOAL <10%	WEEDS	6	9	7	1	12	20	8	7	9	4	8	8		97	12	8%
Ehrharta erecta		0	1	0	0	0	0	0	0	1	0	0	1		3	12	*0%*
Bromus diandrus		**3**	**9**	**1**	**1**	**12**	**11**	**8**	**6**	**5**	**4**	**3**	**8**		69	12	*6%*
Other annual grasses Blackberry, Acacia sprouts		3	0	0	0	0	9	0	0	0	0	4	0		16	12	*1%*
Conicosia pugioniformis		**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**3**		8	12	*1%*
Live carpobrotus		0	0	4	0	0	0	0	1	0	0	2	0		7	12	*1%*
NATIVE vegetative mulch Pine/cypress debris +/- canopy		17	22	1	1	8	23	0	5	15	31	3	0		126	12	10%
NON-NATIVE DEBRIS - iceplant Acacia stumps/ Eucalyptus		21	0	20	0	0	4	24	10	10	4	0	41		134	12	11%
TOTAL PLANT COVER and TOTAL DEBRIS ON GROUND		101	108	109	119	91	118	64	71	125	166	52	154		1276	12	106%
Bare sand		38	39	12	11	4	5	52	1	0	16	66	0		245	12	20%
"Dirty" sand (Carpo debris)		20	22	14	9	59	0	20	15	39	0	0	36		233	12	19%
SUCCESS CRITERIA 5 YRS=2021	0	1	2	3	4	5	6	7	8	9	10	11	12			# TRNs	% of transects that met success criteria
% NATIVE COVER >50%	5 yr goal met?	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y		9	12	75%
% NON-NATIVE COVER <10%	5 yr goal met?	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y		10	12	83%
# NATIVE SPECIES/Transect	0	9	7	9	7	7	7	5	6	9	9	4	8		87	12	7
≥30 NATIVE SPECIES onsite?	5 yr goal met?																38 NATIVE SPECIES
# NON-NATIVE SPECIES/Transect		2	2	3	1	2	4	1	3	3	1	3	5		30	12	3
<15 NON-NATIVE SPECIES?	5 yr goal met?																19 NON-NATIVE SPECIES

Transect Data – JD Canepa, Native Solutions

Appendix C. Percent Absolute Cover of Native and Non-Native Species by Year – 2020, 2021

PERCENT Absolute COVER																2020
SUCCESS CRITERIA	transect #	1	2	3	4	5	6	7	8	9	10	11	12		SUM	# TRNs	AVG Percent Cover 12 Transects
Percent cover native species GOAL >50%	NATIVE	49	65	98	124	60	64	51	44	81	123	36	85		844	12	70%
Percent cover non-native spp. GOAL <10%	NON-NATIVE	20	38	7	5	20	61	12	19	65	18	12	92		369	12	31%
Ehrharta erecta		0	1	0	0	0	0	0	0	0	0	0	20		21	12	*2%*
Bromus diandrus		**16**	**36**	**1**	**5**	**14**	**36**	**11**	**14**	**40**	**22**	**0**	**28**		220	12	***18%***
Other annual grasses Blackberry, Acacia sprouts		0	1	0	0	0	13	0	1	13	1	5	20		54	12	*4%*
Conicosia pugioniformis		**4**	**0**	**2**	**0**	**7**	**4**	**1**	**0**	**11**	**0**	**0**	**35**		64	12	***5%***
Live carpobrotus spp.		0	0	4	0	0	8	1	4	1	0	7	9		34	12	*3%*
NATIVE vegetative mulch Pine/Cypress debris +/- canopy		3	16	6	0	31	53	0	38	10	17	6	0		179	12	15%
NON-NATIVE debris - iceplant, Euc/Acacia stumps/lvs/debris		25	21	21	0	0	0	24	23	0	6	0	1		121	12	10%
TOTAL PLANT COVER and TOTAL DEBRIS ON GROUND		96	141	132	129	111	178	87	123	155	164	53	178		1548	12	129%
Percent cover bare sand		51	53	19	16	10	3	45	4	0	8	57	3		269	12	22%
"Dirty" sand (light carpo debris)		21	10	14	9	35	0	35	25	20	11	0	35		214	12	18%
SUCCESS CRITERIA	0	1	2	3	4	5	6	7	8	9	10	11	12			# TRNs	% of transects that met success criteria
% NATIVE COVER >50%	5 yr goal met?	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y		9	12	75%
% NON-NATIVE COVER ≤10%	5 yr goal met?	N	N	Y	Y	N	N	N	N	N	N	N	N		2	12	17%
																	AVG # Species/TR
# NATIVE SPECIES/Transect	0	9	7	10	7	6	8	5	6	9	9	5	8		89	12	7
≥30 NATIVE SPECIES	5 yr goal met?																35 NATIVE SPECIES
# NON-NATIVE SPECIES/Transect		3	2	3	1	2	5	3	3	6	2	2	6		38	12	3
≤15 NON-NATIVE SPECIES	5 yr goal met?																22 NON-NATIVE SPECIES

Transect Data – JD Canepa, Native Solutions

APPENDIX D

Appendix D. Management Recommendations and Estimated Costs 2021-2023

RESTORATION PLANNING	DETAILS	CURRENT BUDGET	Additional BUDGET
AND ACTIVITIES		**2021-2022**	**2022-2023**
		CONTRACTED	
Labor & Pebble Ridge Vol Crews	(4 days) Crew Supervision/ Training @ $200/day	**$800**	**$1,000**
Volunteer Workdays/Adults	(2 mornings) Supervision/Training @$200/day	**$400**	**$600**
Volunteer Coordination	Organization/coordination	**$250**	**$250**
Mentor CSUMB/student research	Tidestrom's lupine census	**JDC Donation**	
Weed Eradication	Flame/Spray/ Handweed	**$1,500**	**$1,600**
Project Management	Logistics, Admin, Meetings	**$600**	**$750**
Habitat Restoration Tasks	Seed collection/Propagation/Outplanting	**$1,000**	**$800**
Supplies (bags, tarps, cages, stakes)	Includes Forest Understory Plants	**$450**	**$500**
CABLE PLANTED AREAS			
Cable Guideline fencing			
DESIGN/ OVERALL VISION			
Signage-Public Works/Design/Install	In-house, Regulatory, directional		
Signage Design/ Approval	Interpretive		
Signage Creation/Installation	permanent interpretive signage		
Entrances for Cabling/Signage:	1) Ocean Ave- bathroom area, volleyball courts		
	2) San Antonio @ wall		
2-rail Wood fence to define perimeter	San Antonio and Ocean Avenue borders		
1-rail Wood fence to define ESHA	Sand/Sea Property Boundary		
MONITORING			
Transects/Tidestrom's lupine/analysis	use student assistance	**$2,000**	**$2,000**
Report	2021-2022	**$2,000**	**$2,000**
Mapping (Contractor)		**$500**	**$500**
Coastal Commission			
CA. Dept of Fish and Wildlife	Renew permit, report	**$500**	
PROJECT TOTAL		**$10,000**	**$10,000**

APPENDIX E

Appendix E. Two Year Work Plan 2021-2023
North Dunes Restoration Project

North Dunes Project Tasks	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	COMPLETED ITEMS
Restoration Plan/ CDPermit													WORK STARTED DEC 2016
Coastal Development Permit (Transect Data Yrs 1-5) to CA. Coastal Commission								2021					CDP 16-315 (OCT 2016) 5 Yr Renewal (AUG 2021)
Created Live Tree Removal Map & Schedule (JDC)													CDP Amended (2017)
Approval/ Coordination - City/State Agencies													
Renew Permit for Tidestrom's lupine (seed collection, planting)			Gray fill here										US Fish and Wildlife
Project management													
Planning/ Update Implementation Schedule													
Monitor Transects & Survey Tidestrom's Lupine													
Annual Report													
Endangered Species Management													
ID & Remove Lupine hybrids, Lupinus chamissonis													
Propagate/Transplant Tidestrom's Lupine													
Plant Establishment													
Seed Collection													
Propagation													
Transplant, Plant propagated seedlings, Water													as needed
Weed Control													
Supervision of Labor Crews/ Volunteer projects													
Prioritize weed areas, Senescent debris clearance										Gray fill here			Reduce debris that harbors grasses, oxalis
Weed prescribed areas to maintain native species													
Remove iceplant piles within 4-6 wks													
Spray - Ehrharta, Conicosia, Carpobrotus													as needed
Fencing/ Stabilize Sand													
Cable /Post /Signage Maintenance													as needed
Annual Maintenance: boardwalk, cabling													as needed
Stabilize sand with dune grass/straw plugs													as needed

APPENDIX F

Appendix F—North Dunes Project, Selected Photos

Nursery propagation of site-specific seedlings (Dune buckwheat (*Eriogonum parvifolium*), beach sagewort (*Artemisia pcynocephala*), tree lupine (*Lupinus arboreus*))

A total of 5900 plants (32 native species) were installed at the North Dunes from 2017-2021.

Volunteer crews stretch resources

From 2017–2021, the Pebble Ridge Vineyard Crew, Carmel-by-the-Sea Garden Club, and MEarth's Sustainable Environmental Education program contributed a total of 2,121 hours to the North Dunes Restoration Project, removing 20.8 tons of weeds and iceplant and planting 1300 site-specific seedlings. *See Table 6.*

Pebble Ridge Vineyard Crew - February 2018
Saul Chavez, Crew Supervisor, planting site-specific, native seedlings at the acacia removal area next to piles of pulled iceplant.

Pebble Ridge Vineyard Crew – May 2020
Successful native plant establishment and weeds under control.

Between 2017-2021, the Pebble Ridge Vineyard Crew donated over 835 hrs of labor to the North Dunes Project. The crew removed 5.9 tons of annual weeds and grasses and pulled over 100 cubic yds of iceplant. The skilled crew installed 700 plants, pruned large native shrubs, and constructed protective cages as needed.

March 2021. Michael and Jesse from the Public Works Department install cable fencing along the foredune bluff where one half acre of acacia was removed.

Eucalyptus removal on private property adjacent to the northern boundary of the North Dunes.

Aug 2020 Boundary fence - North Dunes (left) November 2020 – Eucalyptus removal (right)

The removal of 17 Eucalyptus trees reduces the depletion of ground water and decades-long accumulation of leaves and debris on the property AND the North Dunes. Removal of the trees will improve habitat restoration results in the 4th Avenue swale and boardwalk area (photo below). The owner replaced the grove by planting native species appropriate for the site.

December 2020. Tarps of Eucalyptus debris and weeds from the 4th Avenue swale weeded by the Pebble Ridge Vineyard Crew

From 2017 – 2021, the MEarth Sustainable Environmental Education program staff and volunteers pulled 4740 lbs of weeds and grew and installed 600 site-specific seedlings

Big Sur Charter Students, MEarth Staff and parents weeding foxtail and ripgut brome and planting native dune seedlings (2018)

. . . volunteers help build community support

The Carmel-by-the-Sea Garden Club organizes 10 workdays per year at their Centennial Tree Project (restored 2012–2014). During 2017–2021, Garden Club volunteers removed over 5800 lbs of weeds and debris from the North Dunes.

Weeding Oxalis
March 2019
Corner of Ocean and San Antonio Avenues

Hosting the Bay Visions–Partners 4 Plants Group, November 2019, Tour and Workday, weeding Conicosia and planting native dune grass

Special Status Species

March 2016 Endangered Tidestrom's lupine population adjacent to boardwalk (right of picture). Dense acacia cover extended from ocean bluff to pathway at back of photo.

May 2018 Same view as above after acacia was removed along the ocean bluff *(Jan 2018).* Flags are used as markers for Tidestrom's lupine surveys.

It was a robust seed year for the Tidestrom's lupine. Seed pod clusters are brown and dehisce at the edges of the gray-green lupine plants.

Concerns: Accretion dune-Open recreational area, SW view–allows trampling of Environmentally Sensitive Habitat Area (ESHA) and causes erosion of sand downslope.

Completed: Expanded revegetation zone SE from acacia removal area (1000SF-20ft*50ft), installed cable fencing (right of photo). Narrow existing footpath over top of dune by planting native dune grasses: American dune grass (*Elymus mollis*), creeping wild rye (*Elymus triticoides*), dune bluegrass (*Poa douglasii*).

March 2016 Accretion dune, leeward. Western bracken fern helps to stabilize pathway.

Summer 2018. View of Pescadero Point from the central dune area of the North Dunes. The dune above the cabled area is the 'accretion dune'. By 2019, all the areas within the picture were restored to native species. Sand accretion supports native dune strand and scrub species by reducing annual grass and weed proliferation. Iceplant is 'managed' in selected areas to help prevent erosion from recreational activities.

Photo courtesy of Judy Cunningham, Carmel-by-the-Sea Garden Club, summer 2020
A colorful and diverse blend of native coastal dune shrubs thrive in the central dune area. Summer fog provides crucial moisture to the vegetation. Existing native vegetation was augmented with dune buckwheat (*Eriogonum parvifolium*), beach sagewort (*Artemisia pcynocephala*) and CA beach poppy (*Eschscholzia californica* var. *maritima*)