Oceano Dunes State Vehicular Recreation Area
Dust Control Program

Draft 2024 Annual Report and Work Plan

August 1, 2024

State of California
Department of Parks and Recreation

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Oceano Dunes State Vehicular Recreation Area Dust Control Program
2024 Annual Report and Work Plan
DRAFT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

2024 Annual Report and Work Plan Attachments (Separate Documents)

List of Abbreviations and Acronyms	
Abbreviation or Acronym	**Full Phrase or Description**
°	degrees
<	less than
>	greater than
≥	greater than or equal to
u_*	shear velocity
$\mu g\ m^{-3}$	micrograms per cubic meter
AGL	above ground level
ARWP	Annual Report and Work Plan
ASU	Arizona State University
B	beach area used in foredune morphological change analysis
BAM	Beta Attenuation Mass
CAAQS	California Ambient Air Quality Standard
Cal Poly	California Polytechnic State University
CARB	California Air Resources Board
CDP	Coastal Development Permit
cm	centimeter
CSV	comma-separated values
DTM	digital terrain model
DRI	Desert Research Institute
FAQ	Frequently Asked Questions
FD	foredune area used in foredune morphological change analysis
FEM	Federal Equivalent Method
FESA	Federal Endangered Species Act
FRA	foredune restoration area
GCD	geomorphic change detection
GIS	geographic information system
$g\ m^{-2}\ d^{-1}$	grams per square meter per day
GPS	global positioning system
GSD	ground sampling distance
HCP	Habitat Conservation Plan
IR	infrared
ITP	Incidental Take Permit
$kg\ m^{-3}$	kilograms per cubic meter
km	kilometer

List of Abbreviations and Acronyms	
Abbreviation or Acronym	**Full Phrase or Description**
LD	landward dune area used in foredune morphological change analysis
m	meter
$m\ s^{-1}$	meters per second
m^2	square meter
$m^3\ m^{-2}$	cubic meters per square meter
$m^3\ m^{-2}\ mo^{-1}$	cubic meters per square meter per month
$mg\ m^{-2}\ s^{-1}$	milligrams per square meter per second
MP	megapixel
NAAQS	National Ambient Air Quality Standard
NDVI	Normalized Difference Vegetation Index
NIR	near-infrared
NOF	North Oso Flaco (foredune)
ODSVRA	Oceano Dunes State Vehicular Recreation Area
OHMVR Division	Off-Highway Motor Vehicle Recreation Division
OHV	off-highway vehicle
P66	Phillips 66
Pan	panchromatic
PE	Plover Exclosure
PI-SWERL	Portable In-Situ Wind Erosion Laboratory
PM	particulate matter
PM_{10}	particulate matter with a diameter of 10 microns or less
PMRP	Particulate Matter Reduction Plan
PPK	post-processing kinematic
PST	Pacific Standard Time
RE	red edge
RGB	red, green, and blue
RH	relative humidity
SAG	Scientific Advisory Group
SfM	Structure-from-Motion
SLOAPCD	San Luis Obispo County Air Pollution Control District
SOA	Stipulated Order of Abatement
SODAR	sonic detection and ranging
State Parks	California Department of Parks and Recreation
SVRA	State Vehicular Recreation Area

List of Abbreviations and Acronyms	
Abbreviation or Acronym	**Full Phrase or Description**
TP	treatment plot
TPM_{10}	Total Hourly PM_{10}
TWPD	Total Wind Power Density
UAS	uncrewed aerial system
UCSB	University of California, Santa Barbara
USEPA	United States Environmental Protection Agency
$W\ m^{-2}$	Watts per square meter
WPD	wind power density

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1 INTRODUCTION

The California Department of Parks and Recreation (State Parks) has prepared this 2024 Annual Report and Work Plan (ARWP) for the Oceano Dunes State Vehicular Recreation Area (ODSVRA) Dust Control Program to comply with the Stipulated Order of Abatement (SOA) approved by the San Luis Obispo County Air Pollution Control District (SLOAPCD) Hearing Board in April 2018 (Case No. 17-01) and amended in November 2019 and October 2022.[1]

State Parks' 2024 ARWP is the sixth document summarizing the status and overall progress of the ODSVRA Dust Control Program in meeting SOA requirements. Each ARWP has applied the best available scientific methods, involving both field data collection and air quality modeling, to prioritize and control emissions of particulate matter with a diameter of 10 microns or less (PM_{10}) from the ODSVRA. Each ARWP has also been prepared in coordination with the SOA Scientific Advisory Group (SAG) and in accordance with SOA requirements; however, the SOA's requirements have changed over time and, accordingly, the contents and information presented in each ARWP have changed over time as well.

State Parks' first four ARWPs (2019 to 2022) were prepared in accordance with the requirements of the original 2018 SOA and the November 2019 SOA amendments, which established two primary compliance targets for the Dust Control Program: 1) a 50% reduction in 24-hour PM_{10} mass emissions, as compared to specific 2013 baseline conditions; and 2) achievement of the state and federal 24-hour PM_{10} ambient air quality standards at SLOAPCD air quality monitoring stations downwind of the ODSVRA.[2] The efforts documented in State Parks' 2019 to 2022 ARWPs significantly reduced PM_{10} emissions from the ODSVRA and substantially improved air quality conditions downwind of the park.

The October 2022 SOA amendments substantially changed the metric against which State Parks measures Dust Control Program progress, replacing the requirement to reduce baseline PM_{10} emissions by 50% and achieve absolute ambient air quality standards with a new requirement "designed to eliminate emissions in excess of naturally occurring emissions from the ODSVRA that contribute to downwind violations of the state and federal PM_{10} air quality standards." While the 2022 SOA amendments changed the approach to evaluating SOA compliance, they did not clearly and fully define "emissions in excess of naturally occurring emissions." State Parks' 2023 ARWP therefore presented initial information on the investigation, development,

[1] The SOA, as amended, is available on the following SLOAPCD website: https://www.slocleanair.org/who/board/hearing-board/actions.php.
[2] State Parks' 2019 to 2023 ARWP documents are available on the following SLOAPCD website: https://www.slocleanair.org/air-quality/oceano-dunes-efforts.

and refinement of the SOA's new excess emissions framework.[3]

This 2024 ARWP builds on the technical groundwork and progress made in the 2023 ARWP by State Parks, the SAG, and the SLOAPCD, providing the first full comprehensive report on progress under the new excess emissions framework established by the 2022 SOA amendments. As explained in more detail in this 2024 ARWP, State Parks is pleased to demonstrate that the substantial progress made in reducing PM_{10} emissions by prior methodologies has been sustained and confirmed by the SOA's new methods, and that the ODSVRA is not presently in a condition of excess emissions. The 2024 ARWP also provides the first opportunity to plan for future work under the new excess emissions framework, with regular monitoring and assessment planned as part of State Parks' overall adaptive management strategy.

The SOA, as amended, establishes specific ARWP content requirements. These requirements generally include a review of dust control progress made over the previous year, a work plan and estimates of progress anticipated to be made for the coming year, and summary budget and schedule information.[4] Accordingly, this 2024 ARWP is organized as follows:

- **Chapter 2, Annual Report (August 1, 2023, to July 31, 2024),** describes Dust Control Program activities implemented in the previous 12 months, including progress made toward SOA goals.
- **Chapter 3, Work Plan (August 1, 2024, to July 31, 2025),** describes the Dust Control Program activities to be undertaken in the coming 12 months, including activities related to the excess emissions compliance framework established by the SOA.
- **Chapter 4, Budgetary Considerations,** describes the estimated budget to develop and implement the 2024/2025 Work Plan.
- **Chapter 5, Implementation Schedule,** presents schedules for the Dust Control Program activities to be initiated, undertaken, and/or completed in the coming 12 months.
- **Attachments 01 – 12** present, in their entirety, important documents that are summarized and/or referenced in this 2024 ARWP. Some of these documents have undergone the scientific review process agreed upon by State Parks and the SAG and,

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[3] The 2023 ARWP was the first ARWP prepared under the October 2022 amendments. The changes to the SOA requirements resulting from the October 2022 amendments were neither minor nor administrative and, therefore, the 2023 ARWP generally focused on identifying the analysis and work products necessary to finalize the new excess emissions framework and the activities that State Parks and the SAG would undertake to develop and refine the new excess emissions framework that forms the basis for sustained implementation of the Dust Control Program.

[4] The specific content to be included in the ARWP and the SAG and SLOAPCD process for reviewing and approving the ARWP are described in the original 2018 SOA, specifically, conditions 4 and 5, as modified by the 2019 SOA amendments (modifications 7 and 8) and 2022 SOA amendments (modification 6).

therefore, the SAG's review of these documents is included with this 2024 ARWP.

This 2024 ARWP has been prepared under the supervision of Ronnie Glick, Senior Environmental Scientist, and Jon O'Brien, Environmental Program Manager, Off-Highway Motor Vehicle Recreation Division (OHMVR Division), whom State Parks has designated as the Project Manager for the Dust Control Program pursuant to the SOA, as amended. State Parks developed the 2024 ARWP in consultation and coordination with the SAG ARWP subcommittee.

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2 ANNUAL REPORT (AUGUST 1, 2023, TO JULY 31, 2024)

This chapter reports on Dust Control Program activities undertaken between August 1, 2023, and July 31, 2024, and the corresponding progress made toward achieving air quality objectives during this time.

As a general overview, the ODSVRA Dust Control Program is a comprehensive, multi-year, adaptive management program designed to reduce saltation and dust generation within the ODSVRA and improve air quality downwind of the ODSVRA.[5] State Parks initiated the program in 2011 as a series of studies and pilot projects. Over time, the program has adapted to become an iterative series of dust control-related activities that are evaluated and modified as necessary to meet the evolving requirements of the SOA. Typical annual Dust Control Program activities include the following:

- **Dust control projects** are control measures that reduce or stop saltation and dust generation at the ODSVRA. These measures may be seasonal, temporary, or permanent in nature.[6] State Parks' report on dust control projects is provided in Section 2.1.
  - Seasonal and temporary projects generally include wind fencing, straw bales and broadcast surface straw treatments, and use of other materials that can sometimes, but not always, be recovered and reused in subsequent dust control projects. State Parks has also excluded motor vehicles from areas (vehicle exclusion areas) and has explored, in a very limited manner in 2014, the use of soil stabilizers as a form of seasonal and/or temporary dust control at the ODSVRA.
  - Permanent dust control consists of vegetation plantings, including foredune, backdune, and supplemental planting efforts (i.e., replanting or maintaining vegetation coverage in previously planted projects).
  - Two related but independent activities that provide dust control benefits are State Parks' long-term closure of the ODSVRA Western Snowy Plover and California Least Tern nesting exclosure and the seasonal closure of certain beach and transportation corridors. These closures, which were done to protect nesting shorebirds, prohibit vehicular and non-vehicular recreation from occurring, which has been shown to reduce saltation and

[5] State Parks and the SLOAPCD have conducted and continue to conduct substantial research to better understand the science of dust emissions, dust controls, and dune restoration at the ODSVRA. While the SAG does not directly conduct research, it does evaluate existing knowledge and assess recent research conducted by State Parks and its third-party contractors. In February 2023, the SAG independently published a comprehensive report (entitled "Oceano Dunes: State of the Science") that defines key terms like saltation and synthesizes information relevant to understanding dust generation and mitigation at the ODSVRA. This report is available on the following SLOAPCD website (under "Winter 2023 Update, State of the Science Final Report"): https://www.slocleanair.org/air-quality/oceano-dunes-efforts.

[6] Seasonal dust control projects are installed for a defined period, usually between March 1 and October 31 of each calendar year. In contrast, temporary projects are installed indefinitely, but not permanently.

dust generation at the ODSVRA. It is noted that State Parks manages the nesting exclosure area for multiple purposes.

- **Field monitoring** collects the data identified by State Parks, the SAG, and the SLOAPCD necessary to support State Parks' adaptive management approach to dust control at the ODSVRA. Field monitoring activities vary by year to meet the specific needs of the Dust Control Program. Not all types of data are collected each year; however, field monitoring generally includes the installation, operation, and/or maintenance of ground and aerial equipment that collects data on one or more of the following: meteorological conditions, PM_{10} concentrations, saltation activity, surface emissivity characteristics, foredune deposition and erosion rates, and vegetation coverage. The data that are collected are verified, evaluated, and used to improve the effectiveness of dust control projects and the performance of the air quality models used to assess Dust Control Program progress. State Parks' report on field monitoring activities is provided in Section 2.2.
- **Air quality modeling** is the method stipulated by the SOA, as amended, for evaluating compliance with the SOA's air quality requirement, which, as of October 2022, is "to eliminate emissions in excess of naturally occurring emissions from the ODSVRA that contribute to downwind violations of the state and federal PM_{10} air quality standards." Air quality modeling is also used, in part, to demonstrate progress in meeting other evaluation metrics developed by State Parks, the SAG, and the SLOAPCD. State Parks' report on air quality modeling activities is provided in Section 2.3.
- **Track-out control** is a program required by the SOA to prevent track-out of sand onto the Grand Avenue and Pier Avenue entrances to the ODSVRA. State Parks' report on track-out control activities is provided in Section 2.3.
- **Other Dust Control Program activities** include actions that State Parks, the SAG, and the SLOAPCD may undertake to support and inform the overall adaptive management approach to dust control at the ODSVRA, such as, but not limited to, the implementation of the ODSVRA public relations campaign and SAG, SLOAPCD, or other entity preparation and/or review of independent studies. State Parks' report on other activities related to the Dust Control Program is provided in Section 2.4.

State Parks notes that while the SOA requires State Parks to report on activities implemented over the previous year by August 1, 2024, this 2024 ARWP reports on activities that were started more than one year ago (i.e., before August 1, 2023) and completed in the past year (i.e., between August 1, 2023, and July 31, 2024). It also reports on activities started in the past year that State Parks, its contractors, and/or the SAG could not complete in time for reporting in this ARWP cycle. This lag in reporting is due to the seasonal nature of data collection efforts and the time involved to process, analyze, interpret, review, and report the data collected for the Dust Control Program.

2.1 REPORT ON DUST CONTROL PROJECTS

From August 1, 2023, to July 31, 2024, State Parks completed the following dust control projects:

- **Converted 37.5 acres of temporary projects to vegetation.**[7] State Parks converted a total of 37.5 acres of temporary wind fencing (32.5 acres) and straw treatment (5.0 acres) projects in the center of the ODSVRA open riding and camping area to vegetation (see Figure 2-1).[8] A total of three temporary projects were converted to vegetation, as follows:
    - Vegetation project 2024-VG-01 (21.7 acres) replaced a wind fencing project originally installed in 2021 (2021-WF-01; see Attachment 01, Figure A01-12).[9]
    - Vegetation project 2024-VG-02 (5.0 acres) replaced the final amount of a straw treatment project originally installed in 2022 (11.8 acres, 2022-ST-02; see Attachment 01, Figure A01-13) and partially converted to vegetation in 2023 (6.0 acres, 2023-VG-02; see Attachment 01, Figure A01-14).
    - Vegetation project 2024-VG-03 (10.8 acres) replaced a wind fencing project originally installed in 2021 (2021-WF-02; see Attachment 01, Figure A01-12).

State Parks planted a total of 116,112 plants and spread a total of 533 pounds of native dune seed and 2,025 pounds of sterile seed in the above vegetation conversion projects. Refer to Attachment 02 for information on the species list, number of seedlings planted, and pounds of seed applied for each conversion project.

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[7] As recommended by the SAG, the main body of this ARWP and Attachment 01 to this ARWP report the size of dust control projects to the nearest tenth of an acre, with acreage values rounded up (values 0.05 and above) or down (values below 0.05) to the nearest tenth of an acre as necessary.

[8] State Parks has implemented dust control projects at the ODSVRA since 2011. The "Dust Control Program ID" shown in Figure 2-1 represents the chronological order of dust control projects, beginning with the first straw treatment project in 2011 (ID #01) and concluding with the final vegetation project in 2024 (ID # 69). For projects installed in the same dust control year (defined as August 1 of one year to July 31 of the next year), projects are numbered from north to south. In some instances, temporary projects have been converted to vegetation, resulting in two distinct projects in the same geographic area. Thus, while State Parks has implemented 69 different projects over time, only 40 projects are active as of July 31, 2024. Refer to Attachment 01 for annual maps of individual dust control projects and dust control project areas.

[9] The "Project ID" shown in Figure 2-1 identifies the year the project was undertaken, the type of project it was, and how many of the same type of project were installed in the dust control year (defined as August 1 of one year to July 31 of the next year). Projects are defined as straw treatment (ST), wind fencing (WF), "temporary vehicle exclusion (TV), and vegetation (VG). For example, "2024-VG-03" is the third vegetation project installed in the 2024 dust control year.

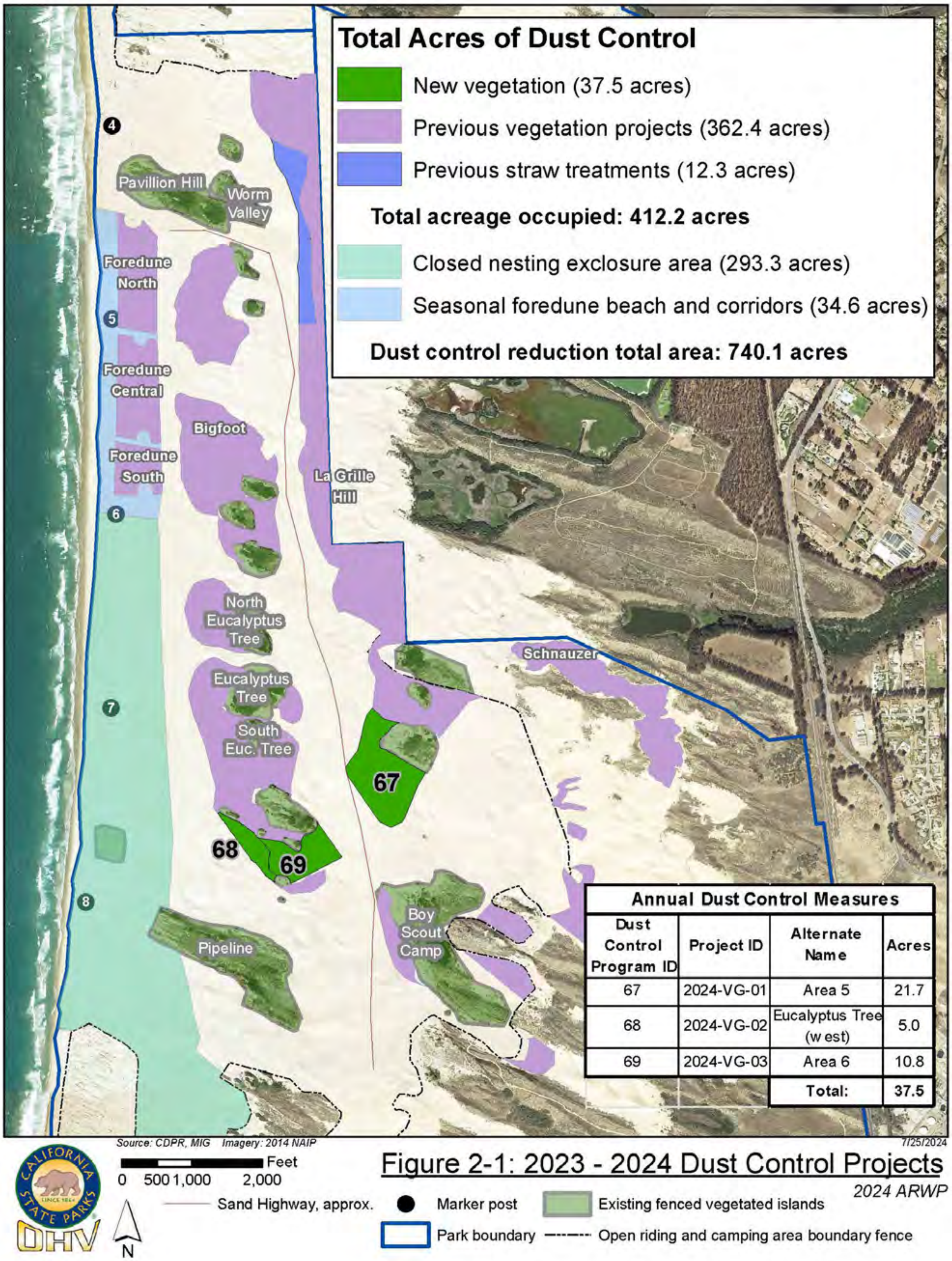

Figure 2-1: 2023 - 2024 Dust Control Projects

2024 ARWP

- **Conducted supplemental vegetation plantings.** Supplemental planting and seeding activities often focus on the west-facing portions of vegetation installations where direct wind and sand activity bury or otherwise compromise treatments. During the 2023-2024 reporting period, State Parks planted 7,110 plants and spread approximately 27.5 pounds of native dune seed and 125 pounds of sterile seed in one 2.4-acre area near the center of the ODSVRA open riding and camping area that was originally planted with vegetation (2022-VG-10; see Figure 2-2 and Attachment 01, Figure A01-13). Refer to Attachment 02 for information on the species list, number of seedlings planted, and pounds of seed applied for each supplemental planting project.
- **Maintained 12.3 acres of existing temporary dust control projects.** State Parks maintained 12.3 acres of existing straw treatments originally installed in 2022 in the northeast corner of the ODSVRA open riding and camping area (2022-ST-01; see Figure 2-2 and Attachment 01, Figure A01-13).
- **Seasonally closed 34.6 acres of foredune beach and transportation corridor areas.** State Parks' installation of a 48-acre foredune at the end of 2019 resulted in a narrow beach area to the west of the foredune project and transportation corridors in between different foredune treatment areas, as well as a small corridor to the south of the foredune project, neighboring the nesting exclosure (see Figure 2-1), that are subject to Western Snowy Plover and California Least Tern nesting activity during the breeding season. Consistent with management activities since 2020, State Parks installed seasonal fencing around these areas to protect potential nest sites. In total, State Parks seasonally closed 34.6 acres for approximately seven months from March 1, 2023, to September 30, 2023. The foredune beach and corridor areas were again seasonally closed on March 1, 2024.
- **Continued the closure of the Western Snowy Plover nesting exclosure.** In October 2021, State Parks closed the 293.3-acre[10] nesting exclosure area to vehicular and non-vehicular recreation.[11] Since then, State Parks has maintained the closed status of this area, installing and maintaining perimeter fencing as necessary.

As of July 31, 2024, State Parks actively manages and maintains 40 different dust control

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[10] The size of the nesting exclosure fluctuates annually with changes in sand topography and fencing installation. In 2023, the nesting exclosure (including the area above the high tide line on the closed shoreline) was approximately 298 acres, as compared to an average of 294 acres for the 19-year period 2004 to 2022, and a range of 271 to 307 acres over the same time. For the purposes of the ODSVRA Dust Control Program, the size of the nesting exclosure is consistently reported as 293.3 acres, which was the size of the nesting exclosure when dust control benefit was first credited to this area.

[11] The decision to close this area was an operational choice. If State Parks elects to reopen this area in the future, State Parks would, in coordination with the SAG and the SLOAPCD, simultaneously identify and implement dust control projects in other areas that equal the credited mass emissions reductions from the nesting exclosure.

projects.[12] In total, these 40 dust control projects, plus the closed nesting exclosure area and seasonally closed foredune beach and transportation corridor areas, occupy 740.1 acres of land at the ODSVRA. The ODSVRA's dust control projects are summarized in Table 2-1 and shown in Figure 2-2. Refer to Attachment 01 for additional maps showing historical dust control project locations and all dust control projects in place as of July 31, 2024.

Table 2-1. Cumulative Dust Control Projects Installed as of July 31, 2024

Type of Dust Control Project	**Number of Projects(A)**	**Acres Controlled by Dust Control Projects**		
		Inside Open Riding and Camping Area	**Outside Open Riding and Camping Area**	**ODSVRA Total**
Vegetation				
Foredune	3	48.0	0.0	48.0
Backdune	36	276.0	75.9	351.9
Subtotal	*39*	*324.0*	*75.9*	*399.9*
Seasonal and/or Temporary Project				
Straw treatment	1	12.3	0.0	12.3
Wind fencing	0	0.0	0.0	0.0
Temporary vehicle exclosure	0	0.0	0.0	0.0
Other(B)	0	0.0	0.0	0.0
Subtotal	*1*	*12.3*	*0.0*	*12.3*
Other Operational Activity				
Closed nesting exclosure area	-	293.3	0.0	293.3
Seasonally closed foredune beach and corridor area	-	34.6	0.0	34.6
Subtotal	-	*327.9*	*0.0*	*327.9*
Totals(C)	**40**	**664.2**	**75.9**	**740.1**

(A) Value reflects the number of projects in the ground as of July 31, 2024, and does not consider planned activities described in Chapter 3 of this ARWP.
(B) "Other" refers to porous roughness elements, soil stabilizers, or other types of dust control projects.
(C) Without the closed nesting exclosure and seasonally closed foredune beach and corridor area, there are 336.3 acres of dust control inside the open riding and camping area and 412.2 total acres of dust control at the ODSVRA.

[12] While State Parks has implemented 69 different dust control projects over time, only 40 projects are active and in the ground as of July 31, 2024. Refer to footnotes 8 and 9 for additional details on State Parks' system for identifying dust control projects implemented over time.

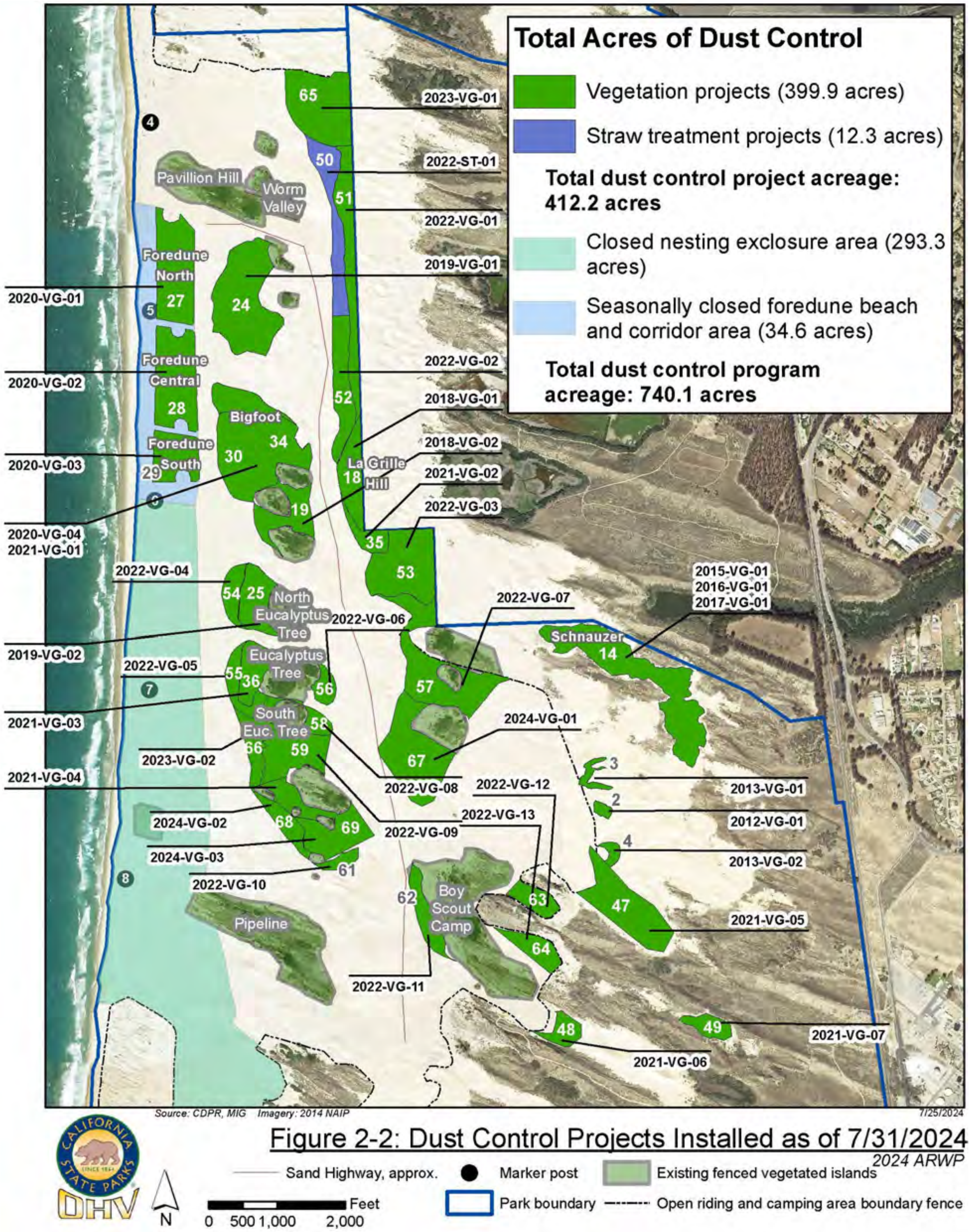

Figure 2-2: Dust Control Projects Installed as of 7/31/2024

2024 ARWP

2.2 REPORT ON FIELD MONITORING

State Parks and the SLOAPCD have collected data on the conditions that lead to dust generation at the ODSVRA for almost two decades, with more recent efforts undertaken in coordination with the SAG. State Parks' field monitoring activities support the scientific investigation and adaptive management of dust control at the ODSVRA, provide context and in-situ observations vital to assessing individual dust control project effectiveness and air quality model performance, and support the evaluation of overall Dust Control Program success. Some monitoring activities, such as data collection at State Parks' S1 meteorological tower (see Figure 2-3), have been occurring near-continuously for more than a decade or are repeated annually to provide a record of the change in conditions at the ODSVRA. Other monitoring activities are seasonal or temporary in nature and may address more specific data needs identified by State Parks, the SAG, and the SLOAPCD. In general, State Parks' field monitoring activities include the following:

- **Meteorological monitoring** to measure wind speed, wind direction, temperature, and humidity throughout the ODSVRA. Meteorological monitoring coupled with PM_{10} monitoring provides important information on the dispersion characteristics of PM_{10} through the ODSVRA.
- **PM_{10} monitoring** to measure PM_{10} concentrations in the air. State Parks' PM_{10} monitoring is conducted primarily within the ODSVRA using instruments that go through rigorous installation procedures and data validation processes. The SLOAPCD also conducts PM_{10} monitoring in accordance with state and federal Clean Air Act requirements downwind of the ODSVRA. The measurements of actual airborne PM_{10} concentrations are used to calibrate, verify, and improve confidence in required SOA modeling methodologies. The measurement of changes in PM_{10} concentrations over time also provides empirical evidence for Dust Control Program progress.
- **Saltation monitoring** to physically collect and/or count the movement of sand particles throughout the ODSVRA under different wind conditions. These instruments help determine when the wind is strong enough to cause sand particles to start to move, initiating the dust generation process. Saltation begins when the strength of the wind exceeds a critical value referred to as the threshold wind speed.
- **Portable In-Situ Wind Erosion Laboratory (PI-SWERL) monitoring** to measure the potential amount of PM_{10} emissions that can be generated throughout the ODSVRA under different wind shear conditions. This is often referred to as sand surface "emissivity" and has been a critical parameter in air quality modeling stipulated by the SOA.
- **Dune morphology and vegetation change monitoring** to measure changes in sediment deposition and erosion within the 48-acre foredune restoration area (FRA) and changes in

vegetation coverage in the FRA, as well as backdune areas of the ODSVRA.[13] This monitoring is accomplished via uncrewed aerial system (UAS) surveys (i.e., drone surveys), photographic surveys, and human surveys. Dune morphology and vegetation change monitoring is used to assess the performance of different vegetation projects at the ODSVRA.

State Parks' report on field monitoring activities conducted during the reporting period is provided below.

2.2.1 METEOROLOGICAL AND PM_{10} MONITORING

State Parks' meteorological and PM_{10} monitoring network varies slightly from year to year depending on the specific goals, objectives, and dust control projects identified in each ARWP cycle. From approximately April 1, 2023, to September 30, 2023, State Parks maintained the meteorological and PM_{10} monitoring network shown in Figure 2-3, consisting of 15 operational sites located throughout and downwind of the ODSVRA.[14] The network has been in operation since 2020, but prior to 2021 the number of stations was smaller and in 2020 there were COVID-19-related restrictions on off-highway vehicle (OHV) activity from March to September. The period of record with a full complement of stations and active OHV activity is restricted to 2021 through 2023. The network is again in operation in 2024. A summary of the results from the monitoring network is provided below and the full report (Gillies and Nikolich, 2024)[15] is provided in Attachment 03.

Each station has a MetSens500 (Campbell Scientific, Logan, UT) instrument that measures wind speed and wind direction (ultrasonically), ambient temperature, atmospheric pressure, and relative humidity (RH), and a MetOne 212 (MetOne, Grants Pass, OR) particle profiler to measure PM_{10}. Stations on open sand areas also have Sensit saltation sensors (BBQ, Lagrande, Camping, Shoreline, Windfence, Acacia, Cottonwood, Tabletop, Pipeline, and Scout; see Figure 2-3). The MetOne instrument is calibrated against a Beta Attenuation Mass (BAM) PM_{10} monitor in a dust chamber prior to deployment and after removal from the field in October.[16]

[13] The 48-acre FRA consists of dust control projects 2020-VG-01, 2020-VG-02, and 2020-VG-03 (see Figure 2-2). "Backdune areas" generally refers to the dunes east of the 48-acre FRA. As shown in Table 2-1, all dust control projects except the three projects associated with the FRA are located in backdune areas.
[14] The Northern Dune Preserve/Moymell station was not operational in 2023.
[15] Gillies, J.A., and G. Nikolich, 2024. Report of Findings: ODSVRA Meteorological and PM_{10} Monitoring Network, 2023. Prepared for State Parks and the SAG. February 15, 2024.
[16] MetOne particle profiler PM_{10} concentrations are derived from environmentally controlled and field-calibrated relations between particle count data collected by the MetOne instrument and mass-based PM_{10} concentration data collected by a United States Environmental Protection Agency (USEPA) Federal Equivalent Method (FEM) BAM PM_{10} monitor. Refer to State Parks' 2021 ARWP, Attachment 06, for detailed MetOne particle profiler PM_{10} calibration procedures.

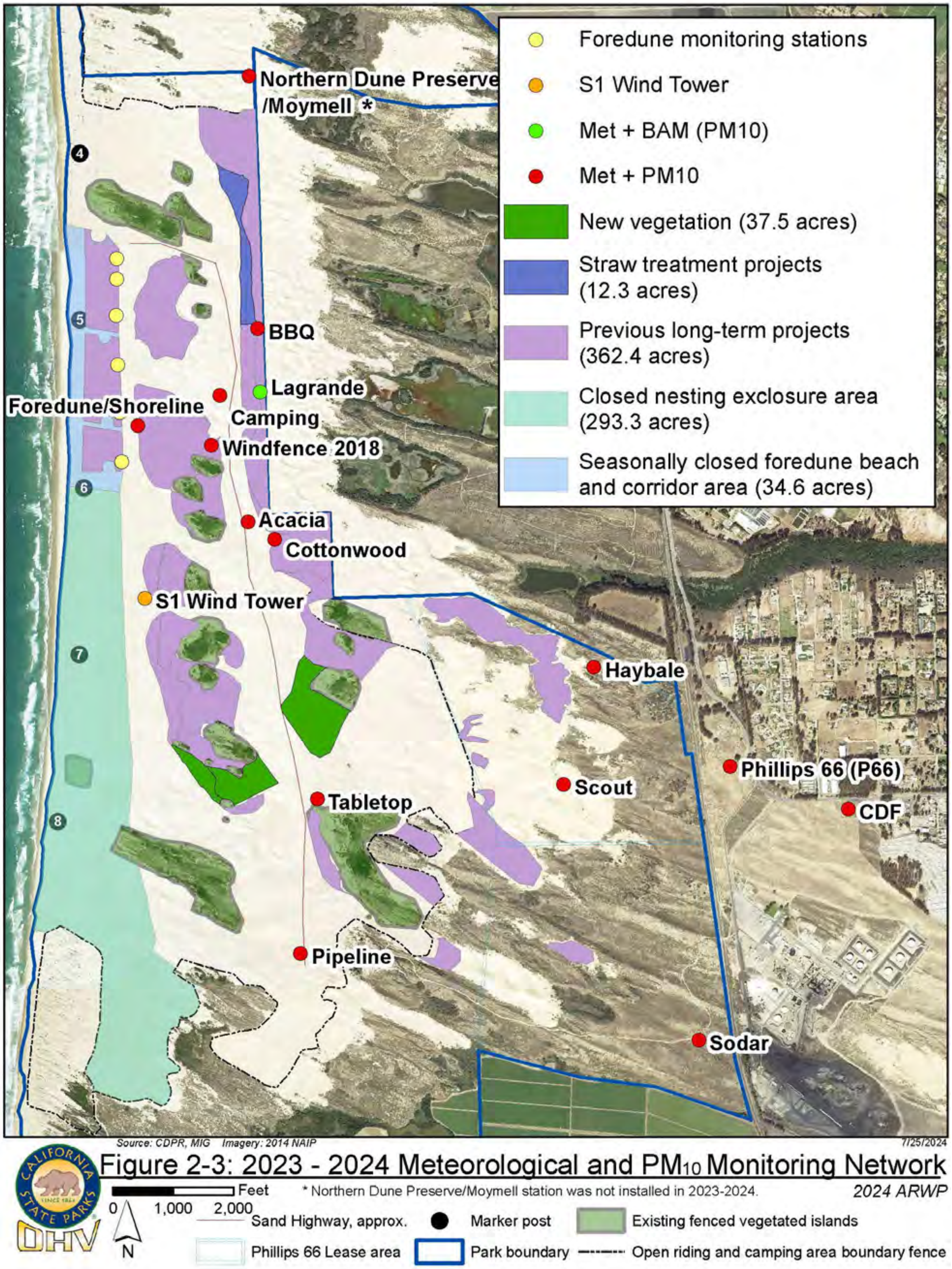

Figure 2-3: 2023 - 2024 Meteorological and PM_{10} Monitoring Network

The environmental data collected by these stations provide a means to examine spatial trends in PM_{10} concentrations (in micrograms per cubic meter, or µg m^{-3}) across the ODSVRA in relation to wind speed (in meters per second, or m s^{-1}) and wind power density (WPD, in Watts per square meter, or W m^{-2}), and to evaluate if these relations have changed through time.

WPD (in W m^{-2}) is defined as:[17]

$$WPD = 0.5\, \rho_a\, u_z^3$$

Where:

ρ_a = Air density at sea level (1.212 kilograms per cubic meter [kg m^{-3}], and assumed constant)

u_z = Wind speed (m s^{-1}) at measurement height z (in meters [m]) above ground level (AGL)

For comparison among different locations and between different years, the height of measurement of wind speed and the lower limit of mean hourly wind speed for summation of Total Wind Power Density (TWPD) must be the same. To standardize the calculation of TWPD, a lower limit of wind speed is chosen that corresponds with the lowest speed where the relation between increasing wind speed and simultaneous increase in PM_{10} is observed at a monitoring station. For the in-park stations, this wind speed is chosen to be 5.5 m s^{-1} measured at 3.5 m AGL (see Attachment 03). The TWPD by month for the period April to September in 2021 through 2023 for the in-park and out-of-park monitoring stations[18] indicates that in this period greater TWPD values are observed in the months of April, May, and June as compared with the summer months of July, August, and September (see Attachment 03).

Along the north-south dimension of the network, higher mean hourly PM_{10} concentrations are observed in the north (BBQ) compared to the south (Pipeline) for lower wind speeds. In 2023, the mean hourly PM_{10} concentration range at the BBQ station was 324 µg m^{-3} (±122 µg m^{-3}) to 861 µg m^{-3} (±485 µg m^{-3}), for the wind speed range 8.5 m s^{-1} to 10.5 m s^{-1}, respectively, while at the southern-most station, Pipeline, the PM_{10} concentration range was 83 µg m^{-3} (±24 µg m^{-3}) to 411 µg m^{-3} (±110 µg m^{-3}), for the wind speed range 8.5 m s^{-1} to 13.5 m s^{-1} (note there was only one PM_{10} reading for the mean hourly wind speed 14.5 m s^{-1}). The observations of wind and PM_{10} support previous reporting[19] that wind speed increases from north to south and

[17] Kalmikov, A., 2017. Wind power fundamentals. In Wind Power Engineering, ed. T.M. Letcher. Elsevier Science Publishing Co., Incorporated.

[18] The Desert Research Institute (DRI) analysis uses "in-park" and "out-of-park" descriptors for the PM_{10} monitoring network. In 2023, in-park stations included (see Figure 2-3) BBQ, Camping, Lagrande, Shoreline, Windfence, Acacia, Cottonwood, Tabletop, Scout, and Pipeline. All of the in-park stations are located within the ODSVRA open riding and camping area except Scout. Out-of-park stations included (see Figure 2-3) Haybale, Phillips 66 (P66), CDF, and Sodar. The Haybale and Sodar stations are located outside the ODSVARA's open riding and camping area but within the ODSVRA boundary. P66 and CDF are located outside the ODSVRA boundary.

[19] Gillies, J.A., and V. Etyemezian, 2014. Wind and PM_{10} Characteristics at the ODSVRA from the 2013 Assessment Monitoring Network. Prepared for State Parks. January 14, 2014.

emissivity of PM_{10} from the sand surfaces.[20,21,22] The change in the ratio of Total Hourly PM_{10} (TPM_{10}) to TWPD for the in-park and out-of-park stations for available data from April to September 2021 through 2023 is shown in Figure 2-4.

As shown in Figure 2-4, for the period April to September 2022 and April to September 2023, the mean seasonal TPM_{10}/TWPD ratio for the in-park stations is variable as a function of position. The stations with the greatest TPM_{10}/TWPD ratio have consistently been the three northern stations BBQ, Camping, and Lagrande, as well as Acacia. These stations are all on the downwind side of the “sand highway” route (see Figure 2-3) that is consistently used by OHV riders to access the ODSVRA riding areas. The in-park stations shown in Figure 2-4 are ordered north to south and show that the TPM_{10}/TWPD ratio decreases toward the south, suggesting again that the emissivity of the sand is lower, producing lower concentrations of PM_{10} for similar levels of WPD compared to the northern stations.

The out-of-park stations (Haybale, P66, SODAR[23], and CDF) also show variability in the TPM_{10}/TWPD ratio across the three-year record. CDF registers the highest TPM_{10}/TWPD ratio as it has the lowest TWPD values on a monthly basis, but still has PM_{10} concentration levels similar to the monitoring stations farther to the west that experience higher wind speeds.

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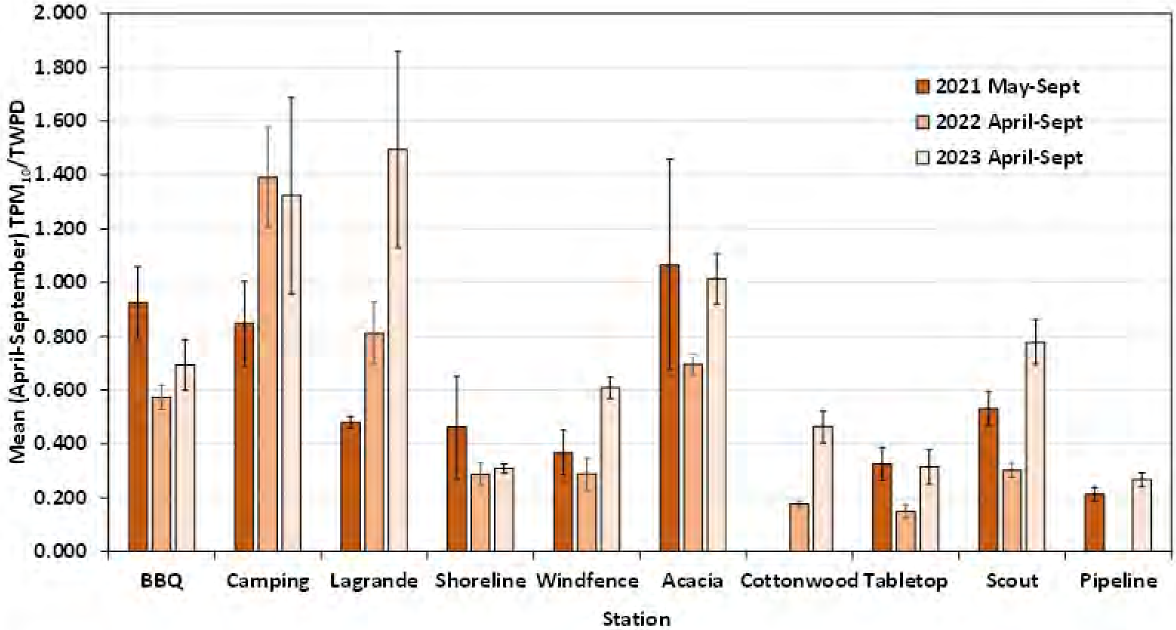
[20] Etyemezian, V., J.A. Gillies, D. Zhu, A. Pokharel, and G. Nikolich, 2014. 2013 Intensive Wind Erodibility measurements at and Near the Oceano Dunes State Vehicular Recreation Area. Prepared for State Parks. July 8, 2014.

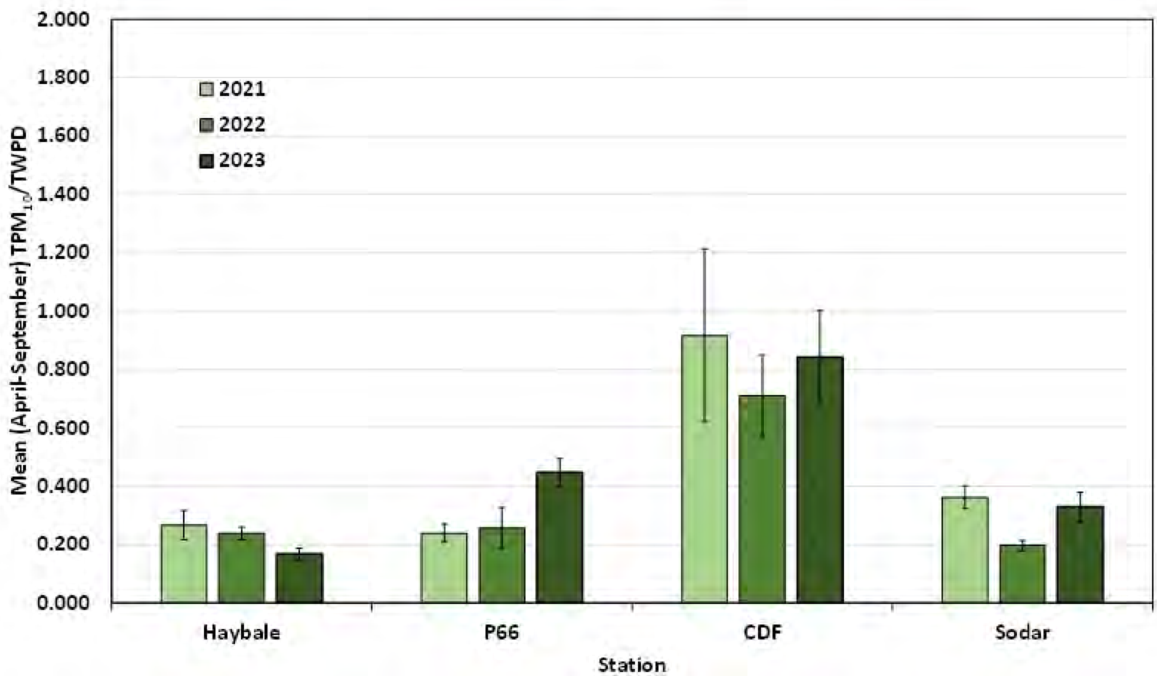
[21] Gillies, J.A., and V. Etyemezian, 2014. Addendum to the PI-SWERL Report of Etyemezian et al., 2014. Particle Size Distribution Characteristics and PI-SWERL™ PM_{10} Emission Measurements: Oceano Dunes State Vehicular Recreation Area. Prepared for State Parks. February 3, 2015.

[22] The SAG’s December 19, 2023, memo “SAG Recommendations for Establishing Emissivity Grids to be used in Modeling of Pre-Disturbance Conditions and Future Excess Emissions Reductions” is included as Attachment 08 to this ARWP.

[23] SODAR stands for sonic detection and ranging. This monitoring site formerly included a SODAR instrument. The instrument was installed in May 2019 and removed from operation in February 2023.

Figure 2-4. Comparison of Mean Ratio of TPM_{10}/TWPD for April to September, 2021 to 2023, for In-Park and Out-of-Park Monitoring



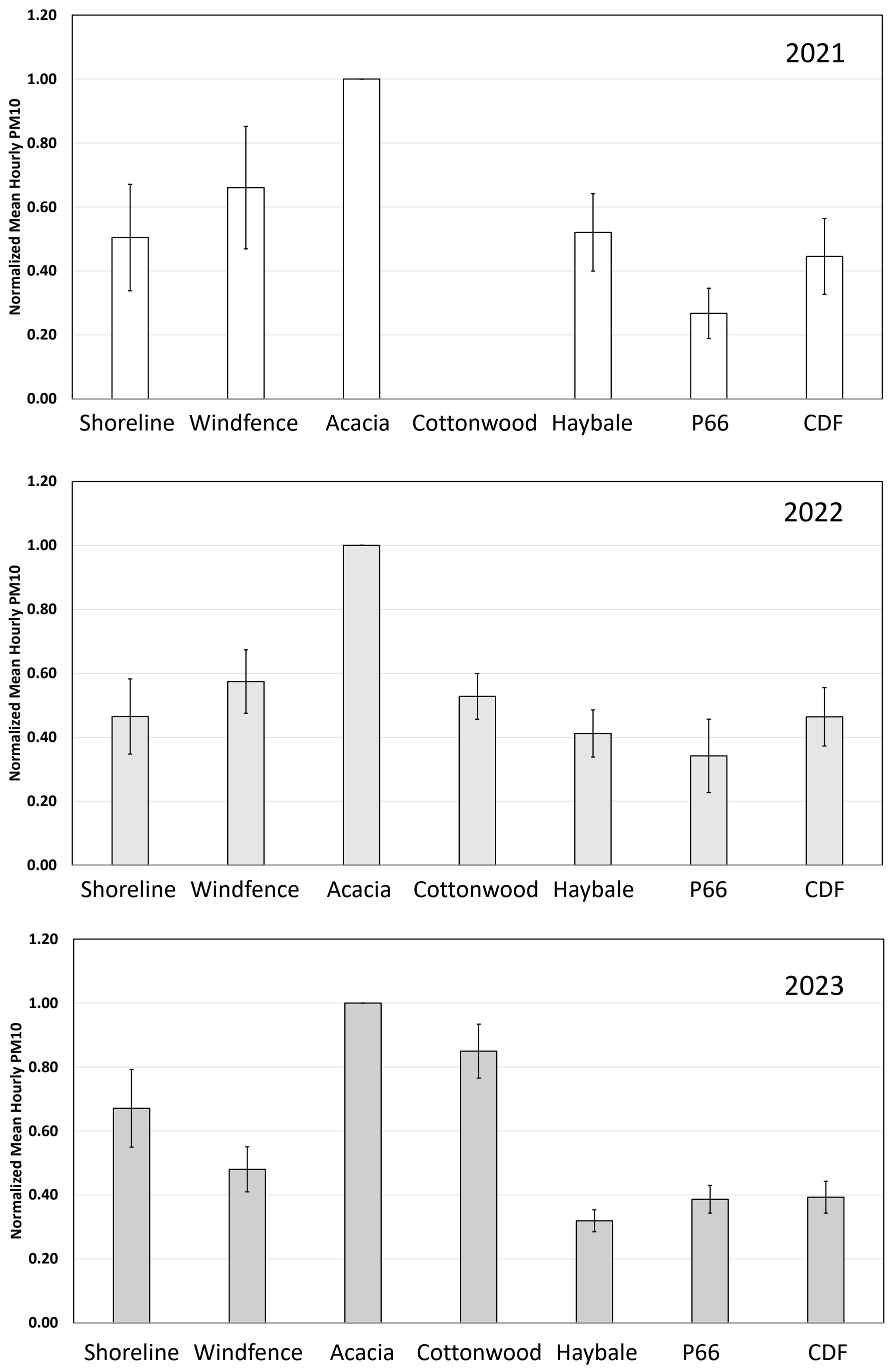


The monthly TPM_{10}/TWPD ratio (based on the summation of mean hourly data) for the in-park stations (top panel) and the out-of-park stations (bottom panel). The values represent the mean ratio based on the six (individual) monthly ratio values. The error bar represents the standard deviation of the mean value.

State Parks' meteorological and PM_{10} network station data also provide a means to examine longitudinal and latitudinal trends in PM_{10} as well as changes upwind and in the lee of vegetation islands. The stations Shoreline, Windfence, Acacia, Cottonwood, Haybale, P66, and CDF define a west-to-east transect approximately 4.2 kilometers (km) long at an azimuth of approximately 300°. The spatial trend in normalized mean hourly PM_{10} concentration for the six-month period from April to September along this transect for wind in the directional range 246° to 326° and when hourly wind speed measured at the Shoreline station was greater than or equal to (≥) 5.5 m s^{-1} (same as lower limit of wind speed for defining TPM_{10}/TWPD ratio) is shown in Figure 2-5 for 2021, 2022, and 2023 for each of these stations. Note that the PM_{10} has been normalized by dividing the mean hourly PM_{10} concentration at a station by the mean hourly PM_{10} concentration at the Acacia station, which consistently had the greatest PM_{10} concentrations along this west-to-east transect. The pattern of high PM_{10} values in the riding area of the ODSVRA, as typified by the Shoreline, Windfence, Acacia, and Cottonwood stations, followed by a noticeable decrease beginning at the Haybale station is observed across the three years. Upwind of Acacia the normalized mean hourly values for the Shoreline and Windfence stations are lower, and downwind of Acacia there is a decrease at Cottonwood, and then a more significant decrease in the normalized mean hourly PM_{10} values for the out-of-park stations that are not located on emissive surfaces. These stations, i.e., Haybale, P66, and CDF, are in the zone where dispersion and deposition dominate the transport process affecting the concentration of PM_{10}.

Three of the network stations, Shoreline, Windfence, and Camping (see Figure 2-3), are positioned to examine the effect of a large area of vegetation on the concentration of PM_{10} in an upwind-downwind configuration (Shoreline and Windfence) and in the absence of vegetation for an approximately equivalent length of fetch, i.e., the distances from the shore to Windfence and Camping are approximately equal. The dust control project/revegetation area identified as Bigfoot (see Figure 2-2), which has the Shoreline station on the west and Windfence station on the east (see Figure 2-3), was initiated in 2019. The mean hourly PM_{10} concentrations at these stations for a constrained wind direction range of 284° to 300° and for wind speed ≥5.5 m s^{-1}, for a period of overlapping time (April to July), were used to determine if the effect of vegetation on PM_{10} concentrations could be demonstrated.

Figure 2-5. Comparison of Normalized Mean Hourly PM_{10} Concentrations Along a 4.2-Kilometer West-to-East Transect

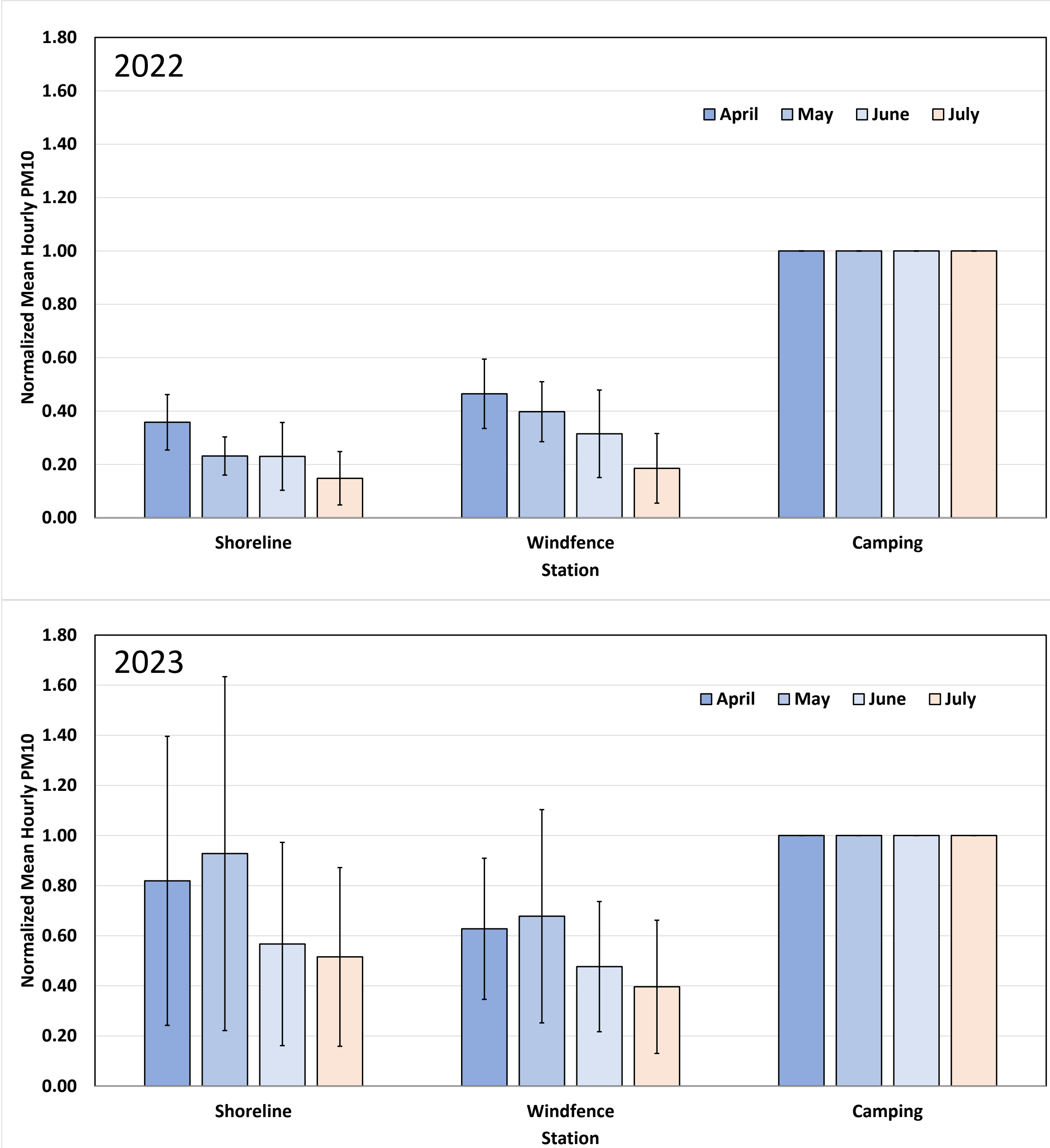


Normalized (by Acacia) mean hourly PM_{10} concentration for wind in the directional range 246° to 326° and when wind speed measured at the Shoreline station was ≥5.5 m s^{-1}, for the combined period of April to September 2021, 2022, and 2023. The values represent the mean for all the hours that meet the data filter criteria for wind speed and wind direction. The error bar represents the standard deviation of the mean value.

If the hourly mean PM_{10} concentrations (for matching hours following application of the wind speed and direction filters) for Shoreline and Windfence are normalized by dividing by the PM_{10} concentrations at the Camping station, the change in concentration across the Bigfoot dust control area can be compared for the period April to July for 2022 and 2023 (see Figure 2-6).[24] This analysis suggests that between 2022 and 2023 the mean hourly concentrations of PM_{10} for the given wind speed and wind direction constraints have become lower at the Windfence station than at the Shoreline station. The variability in the mean monthly values is significant (standard deviations of the mean values are shown as error bars in Figure 2-6), and it cannot be definitively stated that this effect is due to the maturation of the vegetation dust control; however, Figure 2-5 shows that for a wider range of wind direction and for PM_{10} concentrations normalized to the Acacia station, Windfence was lower than the Shoreline mean value in 2023. In previous years, Windfence had greater mean values than Shoreline. This comparison of PM_{10} concentrations among these three stations can be continued for 2024 to determine if the mean hourly PM_{10} values at Windfence continue to show lower values than Shoreline when compared with Camping. A continued decrease in normalized mean hourly PM_{10} at Windfence compared with Shoreline could signal the increasing effectiveness of the Bigfoot revegetation dust control area as the vegetation matures (i.e., increases in areal coverage and plant height) to influence the PM_{10} emitted upwind of Shoreline.

[24] There were limited data available with these constraints applied for 2021, which did not allow for further analysis.

Figure 2-6. Comparison of Normalized Mean Hourly PM_{10} Concentrations Upwind and Downwind of Areas With and Without Vegetation



Normalized (by values at Camping) mean hourly PM_{10} concentration for wind in the directional range 284° to 300° and when wind speed measured at the Shoreline station is ≥5.5 m s^{-1}, for the combined period April to July 2022 and 2023. The Windfence station is immediately downwind of an area with vegetation, and the Shoreline station is west of Windfence and upwind of the vegetation but downwind of the FRA. The Camping station is downwind of an area without vegetation.

In summary, the 2023 wind speed and WPD data (Figure 2-4) show that for the north-south distance covered by the network (BBQ to Pipeline) the wind speed was higher in the south than the north, which corroborates what has previously been reported and indicates that this pattern has endured since monitoring was initiated. The data show that the PM_{10} concentrations for the same WPD are higher in the northern stations (BBQ, Lagrande, and Acacia), indicating that the emissivity of the sand surfaces upwind of these stations remains high in relation to the other stations and is still a rich source area for PM_{10} emissions. The high PM_{10} concentrations and emissivity in this area may be due to the presence of the "sand highway," which remains a high use area for OHVs. The gradient of decreasing emissivity from north to south has also been observed in the PI-SWERL data (see Section 2.2.4). The 2023 TPM_{10}/TWPD data indicate that this pattern has endured since monitoring was initiated.

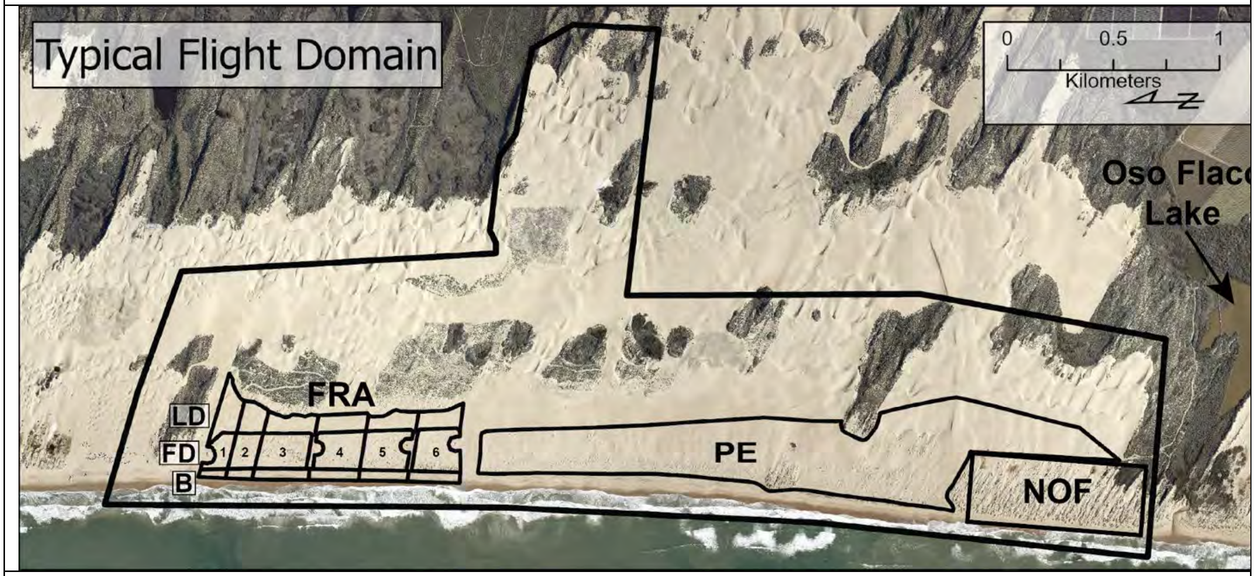
Data from the monitoring network stations show that the concentration gradient of PM_{10} along an approximately 4.2-km-long west-to-east transect (Shoreline to CDF) shows a consistent peak concentration occurring at the Acacia station (see Figure 2-5). This peak likely reflects the greater emissivity of the sand in this area that is highly influenced by the "sand highway." The concentration of PM_{10} diminishes by, on average, 63% (±5%) for the Haybale, P66, and CDF stations, which are farther east of the open sand areas of the riding and non-riding areas of the ODSVRA, as compared to the Acacia station.

2.2.2 Uncrewed Aerial System (UAS) Surveys

Since 2019, a crew from the University of California, Santa Barbara (UCSB) (and formerly Arizona State University [ASU]) has flown a fixed-wing, fully autonomous WingtraOne UAS (or drone) with high resolution visual (red, green, and blue [RGB]) and multispectral cameras to map geomorphic and vegetation changes across the ODSVRA. The focus for the analyses of the UAS monitoring has been primarily on the FRA plots and adjoining beach and backdune areas. The typical extent of the UAS mapping domain is shown in Figure 2-7 and includes most of the open riding and camping area of the ODSVRA as well as the Western Snowy Plover nesting exclosure (Plover Exclosure, or PE) and the North Oso Flaco (NOF) foredune reference site.

To date, 10 UAS mapping campaigns have been conducted dating back to October 2019, just prior to implementation of the restoration treatments in February 2020 (see Table 2-2). Initially, only RGB imagery was captured until October 2020 (following the first plant growth season) when both RGB and multispectral imagery (used to map vegetation) was also flown concurrently, resulting in eight multispectral datasets to date. UAS flights occur biannually in October and February, as constrained by the nesting season for Western Snowy Plover (March through September), during which State Parks does not permit UAS flights. This timing also roughly brackets the plant growth and sand-transporting wind seasons.

Figure 2-7. UAS Mapping Domain



Map showing the typical extent of the UAS surveys (north oriented to the left). The FRA and foredune (FD) treatment plots (TP) 1-6 are shown with adjoining beach (B) and landward dune (LD) polygons for examining volumetric exchanges with the FRA. The Western Snowy Plover exclosure (PE, as of February 2024) and North Oso Flaco (NOF) reference site are also shown. The underlying orthomosaic is from January 27, 2023.[25]

Table 2-2. UAS Survey Campaign Specifications

UAS Survey Campaign	Survey Date	Sensor Payload	Average Altitude (m)	Ground Sampling Distance (GSD, centimeters per pixel)	Total Uncertainty (m)
1. Baseline pre-restoration survey	October 1-2, 2019	Sony RX1RII	114	1.45	0.038
2. Initial treatment installations	February 10-11, 2020	Sony RX1RII	123	1.56	0.033
3. First post-treatment survey and growing season	October 13-15, 2020	Sony RX1RII	121	1.54	0.037
	October 16, 2020	Micasense RedEdge-MX	113	7.53	—

[25] National Geodetic Survey, 2024. 2023 NOAA NGS Aerial Imagery for Situational Awareness: Central California. https://www.fisheries.noaa.gov/inport/item/69185.

Table 2-2. UAS Survey Campaign Specifications					
UAS Survey Campaign	**Survey Date**	**Sensor Payload**	**Average Altitude (m)**	**Ground Sampling Distance (GSD, centimeters per pixel)**	**Total Uncertainty (m)**
4. End of first year of geomorphic response and vegetation growth	February 17-18, 2021	Sony RX1RII	120	1.52	0.030
	February 18-21, 2021	Micasense RedEdge-MX	118	7.89	—
5. Second growing season	October 4-5, 2021	Sony RX1RII	121	1.54	0.025
	October 5-7, 2021	Micasense RedEdge-MX	119	7.82	—
6. End of second year of geomorphic response and vegetation growth	February 23-25, 2022	Sony RX1RII	112	1.42	0.043
	February 25-26, 2022	Micasense RedEdge-MX	116	7.71	—
7. Third growing season	October 17-18, 2022	Sony RX1RII	125	1.66	0.026
	October 19-21, 2022	Micasense RedEdge-P	111	3.67	—
8. End of third year of geomorphic response and vegetation growth	February 23, 2023	Sony RX1RII	121	1.59	0.034
	February 20-21, 2023	Micasense RedEdge-P	120	3.97	—
9. Fourth growing season	October 9, 2023	Sony RGB61	108	1.65	0.049
	October 10-13 2023	Micasense RedEdge-P	135	4.42	—
10. End of fourth year of geomorphic response and vegetation growth	February 23, 2024	Sony RGB61	116	1.78	0.071
	February 21-23, 2024	Micasense RedEdge-P	133	4.38	—

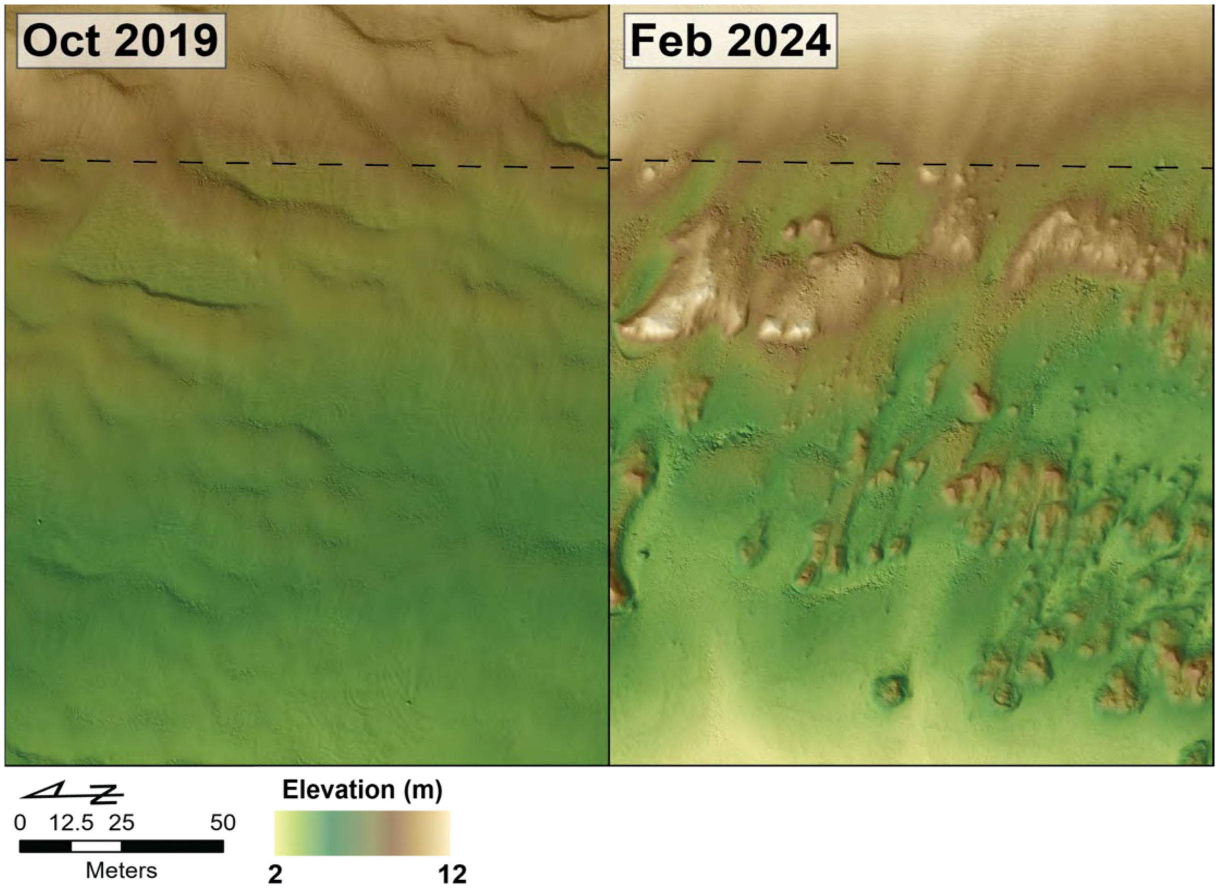
Specifications for the RGB and multispectral UAS campaigns. Multispectral sensors were only used after installation of the vegetation treatments in February 2020. GSD is the distance between the center of adjacent pixels and describes the cell size of each pixel in centimeters (i.e., pixel resolution). Total Uncertainty values are the calculated vertical uncertainty for datasets used in digital terrain model (DTM) development and volumetric change detection mapping. As the multispectral datasets were not used for this purpose, no uncertainty value is shown.

The UAS is typically flown at altitudes over 100 m AGL, as controlled by flight planning software, and is equipped with an on board, survey-grade global positioning system (GPS) with post-processing kinematic (PPK) correction capabilities. During data collection, a GPS base station is operated in static collection mode and these occupation datasets are used to refine UAS photo point locations to within millimeters of their real-world location.

Two different sensor payloads are flown with the UAS to map terrain and vegetation – a visual (RGB) camera and a multispectral camera that includes RGB, plus red edge (RE) and near-infrared (NIR) bands that are used to map vegetation. Over time, due to wear and replacement, different models of sensors have been used. For RGB, a Sony RX1RII 42 megapixel (MP) full-frame camera was used from October 2019 to February 2023, and a Sony RGB61 61 MP full-frame sensor was used since October 2023. Both RGB cameras capture a single image per photo point at a high resolution (less than [<] 2 centimeters [cm]). These images can be stitched together using Structure-from-Motion (SfM) software (Agisoft Metashape) to create an orthophoto mosaic (a single orthorectified, georeferenced image of the entire area of interest), as shown in Figure 2-7.

DTMs of the land surface are also created from the high-resolution RGB imagery using SfM software. This process requires that individual UAS images be captured with high overlap (70% frontlap and sidelap) to provide a multitude of repeat patterns between multiple images that the SfM algorithms use to render surface elevation. The resulting three-dimensional “point clouds” of the underlying surface are georeferenced from the parent images and verified by known fixed locations (e.g., buildings, structures roads, etc.) between flight campaigns. The point clouds are then used to produce gridded (rasterized) DTMs at a resolution of 0.1 m per pixel by assigning an averaged elevation value from all points within each 0.1 square meter (m^2) cell. This resolution is preferred as it offers reduced vertical error and allows for detailed geomorphic interpretation and sediment volume estimations. An example of successive DTMs from the same FRA TP is shown in Figure 2-8.

Figure 2-8. Example Digital Terrain Models



Example DTMs from the October 2019 and February 2024 collection campaigns from FRA TP 3. The development from unvegetated transverse dunes to coalesced, vegetated nebkha ridges is evident in the February 2024 DTM. The dashed line represents the landward extent of the TP.

Successive DTMs are imported into geographic information system (GIS) software (ArcGIS Pro) and the geomorphic change detection (GCD) toolset, developed by Riverscapes Consortium, is used to calculate volumes of change between collocated raster grid cells. This method applies a spatial statistical filter to remove surface changes below a threshold uncertainty value with 95% confidence. This threshold is determined by developing an uncertainty budget that includes the accuracy of the GPS station, the calculated uncertainty of the point cloud, and the root mean square error from the alignment of each point cloud with static features in the landscape. The uncertainty between two surveys is additive and pixels that exceed the minimum level of detection threshold (typically ~5 cm) are included. As such, repeat DTMs derived from the UAS imagery are compared through time. Pixels of statistically significant elevation change are used to create topographic (elevation) change maps for estimating volumetric changes and interpreting corresponding geomorphic changes.[26] Results can also be partitioned into specified units to monitor plot-based change over time, such as between the foredune restoration TPs themselves, as well as their adjoined beach and landward dune components (see Figure 2-7).

Multispectral sensors collect several images simultaneously at each photo point during a flight (vs. a single image for RGB cameras). As a result, and due to a lower limit in flight elevation of the WingtraOne UAS (~110 m), the spatial resolution of the multispectral sensor is slightly coarser (~7 cm). To date, two different multispectral sensors have been used: 1) Micasense RedEdge-MX (October 2020 to February 2022), and 2) Micasense RedEdge-P (October 2022 to present). The former sensor featured a five-band sensor payload (R, G, B, RE, NIR), while the RedEdge-P sensor uses the same five bands and an additional panchromatic (Pan) band that is used to improve the resolution of the dataset from ~7 to ~3.5 cm per pixel.

From multispectral bands, a Normalized Difference Vegetation Index (NDVI) is used to identify vegetation on the surface (differentiated from sand or straw) to quantify plant cover across the FRA (see Figure 2-9). NDVI is calculated using a ratio of the difference in reflectance values of NIR light (reflected strongly by plants) and red (R) light (absorbed by plants), using the following equation:

$$NDVI = (NIR - R)/(NIR + R)$$

Where:

NIR = Near infrared light reflectance

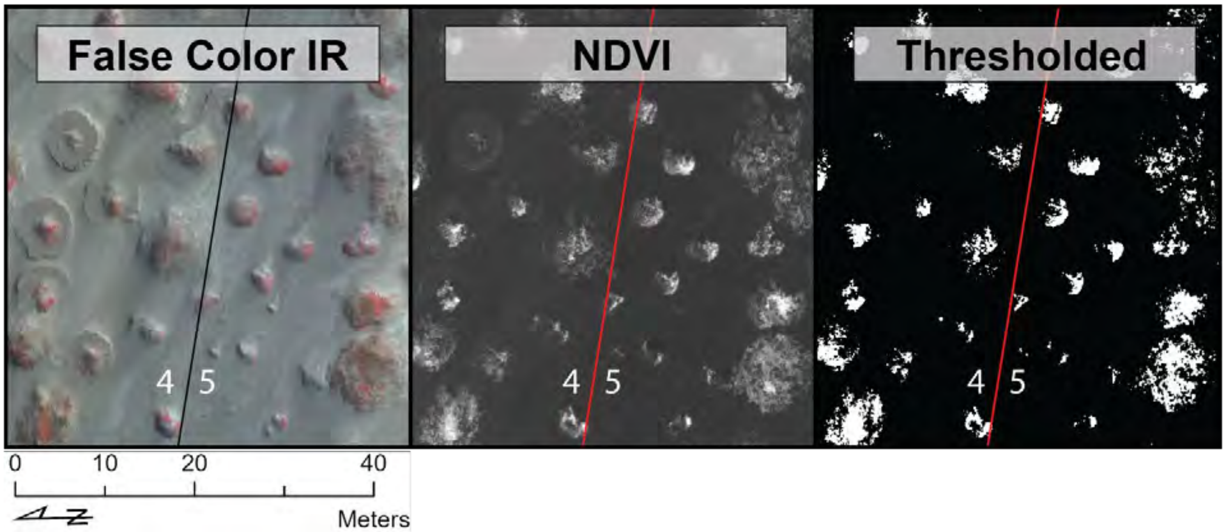
R = Visible red light reflectance

NDVI values range from -1 to +1, and areas with dense vegetation will typically have positive values (~+0.3 to 0.8) while water surfaces or fog (that absorb both bands) tend to have low positive to slightly negative values. Soil surfaces also tend to be characterized by low positive NDVI values (~+ 0.1 to 0.2), depending on color and moisture content. The output histograms of NDVI values for each survey were examined and a threshold value was set to identify pixels with high index values (representative of vegetation) as shown in Figure 2-9. Currently, vegetation cover datasets derived from the UAS surveys do not identify plant species, only pixels that have plant cover.

Resulting datasets from the UAS monitoring flights include georeferenced orthophoto mosaics, DTMs, topographic change maps, and plant cover maps. These datasets are then used to calculate patterns and volumes of sediment erosion/deposition across the TPs and changes in vegetation over time. These results are then used to identify and interpret dune development, sediment budget responses, and vegetation establishment.

[26] Statistical significance is determined in the GCD software based on the error budget and respective uncertainties (in the vertical) for each DTM.

Figure 2-9. Vegetation Pixel Output



Example of the false color infrared (IR) output (shows vegetation as red pixels), NDVI output (vegetation as lighter grayscale colors), and thresholded NDVI (vegetation as white pixels) used to extract distinct vegetation pixels within the TPs. This location is along the boundary of the low-density planting node (TP 4) and high-density node (TP 5) plots.

Further details on the cumulative results of observed geomorphic and vegetation coverage changes, respectively, from the UAS surveys of the FRA through to February 2024 are provided in Sections 2.2.5.1 and 2.2.5.2. below.

Results from 2022-2023 for the UAS monitoring of the FRA were compiled in a report entitled "UCSB 2022-2023 ODSVRA Foredune Restoration UAS Survey Report" that was delivered to State Parks for review in June 2023. Due to time constraints, State Parks was unable to review this report or send it to the SAG for review prior to approval of the 2023 ARWP. However, these results were reported in Section 2.3.3 in the 2023 ARWP without State Parks or SAG review and the full report was not provided as an attachment to the ARWP. This report, and the SAG's review comments, are provided as Attachment 04A to this 2024 ARWP. The SAG comments and suggestions were considered for preparation of the results in UCSB's 2024 UAS report, which is included as Attachment 04B to this 2024 ARWP.

It is also noted that the UAS datasets beyond the FRA have potential use for evaluating changes in vegetation cover, geomorphology, and sediment budget responses in the broader ODSVRA riding areas and other restored sites.

2.2.3 Saltation Monitoring

To observe and characterize the nature of sand transport events within the restoration TPs, time-lapse cameras were installed on the masts of the meteorological monitoring stations within each TP at the landward/eastern edge of the restoration plots in May 2020. The cameras face upwind (roughly west-northwest) and capture oblique images every 30 minutes from 07:00 to 17:30 local time (Pacific Standard Time [PST]). In addition to sand transport events, cameras were deployed to capture other types of formative events, including plant growth/phenology, bedform development and migration, erosion events, and potential dust emissions within the TPs.

A proof-of-concept analysis from a subset of over 3,000 images of various aeolian activity events collected in January 2023 was conducted, and a report entitled "Preliminary Analysis of Time-Lapse Photo Monitoring at the Oceano Dunes Foredune Restoration Site" was delivered to State Parks for review in June 2023. Due to time constraints, State Parks was unable to review this report or send it to the SAG for review prior to approval of the 2023 ARWP; however, a summary of the preliminary results was reported in Section 2.3.6.3 and as Attachment 09 in the 2023 ARWP.

Subsequently, the SAG provided a review and feedback on the time-lapse imagery proof-of-concept report on February 27, 2024. Following broader discussions with State Parks and the SLOAPCD at the joint meeting in March 2024, it was collectively decided that this analysis would not continue due to limited utility of the method for characterizing sand transport events or efficacy of the FRA TPs. The monitoring cameras are still in operation and State Parks will decide if or how further image downloads will occur.

Results from the time-lapse imagery proof-of-concept analysis are provided below in Section 2.2.5.5, as reported in last year's 2022-2023 ARWP. The UCSB report and SAG review comments on this report are also provided as Attachment 05 for reference.

2.2.4 PI-SWERL/Emissivity Monitoring

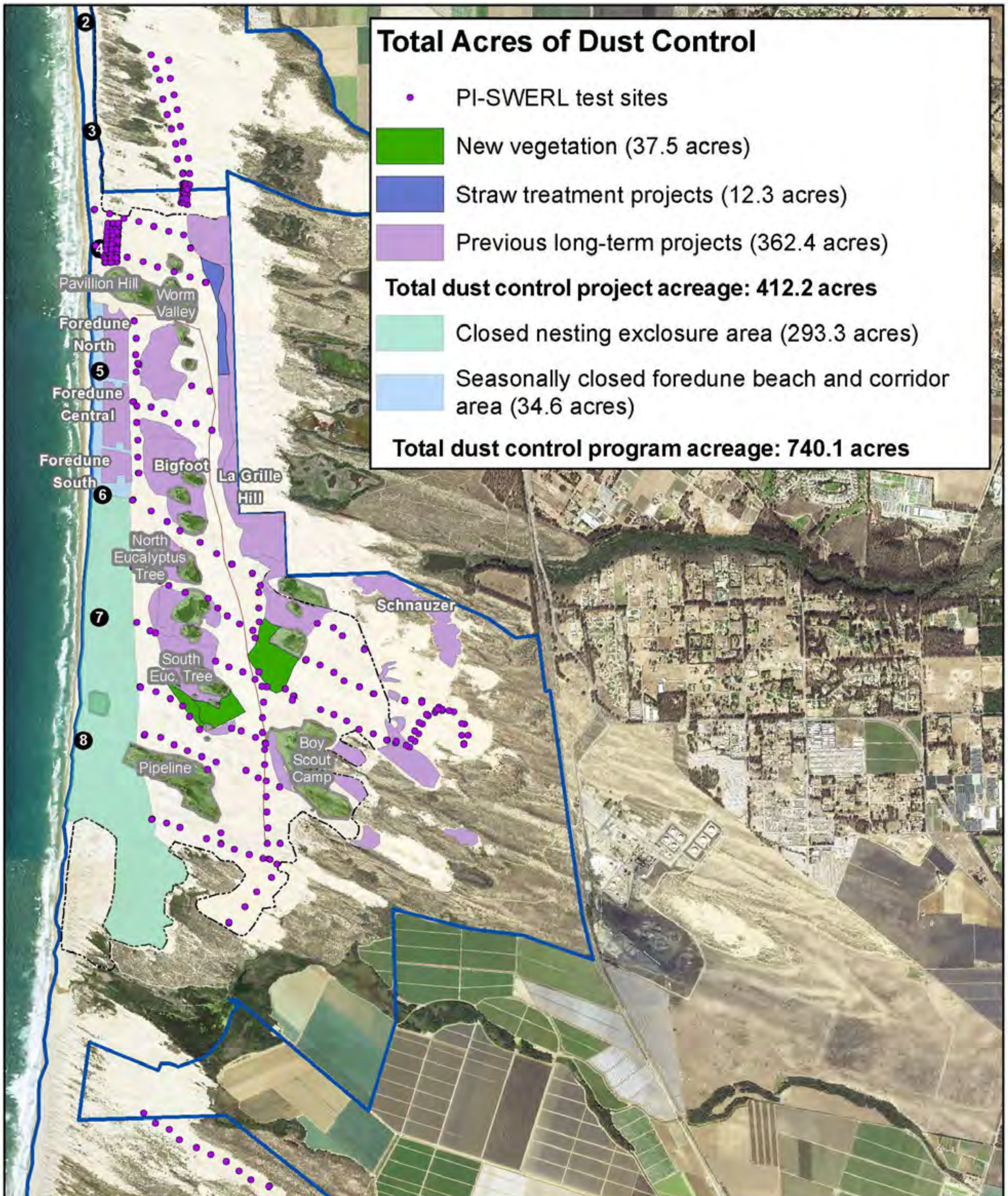
The Desert Research Institute (DRI) has collected PI-SWERL data at the ODSVRA since 2011. The earliest data collection efforts were mainly for information gathering purposes and to help develop sampling methods for later campaigns. Since 2013, DRI has undertaken PI-SWERL measurements of PM_{10} emissivity across the ODSVRA in riding and non-riding areas. Some measurements have been repeated over time by revisiting the 2013 sampling locations, while others have been made in areas deemed critical to understanding changes in emissivity throughout the ODSVRA. In total, between 2013 and September 2022, DRI conducted nearly 1,800 total PI-SWERL emissivity tests at the ODSVRA, including nearly 1,000 individual tests within the ODSVRA's open riding and camping area, more than 500 individual tests outside the open riding and camping area, and nearly 200 individual tests in areas that are or were seasonally open to OHV recreation (e.g., nesting exclosure). Below is a summary of PI-SWERL testing and analyses undertaken by DRI during the 2024 ARWP reporting period (August 1, 2023, to July 31, 2024).

In May 2024, DRI carried out an extensive PI-SWERL measurement campaign at the ODSVRA that was designed to reproduce the sampling that was completed in 2019. Due to changes in the areas under dust control, the shifting of fences since 2019, and the changes in dune topography that restricted safe access to test sites (i.e., travel deemed too dangerous), the sampling undertaken in May 2024 incorporated a large proportion of the 2019 sampling grid but by necessity added new sampling locations. In addition, due to Western Snowy Plover nesting activity in the southern Oso Flaco preserve area, a portion of the target sampling locations was deemed off-limits. A total of approximately 498 locations across the ODSVRA were sampled in May 2024 (see Figure 2-10).[27] DRI is still evaluating the results of the 2024 PI-SWERL survey, which will also go through the Dust Control Program scientific review process (see Section 2.4.4).

2.2.4.1 Mechanical Raking Operations Sampling

As explained in more detail in Section 3.1.5, State Parks has prepared a draft Habitat Conservation Plan (HCP) pursuant to Federal Endangered Species Act (FESA) requirements that identifies the activities that State Parks has responsibility for within the HCP area that could result in take[28] of certain wildlife and plant species protected by the FESA. These activities include but are not limited to public use/recreation management, natural resources management, and park/beach management, including mechanical raking, which is an existing maintenance activity currently being implemented by State Parks on a trial basis. This activity uses a tractor-towed rake to collect nails, broken glass, and other debris that may pose a hazard to visitors or wildlife from open sand areas. The raking action actively disturbs the surface of the sand and removes debris and organic material from the top approximately 2 to 6 inches of the sand surface. In addition to the campaign designed to reproduce PI-SWERL sampling completed in 2019, DRI also conducted a preliminary study designed by the SAG and State Parks to evaluate whether mechanical beach raking could result in a measurable change in the emissivity of a selected beach area.

[27] Of the 498 sampling locations, 453 were selected to reproduce the sampling from 2019 and 45 were selected to complete preliminary study of mechanical raking operations described in Section 2.2.4.1.
[28] FESA (Title 16 of the United States Code, Section 1532) defines take as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.



Source: CDPR, MIG Imagery: 2014 NAIP 7/25/2024

Feet
0 1,000 2,000

N

Figure 2-10: May 2024 PI-SWERL Sampling Locations

2024 ARWP

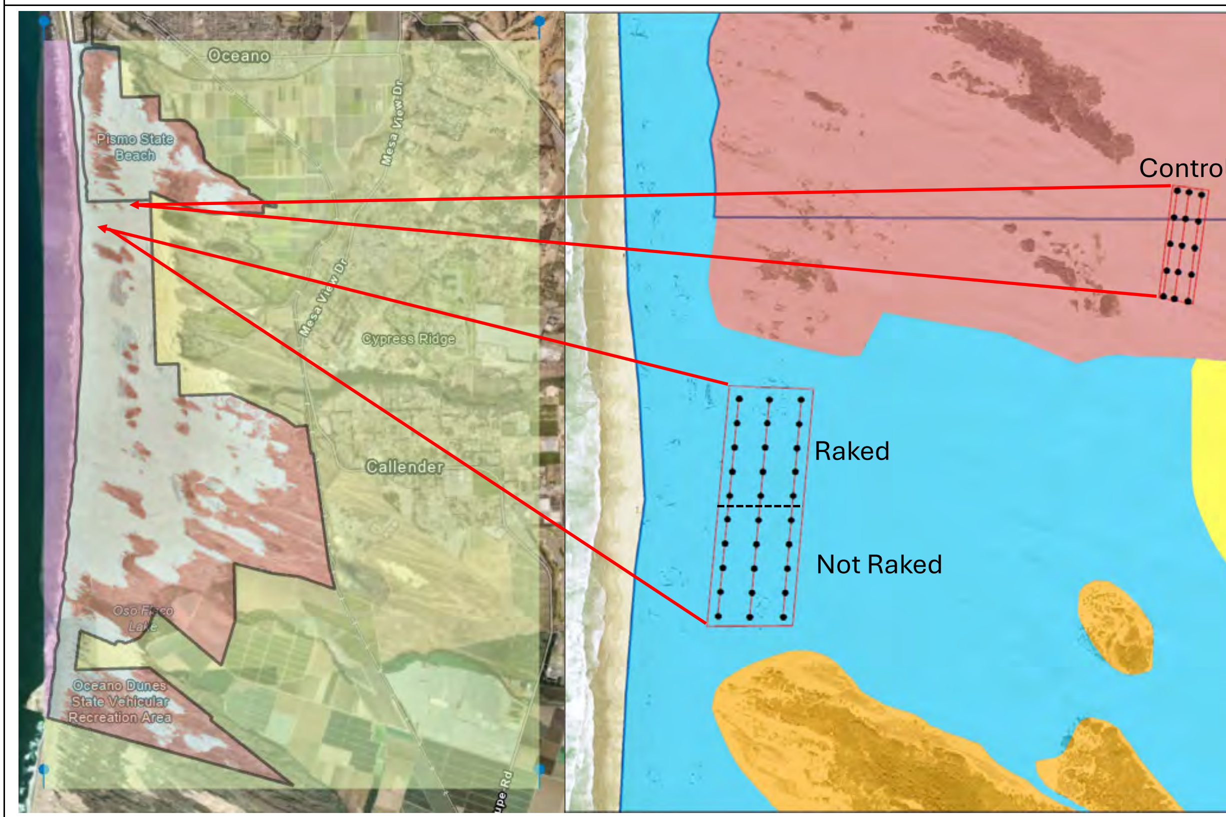
Sand Highway, approx. · Marker post · Existing fenced vegetated islands · Park boundary · Open riding and camping area boundary fence

The methodology followed by State Parks and DRI was as follows:

1) Identify and mark an area of the beach with two approximately equivalent-sized areas, one that would be raked (beach area 1), the other that would not be raked (beach area 2), and both would be exposed to OHV activity.
2) Identify an area of equivalent size in the northern dune preserve that would not be raked or be exposed to any OHV activity (i.e., a control area).
3) Beach area 1 was treated with mechanical raking on May 21, 2024.
4) Beach area 2 was not raked.

The locations of the test areas and PI-SWERL samples are shown in Figure 2-11. In total, 45 PI-SWERL measurements were made, with 30 measurements made on beach area 1 and beach area 2 and 15 measurements made on the control area.

Figure 2-11. Mechanical Raking Test Areas and PI-SWERL Sampling Locations



The locations of the beach raking test areas within the ODSVRA. The raked and not raked areas are within the Riding Area Central-North emissivity zone and the control area is within the Non-Riding Area North emissivity zone (see Section 2.3.2.2). The black circles in the image on the right indicate the approximate positions of the PI-SWERL tests in the areas that were raked and not raked, and the area that was established in the northern dune preserve as the control area (i.e., an area that was not raked and not subjected to OHV activity).

The first set of PI-SWERL measurements were made on May 20, 2024, the day prior to the mechanical raking on beach area 1. Fifteen locations, following an equal-spaced grid pattern, were identified in each of the sampling areas and emissivity at each site was measured using the Hybrid 3500 PI-SWERL test.[29] As the handheld GPS units are accurate to 3 to 5 m, upon returning to test locations there is a certain degree of randomization in position. These locations were measured for emissivity (in milligrams per square meter per second, or mg m^{-2} s^{-1}) again on May 22, 2024, approximately 24 hours after the raking. The third and final measurements were made on May 31, 2024. The SAG had recommended a 14-day period between measurement days, post-raking, but DRI could not accommodate this due to logistical constraints. This may have serendipitously turned out to be an advantage as there was a significant moisture event overnight on May 31-June 1 that could have had a potentially profound effect on emissivity.

The PI-SWERL emissivity data are currently going through a quality assurance/quality control process by DRI. Analysis will follow to examine the following: 1) comparison of the mean emissivity of the raked and non-raked areas prior to raking, 2) comparison of the mean emissivity of the raked and non-raked areas prior to raking with the control area (as measured on May 20, the day prior to raking), 3) comparison of the mean emissivity of the raked and non-raked areas one day after raking, 4) comparison of the mean emissivity of the raked and non-raked areas with the control area as measured one day after raking (May 22), 5) comparison of the mean emissivity of the raked and non-raked areas 10 days after raking, and 6) comparison of the mean emissivity of the raked and non-raked areas with the control area as measured 10 days after raking (May 31).

Comparisons of mean emissivity for each of the areas for each of the measurement days will also be carried out. For example, for the area that was raked, the mean emissivity of the area prior to the raking will be compared to the mean emissivity of the area one day and 10 days after raking. A Student's t-test will be used to determine if there is a significant difference between mean emissivity values for each of the three test shear velocities.

[29] Gillies, J.A., E. Furtak-Cole, G. Nikolich, and V. Etyemezian, 2022. The role of off highway vehicle activity in augmenting dust emissions at the Oceano Dunes State Vehicular Recreation Area, Oceano CA. Atmospheric Environment: X, 13, 100146, doi: 10.1016/j.aeaoa.2021.100146.

2.2.5 Foredune Monitoring

State Parks initiated the 48-acre foredune restoration project in late 2019. The rationale for the treatment was to re-establish a vegetated foredune ecosystem, similar to what might have been present prior to extensive vehicular disturbance, such as observed in early historical aerial photography (e.g., 1939). Such a re-established foredune could naturally disrupt incoming boundary layer flow from the ocean, reduce surface shear stress, and decrease sand flux across the foredune's width and for some distance downwind. As a mitigation strategy, the foredune will reduce saltation-driven dust emissions and contribute to improved air quality downwind. The restoration treatment is based on a SAG design in which the 48-acre FRA is subdivided into three different projects and six different TPs, as follows (see Figure 2-12):

- Project 1 – Foredune North (18.8 acres, 2020-VG-01):
    - TP 1 – Control (4.0 acres): No treatment other than sheep's foot surface texturing to create divots for seeds and low-level aerodynamic roughness
    - TP 2 – Native Seed (5.2 acres): Native seed mix with sheep's foot surface texturing
    - TP 3 – Native Seed and Grain Seed (9.6 acres): Native seed mix and sterile ryegrass seeds with sheep's foot surface texturing
- Project 2 – Foredune Central (18.8 acres, 2020-VG-02):
    - TP 4 – Low-Density Nodes (9.1 acres): Low-density random planting nodes (with a spacing derived from a natural analog site near Oso Flaco Lake) with approximately nine foredune-specific plants per node planted within a 12-foot radius zone of straw to protect seedlings
    - TP 5 – High-Density Nodes (9.7 acres): High-density random planting nodes with the same planting and straw protection strategy
- Project 3 – Foredune South (9.9 acres 2020-VG-03):
    - TP 6 – Parks' Classic (9.9 acres): Sheep's foot surface texturing, spreading straw over the entire area, planting foredune-specific species, and seeding the area with native seed.

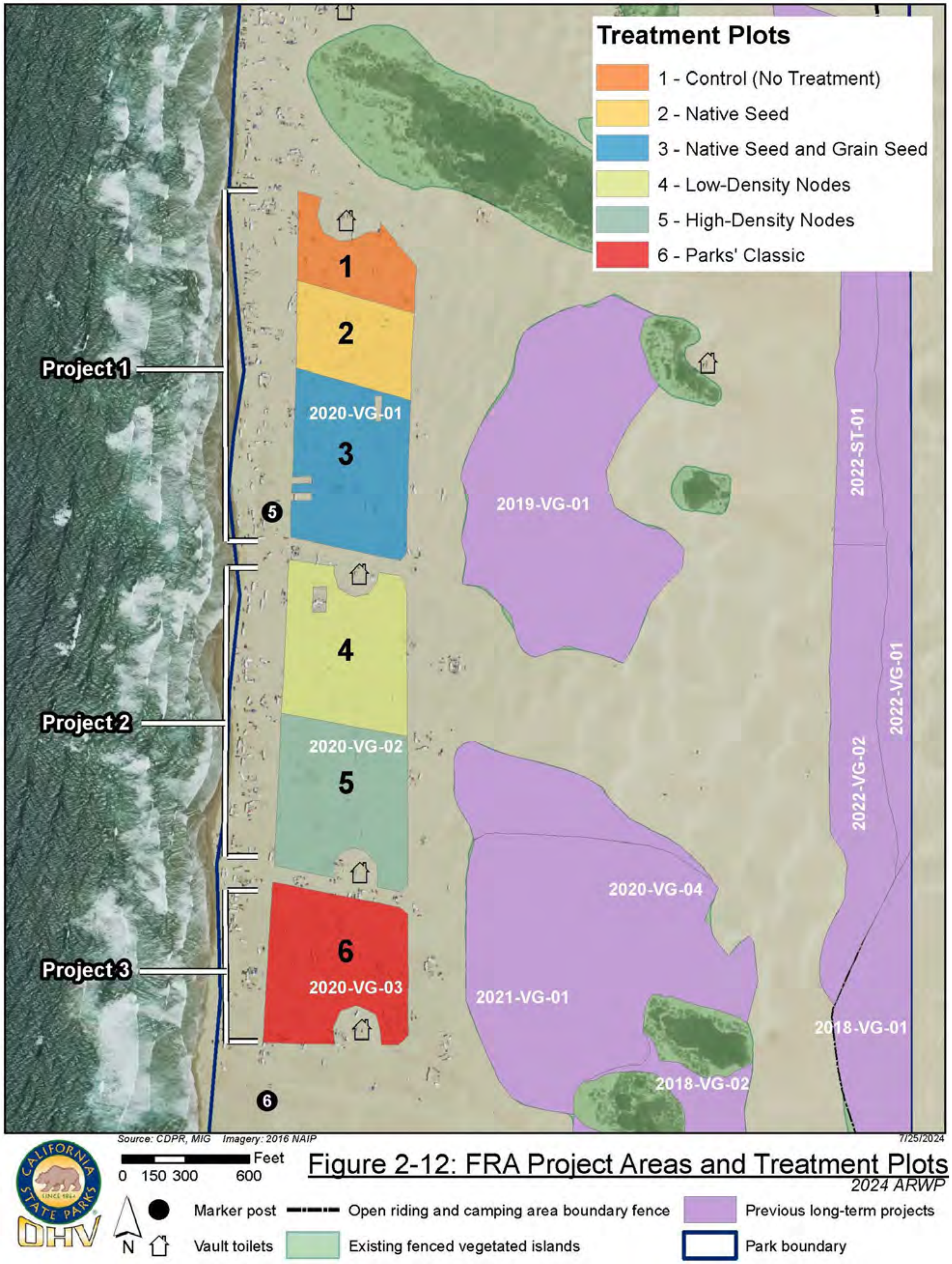


Figure 2-12: FRA Project Areas and Treatment Plots

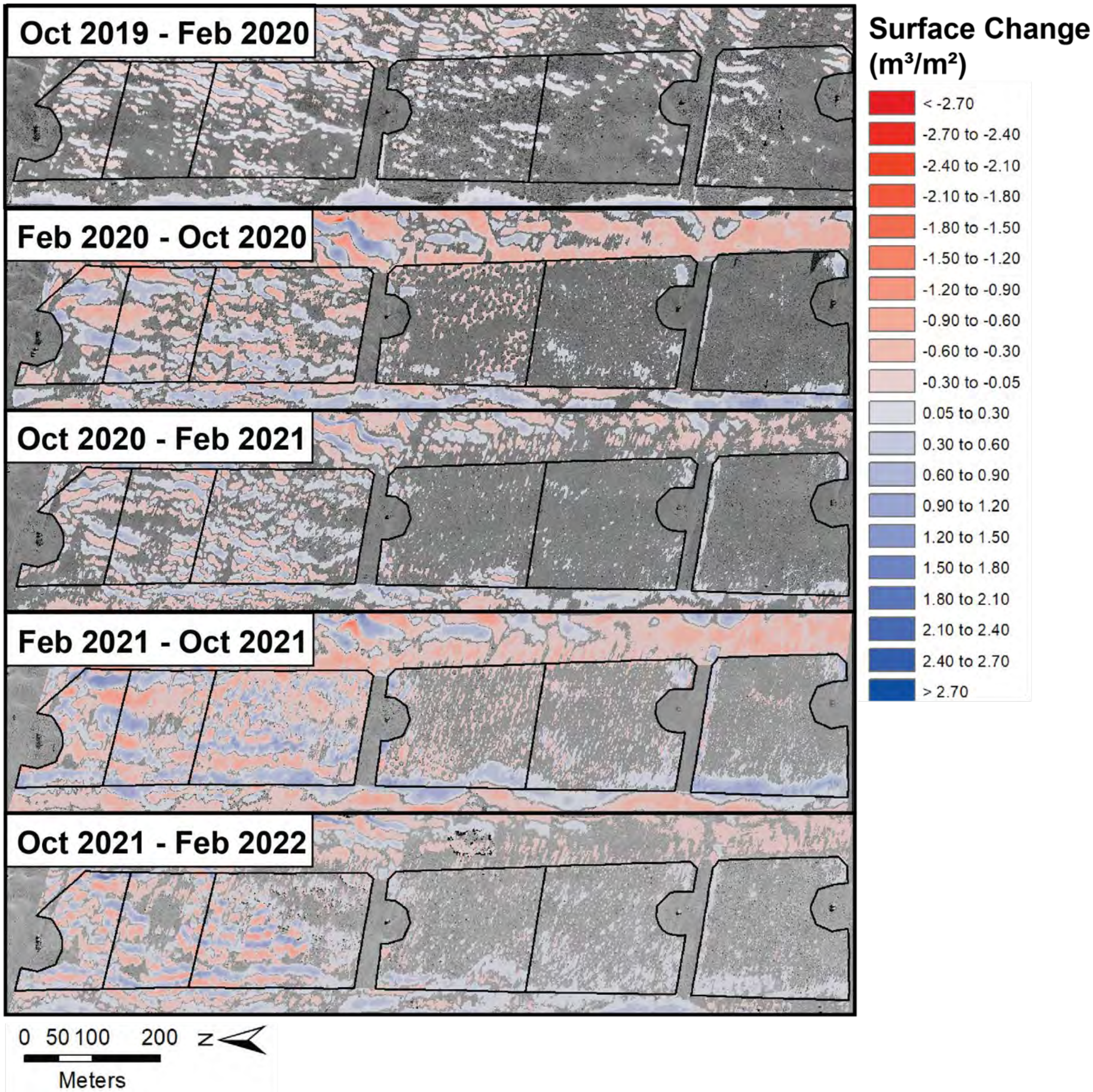
2.2.5.1 FRA Morphological Changes

Figure 2-13 to Figure 2-15 and Table 2-3 provide topographic change maps showing areas of erosion (reds) and deposition (blues) and related values and time series of normalized volumetric changes within the FRA TPs and their adjoined geomorphic units between October 2019 and February 2024. Pixels of statistically insignificant change, as determined by a two-tailed T test at a 95% confidence interval in the GCD package (see Section 2.2.2), are not shown in Figure 2-13 and Figure 2-14 and are not used to calculate sediment volumes. Geomorphic units include each of the foredune treatment areas (FD), an adjoining beach area (B) and landward backdune areas (LD) (see Figure 2-7). The first interval (October 2019 to February 2020) provides baseline reference conditions prior to implementation of the restoration treatments. The remaining intervals show responses of the TPs for the following four wind, plant growth, and dune development seasons through to February 2024.

One key control on the geomorphic responses in the treatments is the amount of sand that enters the upwind beach, which provides the incoming supply for aeolian delivery to the TPs. Beach units saw variable responses of positive (depositional) and negative (erosional) change in sediment volumes that relate to seasonal variations (e.g., winter storm erosion) and migration of rip current embayments. Seasonal to interannual variations are also evident at many locations, reflecting winter beach erosion and/or movement of rip cell embayments that reduce beach width, or spring/summer bar welding on to the upper beach and increased aeolian activity (see also erosion/deposition patterns and trends in Figure 2-13 to Figure 2-15).

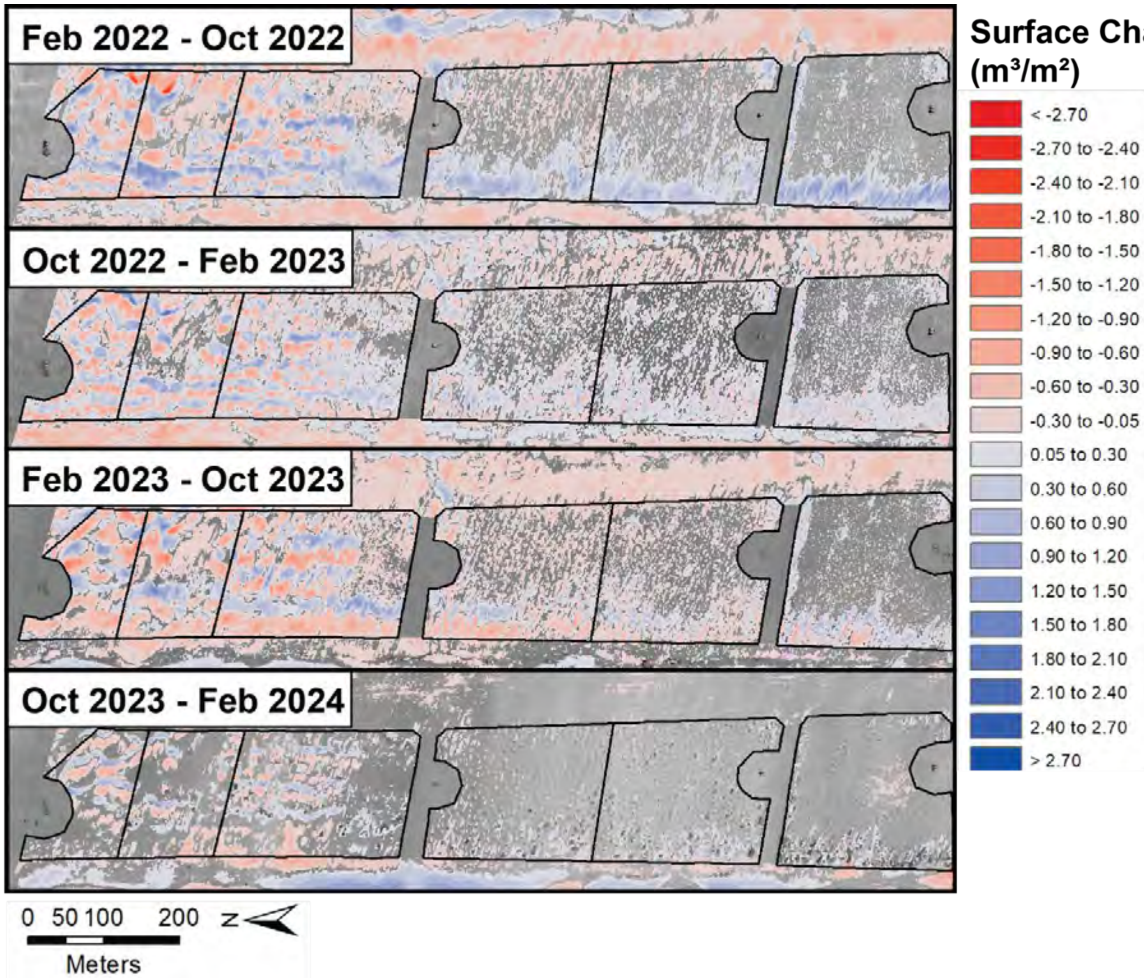
Generally, the beach units show a declining, albeit highly variable, trend in sand volumes from positive values in the initial October 2019 to February 2020 baseline interval to negative values by February 2023. More recently, the beach units fronting all TPs, except TP 6 – Parks' Classic, have shown distinct positive trends and values of sedimentation between October 2023 and February 2024. Net change values since the baseline survey (Table 2-3) suggest beach erosion has dominated in front of the northern plots (TP 1 – Control to TP 3 – Native Seed and Grain Seed), while deposition prevails at the southern plots (TP 4 – Low-Density Nodes to TP 6 – Parks' Classic).

Figure 2-13. Topographic Change Map (October 2019 to February 2022)



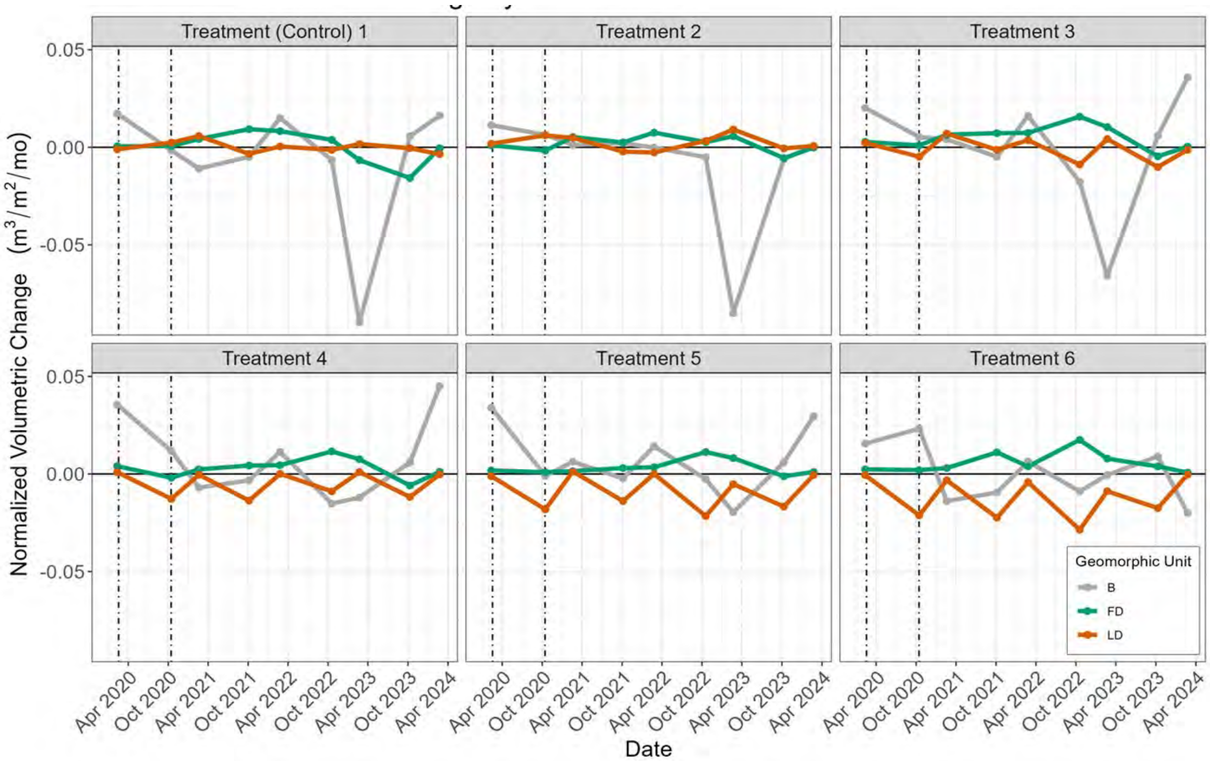
Topographic change map (in cubic meters per square meter, or m^3 m^{-2}) with corresponding pixels of significant elevation change (reds = erosion, blues = deposition) for each survey interval between October 2019 and February 2022 overlain on the UAS photomosaics for the second time step in each interval. Restoration treatment areas are outlined and progress is shown from TP 1 – Control on the left to TP 6 – Parks' Classic on the right (as indicated in Figure 2-7). Intervening OHV transportation corridors, between TP 3 – Native Seed and Grain Seed and TP 4 – Low-Density Nodes, and between TP 5 – High-Density Nodes and TP 6 – Parks' Classic, are not included in the analysis.

Figure 2-14. Topographic Change Map (February 2022 to February 2024)



Topographic change map (in $m^3\ m^{-2}$) with corresponding pixels of significant elevation change (reds = erosion, blues = deposition) for each survey interval between February 2022 and February 2024 overlain on the UAS photomosaics for the second time step in each interval. Restoration treatment areas are outlined and progress is shown from TP 1 – Control on the left to TP 6 – Parks' Classic on the right. Intervening OHV transportation corridors, between TP 3 – Native Seed and Grain Seed and TP 4 – Low-Density Nodes, and between TP 5 – High-Density Nodes and TP 6 – Parks' Classic, are not included in the analysis.

Figure 2-15. Normalized Volumetric Change by Month for Foredune Restoration Treatment Plots



Time series of normalized (in cubic meters per square meter per month, or m^3 m^{-2} mo^{-1}) volumetric changes derived from successive surveys for each FRA TP (FD), adjacent beach (B), and landward dune (LD) unit. Each point represents net results of volumetric change for the preceding interval (e.g., first point represents net change between October 2019 and February 2020, etc.). Dashed lines delimit the COVID-19 closure period (March 2020 through October 2020).

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Table 2-3. Normalized Volumetric Change by Total Area ($m^3\ m^{-2}\ mo^{-1}$) x 100

Treatment Plot	Geomorphic Unit	Oct. 2019 – Feb. 2020	Feb. 2020 – Oct. 2020	Oct. 2020 – Feb. 2021	Feb. 2021 – Oct. 2021	Oct. 2021 – Feb. 2022	Feb. 2022 – Oct. 2022	Oct. 2022 – Feb. 2023	Feb. 2023 – Oct. 2023	Oct. 2023 – Feb. 2024	*Net Change (Oct. 2019 – Feb. 2024)*
TP 1 – Control	B	1.7	-0.2	-1.1	-0.5	1.5	-0.7	-9.0	0.6	1.6	-0.4
	FD	**0.1**	**0.1**	**0.4**	**0.9**	**0.8**	**0.4**	**-0.7**	**-1.6**	**0.0**	**0.0**
	LD	-0.1	0.2	0.6	-0.3	0.0	-0.1	0.2	0.0	-0.4	-0.1
TP 2 – Native Seed	B	1.1	0.6	0.1	0.2	0.0	-0.5	-8.5	-0.6	0.1	-0.6
	FD	**0.1**	**-0.2**	**0.5**	**0.3**	**0.8**	**0.3**	**0.6**	**-0.6**	**0.0**	**0.1**
	LD	0.2	0.6	0.5	-0.2	-0.3	0.3	0.9	-0.1	0.1	0.1
TP 3 – Native Seed and Grain Seed	B	2.0	0.5	0.4	-0.5	1.6	-1.8	-6.6	0.6	3.6	0.0
	FD	**0.3**	**0.1**	**0.6**	**0.7**	**0.7**	**1.6**	**1.0**	**-0.5**	**0.0**	**0.5**
	LD	0.2	-0.5	0.7	-0.1	0.4	-0.9	0.4	-1.0	-0.1	-0.3
TP 4 – Low-Density Nodes	B	3.6	1.2	-0.7	-0.3	1.1	-1.5	-1.2	0.6	4.5	0.6
	FD	**0.4**	**-0.2**	**0.2**	**0.4**	**0.4**	**1.2**	**0.8**	**-0.6**	**0.1**	**0.3**
	LD	0.1	-1.3	0.0	-1.4	0.0	-0.9	0.1	-1.2	0.0	-0.8
TP 5 – High-Density Nodes	B	3.4	-0.1	0.6	-0.2	1.4	-0.3	-2.0	0.6	3.0	0.6
	FD	**0.2**	**0.1**	**0.1**	**0.3**	**0.3**	**1.1**	**0.8**	**-0.1**	**0.1**	**0.4**
	LD	-0.1	-1.8	0.1	-1.4	0.0	-2.2	-0.5	-1.7	-0.1	-1.2
TP 6 – Parks' Classic	B	1.6	2.3	-1.4	-1.0	0.6	-0.9	-0.1	0.9	-2.0	0.1
	FD	**0.2**	**0.2**	**0.3**	**1.1**	**0.4**	**1.7**	**0.8**	**0.4**	**0.1**	**0.7**
	LD	-0.1	-2.1	-0.3	-2.2	-0.4	-2.9	-0.9	-1.8	0.0	-1.7

Normalized surface volumetric changes for the FRA TPs (FD, bold values) and adjoining beach (B) and landward dune (LD) zones. Blue cells indicate sand accumulation; red cells show erosion. Uncertainty values associated with individual measurement campaigns are provided in Table 2-2 in Section 2.2.2.

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In general, net deposition has occurred across all FRA TPs, with some deviations. Most plots saw distinct negative (erosional) responses from February to October 2023 (except for TP 6 – Parks' Classic) (see Figure 2-15 and Table 2-3), but trends shifted to positive in all but one treatment (TP 6 – Parks Classic) in the most recent interval. TP 1 - Control and TP 2 – Native Seed continue to show some of the lowest rates of accumulation, reflective of significant recent beach erosion and consistent sediment bypassing due to limited vegetation establishment and nebkha dune development. TP 3 – Native Seed and Grain Seed, despite showing net negative change in both the beach and landward dunes units, shows the second highest net accumulation of sand. TP 4 – Low-Density Nodes and TP 5 – High-Density Nodes experienced comparatively moderate change, as the fourth and third (respectively) highest accumulating plots. TP 6 – Parks' Classic is the only plot that has not exhibited a negative change interval through time and recorded the greatest net deposition, but this is focused largely on the seaward and northern edges of the plots, where fences have played a role in capturing sand. Since October 2022, all TPs have shown negative (declining) trends in normalized sediment volumes.

The foredune plots vary notably in sedimentation responses to vegetation establishment and/or surface treatments. TP 1 – Control and TP 2 – Native Seed were the least altered by treatment interventions and maintained similar change patterns across all intervals. Sand transport in these plots generated low-lying (0.4- to 0.6-m), slowly migrating semi-continuous transverse and barchanoid dune ridges and protodunes. Negligible plant cover established in TP 1 – Control except for a very few plants near the seaward edge of the plot, first observed in October 2022. Some shadow dunes were present in the landward half of these plots, but these were not associated with vegetation (i.e., nebkha), but rather with nodes of cemented sand and anthropogenic debris.[30] TP 2 – Native Seed exhibited a developing nebkha cluster in the center of the plot, but this had not expanded notably by February 2024. TP 1 – Control and TP 2 – Native Seed recorded the smallest net changes in sand volume over the monitoring period (see Table 2-3).

TP 3 – Native Seed and Grain Seed has developed significant nebkha, predominantly with *Abronia latifolia*, and these dunes have started to coalesce to form discontinuous ridges over 2 m tall, which are the tallest dunes across all of the TPs. The latest two intervals (since February 2023) showed negative and neutral volumetric changes, respectively, within TP 3 – Native Seed and Grain Seed. The February 2023 to October 2023 interval recorded the only negative budget for TP 3 – Native Seed and Grain Seed, since the installation of the TPs. TP 3 – Native Seed and Grain Seed has shown among the greatest and most consistent positive volumetric changes

[30] For more discussion, see Hilgendorf, Z., I.J. Walker, N. Swet, and M. Heffentrager, 2023. UCSB 2022-2023 ODSVRA Foredune Restoration Survey Report. Research report to the Oceano Dunes SAG and State Parks. 44 p. This report is included in this 2024 ARWP as Attachment 04A.

across the sites and the second largest depositional interval (February to October 2022, 0.122 $m^3 m^{-2}$) and second greatest net deposition (October 2019 to February 2023, 0.247 $m^3 m^{-2}$) to date (see Table 2-3).

TP 4 – Low-Density Nodes and TP 5 – High-Density Nodes suffered localized erosion between planting nodes during early intervals. These “erosional streets” persist, although nebkha are growing and slowly coalescing in both plots. TP 4 – Low-Density Nodes and TP 5 – High-Density Nodes experienced the fourth and third highest net positive deposition amounts, respectively, to date (see Table 2-3). Nebkha dunes in TP 5 – High-Density Nodes are larger than in the neighboring TP 4 – Low-Density Nodes and closer in height to the larger dunes in TP 3 – Native Seed and Grain Seed, with some dunes over 1.5 m tall. In the most recent February 2024 surveys, however, dunes in TP 4 – Low-Density Nodes had grown notably, particularly along the seaward half of the plot. Nebkha coalescence was observed in both treatments along the seaward half of the plot by October 2023.

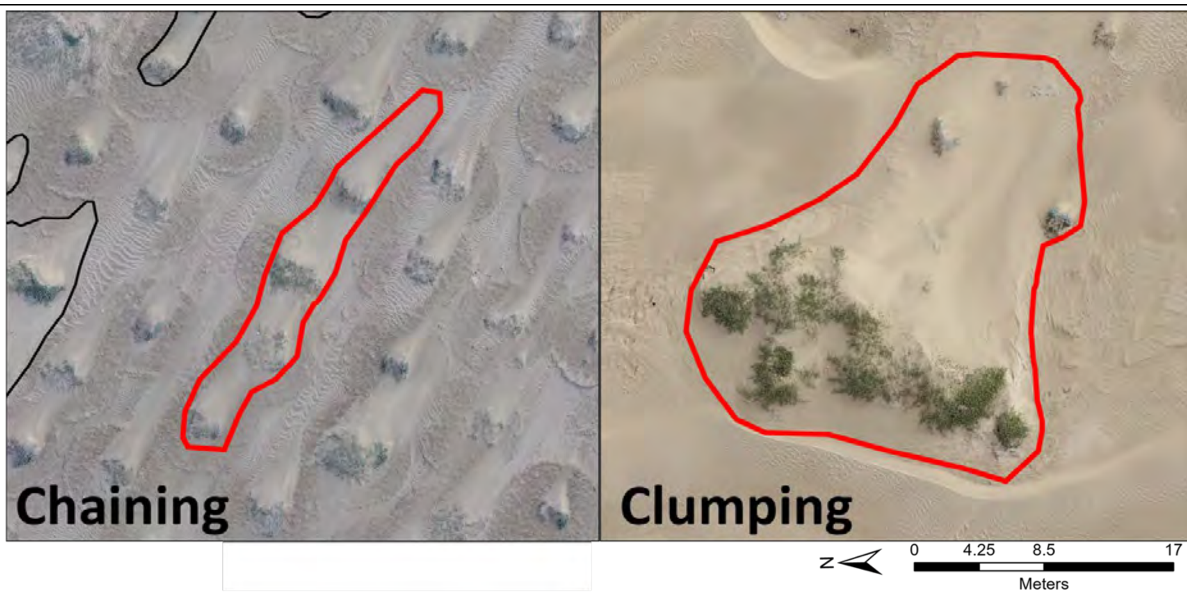
TP 6 – Parks’ Classic had the most intensive treatment with the highest planting density and complete surface straw cover on installation. Although it maintains the highest plant coverage (see Figure 2-17 below and Table 2-4 in Section 2.2.5.2), greatest depositional volumes, and highest net positive sediment budget (see Table 2-3), large nebkha are not developing in this plot, compared to TP 3 – Native Seed and Grain Seed to TP 5 – High-Density Nodes. A notable portion of the accretion in TP 6 – Parks’ Classic is associated with the sand fence on the northern border with the transportation corridor, which has promoted significant drift development in the TP. This influences the net accretion values but does not reflect the effects of the restoration treatment itself. The same fence-drift pattern is also observed on the north fence line of TP 4 – Low-Density Nodes.

Feedbacks between dune roughness, secondary flow patterns, surface shear stress, and sand transport within the FRA treatments continue to evolve and influence dune development. Ongoing work comparing wind data from the meteorological stations at the eastern edge of the plots, nebkha development, and geomorphic change suggests that TP 3 – Native Seed and Grain Seed, TP 5 – High-Density Nodes, and TP 6 – Parks’ Classic have the greatest impact on the wind fields. Variations in roughness and vegetation patterns between the FRA TPs have resulted in two significantly different dune development pathways (see Figure 2-16). First, nebkha in TP 2 – Native Seed and TP 6 – Parks’ Classic show a “clumping” (wind-normal coalescence) response as they widen to produce discontinuous flow-transverse nebkha ridges. This lateral extension of nebkha is key to the development of a shore-parallel foredune ridge and the discontinuous morphology of foredune ridges in central and southern California is the preferred form, given the controls of regional climate and native dune plant communities.[31] Second, nebkha in TP 4 –

[31] Hesp, P.A., and I.J. Walker, 2022. 7.21 Coastal Dunes. Treatise on Geomorphology, 2nd edition, ed. J. F. Shroder, Volume 7, 2022, Pages 540-591. Elsevier. https://doi.org/10.1016/B978-0-12-818234-5.00220-0.

Low-Density Nodes and TP 5 – High-Density Nodes primarily exhibit “chaining” (wind-aligned extension) that connects downwind nebkha via shadow dune extension. This pattern is partly driven by initial positioning of the planting zones and intervening erosional streets, but this type of morphological organization (long streamlined nebkha ridges with erosional deflation troughs) is also observed in the NOF reference site (see Figure 2-7).

Figure 2-16. Variations in Roughness and Vegetation Patterns Between Foredune Restoration Area Treatments

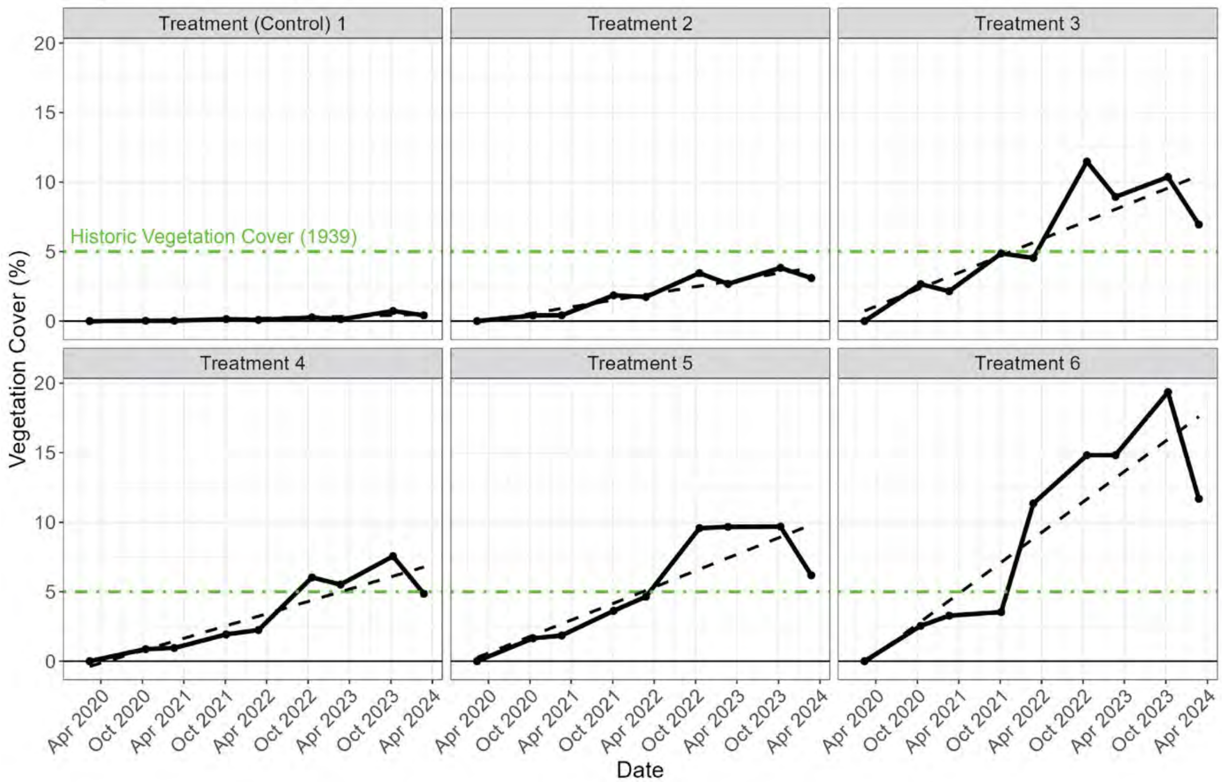


Examples of two distinct dune evolution responses emerging within the TPs. Nebkha chaining (example from TP 5 – High-Density Nodes) involves wind-aligned extension of nebkha and shadow dunes to form long, linear ridges that do not exhibit substantial wind-normal coalescence with proximal nebkha. Nebkha clumping (example from TP 3 – Native Seed and Grain Seed) refers to lateral coalescence of nebkha that produces discontinuous wind-normal dune ridges with some wind-aligned shadow dune extension that facilitates wider nebkha organization with a broader tail.

2.2.5.2 UAS Vegetation Coverage

NDVI values were calculated for all multispectral surveys to detect and map vegetation cover in the FRA TPs and changes over time. Percent plant cover (normalized by total area of each TP) has generally increased over time in all plots except for TP 1 – Control (see Figure 2-17 and Table 2-4). Since implementation, all restoration TPs (TP 2 – Native Seed to TP 6 – Parks’ Classic) have shown an increase in plant cover, with TP 6 – Parks’ Classic and TP 3 – Native Seed and Grain Seed, respectively, experiencing the fastest rates of vegetation establishment and the TP 1 – Control and TP 2 – Native Seed showing negligible to slow rates of plant cover to values that remain below the historical average. Historic plant cover in the FRA specifically, derived from aerial imagery back to 1939, was a maximum of 3.30% in 1939 and then declined to negligible cover by 1985.[32] Since 1985, there was no detectable increase in plant cover at the FRA until after implementation of the restoration treatments in 2020. Following restoration, plant cover had increased to an average of 6.55% across the entire FRA by February 2024.

Figure 2-17. Percent Vegetation Cover by Foredune Treatment



Plant cover (%) by TP over time derived from the multispectral UAS surveys from February 2020 (treatment implementation) through February 2024. Seasonal fluctuations are evident in most treatments due to declining cover before (February) and increasing cover after (October) the plant growth season. Linear regression fits (black, dashed line) show general trends of increasing vegetation cover, while the green dash-dot line is the peak extent of historic vegetation cover in 1966 (5.3%) within the foredune zone of the open riding and camping area in 1966 prior to establishment of the ODSVRA.[33] Corresponding values are shown in Table 2-4.

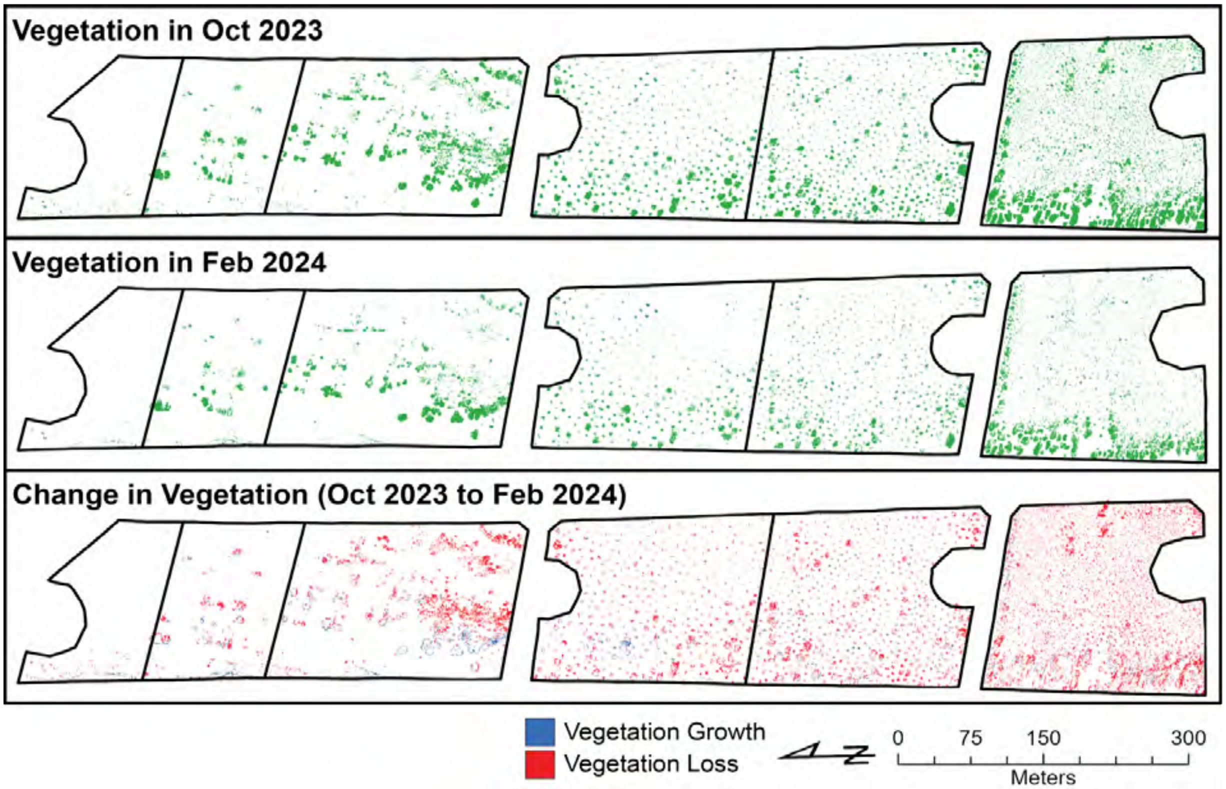
[32] Swet, N., Z. Hilgendorf, and I.J. Walker, 2022. UCSB Historical Vegetation Cover Change Analysis (1930-2020) within the Oceano Dunes SVRA. Technical report to the Oceano Dunes SAG and State Parks. 86 p. This technical report submitted to the SAG and State Parks is available in State Parks' 2022 ARWP (Attachment 07-04).
[33] Swet et al., 2022 (see footnote 32), and Hilgendorf et al., 2021 (see footnote 38).

Table 2-4. Percent Vegetation Cover by Foredune Treatment						
UAS Survey	**TP 1 - Control**	**TP 2 – Native Seed**	**TP 3 – Native Seed and Grain Seed**	**TP 4 – Low-Density Nodes**	**TP 5 – High-Density Nodes**	**TP 6 – Parks' Classic**
February 10-11, 2020	0.00	0.00	0.00	0.00	0.00	0.00
October 16, 2020	0.02	0.41	2.66	0.87	1.65	2.54
February 18-21, 2021	0.03	0.42	2.15	0.95	1.85	3.28
October 5-7, 2021	0.14	1.85	4.87	1.93	3.63	3.54
February 25-26, 2022	0.08	1.74	4.55	2.24	4.64	11.35
October 19-21, 2022	0.26	3.45	11.47	6.03	9.57	14.82
February 20-21, 2023	0.12	2.68	8.93	5.52	9.66	14.83
October 10-13, 2023	0.73	3.83	10.36	7.55	9.68	19.36
February 21-23, 2024	0.42	3.10	6.95	4.85	6.18	11.68

Interestingly, all FRA TPs showed a notable decrease in plant cover in this most recent interval (October 2023 to February 2024). The patterns of vegetation change for this recent interval are shown in Figure 2-18. While all plots recorded decreases in plant cover, TP 6 – Parks' Classic experienced the greatest loss (-7.70%), followed by TP 5 – High-Density Nodes (-3.50%), then TP 3 – Native Seed and Grain Seed (-3.40%). Figure 2-18 shows that declines in plant cover were widespread and relatively evenly distributed across all plots, as opposed to localized impacts along the seaward edge that could relate to high water impacts, for example. Although the cause of this decline is unknown, some combination of relatively wet winters, lower wind conditions (which reduce burial and inhibit the growth of many coastal plants[34]), and saltwater inundation from recent winter storms could be at play. It is unclear if this downturn reflects a plateau response in the plant community, or simply just natural variability as the ecosystem continues to develop. Regardless, continued monitoring is recommended to track progress in plant cover and, in conjunction with State Parks vegetation transect monitoring, to determine if there are particular species responses behind this recent decline in vegetation.

[34] Tobias, M.M., 2015. California foredune plant biogeomorphology. *Physical Geography*, 36(1), pp.19-33.

Figure 2-18. Patterns of Vegetation Change (October 2023 to February 2024)



Change in vegetation between October 2023 and February 2024. Green pixels indicate vegetation in the top two panels (October 2023 and February 2024). The bottom panel shows change in vegetation gains (blue) or losses (red) from October 2023 to February 2024.

2.2.5.3 Line-Intercept Transect Sampling

State Parks monitors changes in vegetation in dust control projects using line-intercept transect sampling and photo point monitoring. This section reports on the line-intercept transect sampling conducted in the 48-acre foredune during the 2024 ARWP reporting period.

The line-intercept method was used to estimate the percent cover of species within the 48-acre foredune project and one reference site that had been closed to vehicular activity for at least 20 years and not subject to restoration plantings in the past. State Parks sampled the following foredune areas in October 2023:

- The 48-acre foredune project (2020-VG-01, 2020-VG-02, and 2020-VG-03, planted in February 2020). This area was also surveyed in 2020 to 2022, and the same transect lines were surveyed in 2023.
- The NOF foredune reference site, which was surveyed in 2021 and again in 2023 to account for potential changes caused by storm surges or other environmental changes.

Four 30-m transects were sampled in each foredune TP and the reference foredune site (yielding 30 transects in total). Starting points for the transect lines were randomly selected using GIS software. Originally, three transect lines were randomly selected from the eight cardinal and intermediate directions (i.e., north, northeast, east, southeast, south, southwest, west, and northwest). In 2022, within the 48-acre foredune project area, a fourth transect line was added in each foredune treatment running in the direction of the prevailing northwest wind. A measuring tape was run along the transect and secured with wooden stakes. It is not uncommon for the wooden stakes to become buried or unburied by sand movement between sampling years. As a result, stakes must sometimes be re-established using a GPS unit, resulting in some variability in the transect beginning and ending points between years (estimated to be less than 1 m based on the GPS unit accuracy). As the vegetation canopy intersected the line, the species was noted on the datasheet along with the beginning and ending measurements of the canopy under “Start” and “Stop.” When the canopies of two different species overlapped, each species was documented separately as two different canopies. A closed canopy for a given species was assumed until gaps in vegetation exceeded the width of 5 cm. All dead woody vegetation was included separately and noted as “dead” unless it was clearly the result of seasonal dieback of a perennial plant that was still viable. Once each 30-m transect was surveyed, a reconnaissance-level survey[35] was conducted of the project area and any additional species observed were noted.

The results of State Parks’ 2023 line-intercept transect sampling are summarized in Table 2-5 and discussed below. Refer to Attachment 06 for detailed information on State Parks’ line-intercept sampling methodology and results.

In 2023, after the fourth growing season for the 48-acre foredune project, only TP 6 – Parks’ Classic, with 17.8% mean vegetation cover, exceeded the vegetation cover of the reference site (16.9% mean vegetation cover; see Table 2-5). The treatment type with the second highest mean vegetation cover was TP 5 – High-Density Nodes, with 11.3% mean vegetation cover. Four of the six different treatment types showed an increase in mean vegetation cover compared to last year’s (2022) transect sampling results: TP 2 – Native Seed, TP 4 – Low-Density Nodes, TP 5 – High-Density Nodes, and TP 6 – Parks’ Classic. One of the six treatment types (TP 3 – Native Seed and Grain Seed) and the NOF reference site showed a decrease in mean vegetation cover compared to the most recent prior transect sampling (2022 for the foredune project and 2021 for the reference site). As in previous years, TP 1 – Control did not show any vegetation cover on the transect lines, but during the reconnaissance survey new vegetation was documented growing on the western edge of the treatment area within debris piles deposited during storm surges the previous winter. This vegetation included both foredune-specific species, which are expected to persist, and wetland-specific species, which are not expected to persist. These

[35] In the reconnaissance-level survey, the entire FRA is searched for additional species by walking in belt transects of no more than 50 feet between surveyors.

wetland species include Marsh Jaumea (*Jaumea carnosa*) and California Club-Rush (*Schoenoplectus californicus*), both obligate wetland species, and Salt Rush (*Juncus lescurii*), a facultative wetland species.[36] It is assumed that plant materials of these wetland species were dislodged from nearby waterways during storm events, deposited within the foredune areas, and managed to persist through the summer. All of the wetland species were found with sporadic distribution along the western-most portion of the 48-acre foredune, were in poor health, and maintained very little cover. The species typically found in foredune habitat that were observed within the storm surge debris, specifically Red Sand Verbena (*Abronia maritima*) and Sea Rocket (*Cakile maritima*), appeared to be healthy and expanding in cover.

Two treatment types (TP 6 – Parks' Classic and TP 4 – Low-Density Nodes) matched the native species richness of the North Oso Flaco reference site with nine native species present (see Table 2-5); however, TP 4 – Low-Density Nodes had two species—Marsh Jaumea and Saltgrass (*Distichlis spicata*)—that were only present within the storm surge debris that was deposited on the shoreline during the previous winter. These species are not expected to persist in the foredune habitat into future years. When including non-native species, none of the 48-acre foredune project treatments met the species richness of the reference site, which had 11 total species present. Excluding wetland-specific species found in the storm surge piles, the foredune treatment with the most total species present was TP 6 – Parks' Classic (10 total species present. Four of the six different treatment types showed an increase in total species richness compared to last year's (2022) transect sampling results, including TP 1 – Control, TP 2 – Native Seed, TP 3 – Native Seed and Grain Seed, and TP 4 – Low-Density Nodes, while TP 5 – High-Density Nodes and TP 6 – Parks' Classic showed a decrease in total species richness.

[36] Wetland determinations are from U.S. Army Corps of Engineers National Wetland Plant List, version 3.5: https://wetland-plants.sec.usace.army.mil/.

Table 2-5. Summary of Foredune Line-Intercept Sampling Results			
Survey Site(A)	**Total Species Richness(B)**	**Mean Percent Cover**	**Range in Percent Cover**
2021(C)			
Foredune TP 1 – Control	0	0.0%	0.0%
Foredune TP 2 – Native Seed	4	1.9%	0.0% - 7.6%
Foredune TP 3 – Native Seed and Grain Seed	5	12.3%	0.0% - 28.7%
Foredune TP 4 – Low-Density Nodes	6	5.7%	0.0% - 13.0%
Foredune TP 5 – High-Density Nodes	10	2.1%	0.0% - 5.6%
Foredune TP 6 – Parks' Classic	8	12.7%	7.5% - 21.3%
Reference Site – NOF Foredune	10	23.0%	6.2% - 60.1%
2022(C)			
Foredune TP 1 – Control	2	0.0%	0.0%
Foredune TP 2 – Native Seed	3	2.7%	0.0% - 21.0%
Foredune TP 3 – Native Seed and Grain Seed	4	10.1%	0.0% - 24.8%
Foredune TP 4 – Low-Density Nodes	7	5.1%	0.0% - 8.6%
Foredune TP 5 – High-Density Nodes	9	6.4%	0.7% - 16.9%
Foredune TP 6 – Parks' Classic	10	13.8%	8.2% - 21.4%
Reference Site – NOF Foredune	10	23.0%	6.2% - 60.1%
2023			
Foredune TP 1 – Control	8	0.0%	0.0%
Foredune TP 2 – Native Seed	5	3.1%	0.0% - 12.5%
Foredune TP 3 – Native Seed and Grain Seed	7	6.7%	0.0% - 12.6%
Foredune TP 4 – Low-Density Nodes	10	7.9%	0.0% - 21.6%
Foredune TP 5 – High-Density Nodes	9	11.3%	0.0% - 30.5%
Foredune TP 6 – Parks' Classic	10	17.8%	5.7% - 44.3%
Reference Site – NOF Foredune	11	16.9%	0.7% - 42.7%

(A) The foredune was planted in 2020. All foredune treatment areas were approximately 3.5 years old at the time of the 2023 line-intercept sampling. State Parks typically conducts this survey once in September or October, when the survey will not disturb nesting Western Snowy Plover and California Least Tern.

(B) Values reflect total species richness (i.e., both native and non-native species).

(C) Refer to State Parks' 2023 ARWP, Section 2.3.6.1, Table 2-16.

2.2.5.4 Comparison of Vegetation Monitoring Results

State Parks line-intercept transect sampling methods were designed to monitor the establishment of vegetation cover and species richness within specific project areas. Two recent and independent reports [37,38] also evaluated vegetation cover within the ODSVRA using aerial imagery to analyze total vegetation cover, each using different imagery sources. Both studies were used to cross-reference the State Parks results.

The historical aerial imagery analysis of the NOF foredune[39] showed vegetation cover of 24.4% in 2012 and 19.1% in 2020, corroborating State Parks' transect results of 23.0% in 2021 and 16.9% in 2023. Variability of results for the State Parks method is expected due to small sample size (four transects), resetting of starting and stopping points with a handheld GPS unit, and differing survey dates from the UAS survey.

A comparison of FRA vegetation coverage results from line-intercept and UAS surveys[40] can be seen in Table 2-6 and Figure 2-19. It is noted the two studies had differing ways of defining vegetation cover and therefore variation in the results is expected. State Parks transect monitoring measured canopy cover, ignoring small gaps between leaves or stems (greater than [>] 5 cm), and included all parts of the vegetation canopy, not only the leaf cover, but also the woody stems, seasonally dormant plants, and dead woody vegetation. The UAS surveys used five-band multispectral imagery acquired from UAS surveys and NDVI method to determine vegetation cover (see Section 2.2.2). This is noteworthy because with NDVI method seasonal variations in cover are expected as seasonal changes in the leaf cover occur (i.e., NDVI does not tend to consider live woody stems or dormant vegetation that does not have photosynthesizing leaves). Species like Beach Primrose and Sea Rocket actively grow in the early spring but become dormant or desiccate entirely in the fall, leaving woody stems with little leaf cover This fluctuation in leaf cover may act in an opposite seasonal change for other species like Red Sand Verbena, which actively grows in the spring and summer and may have leaf yellowing in the winter. This could account for the reduction in cover from October to February, followed by an increase in the following October. In the back dunes, seasonal changes using NDVI are very apparent in the willow thickets within the vegetation islands which drop their leaves in the winter.

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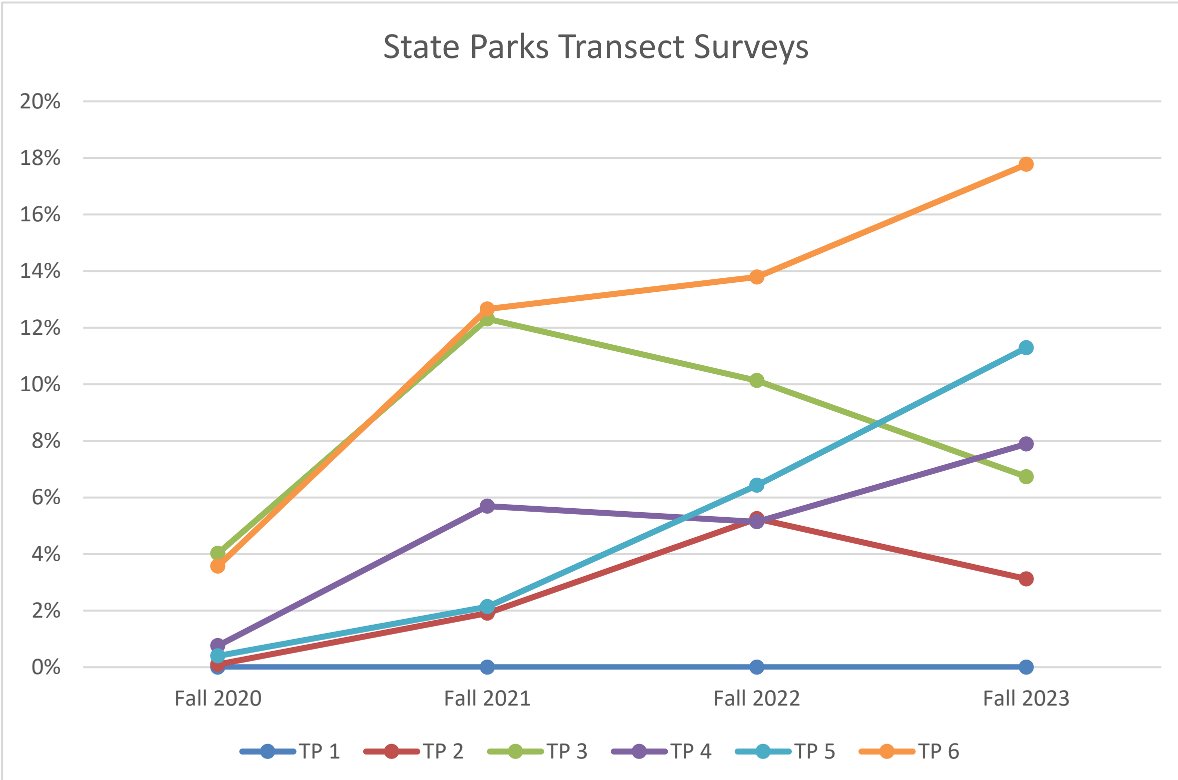
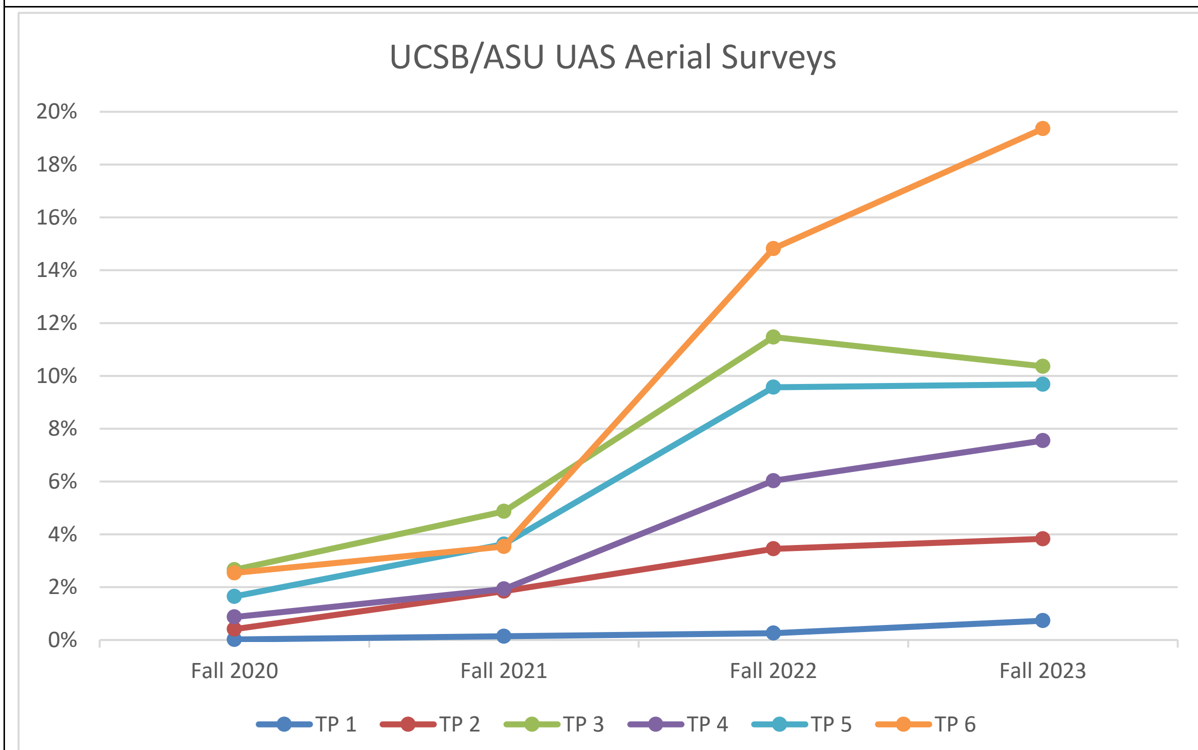
[37] Swet et al., 2022. See footnote 32.
[38] Hilgendorf, Z., C. Turner, and I.J. Walker, 2021. UCSB-ASU 2020-2021 ODSVRA Foredune Restoration UAS Survey Report. This technical report submitted to State Parks is available as Attachment 08 to State Parks' 2021 ARWP.
[39] Swet et al., 2022. See footnote 32.
[40] Hilgendorf et al., 2021. See footnote 38.

Table 2-6. Comparison of 48-Acre Foredune Treatment Vegetation Cover between State Parks Transect Monitoring and UAS Survey Report

Survey	Foredune Treatment Area Percent Vegetation Cover					
	TP 1 – Control	TP 2 – Native Seed	TP 3 – Native Seed and Grain Seed	TP 4 – Low-Density Nodes	TP 5 – High-Density Nodes	TP 6 – Parks' Classic
February 2020 - UAS Survey	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fall 2020 - State Parks Transects	0.0%	0.1%	4.0%	0.8%	0.4%	3.6%
October 2020 - UAS Survey	0.0%	0.4%	2.7%	0.9%	1.7%	2.5%
February 2021 - UAS Survey	0.0%	0.4%	2.2%	1.0%	1.9%	3.3%
Fall 2021 - State Parks Transects	0.0%	1.9%	12.3%	5.7%	2.1%	12.7%
October 2021 - UAS Survey	0.1%	1.9%	4.9%	1.9%	3.6%	3.5%
February 2022 - UAS Survey	0.1%	1.7%	4.6%	2.2%	4.6%	11.4%
Fall 2022 - State Parks Transects	0.0%	5.3%	10.1%	5.1%	6.4%	13.8%
October 2022 - UAS Survey	0.3%	3.5%	11.5%	6.0%	9.6%	14.8%
February 2023 - UAS Survey	0.1%	2.7%	8.9%	5.5%	9.7%	14.8%
Fall 2023 - State Parks Transects	0.0%	3.1%	6.7%	7.9%	11.3%	17.8%
October 2023 –UAS Survey	0.7%	3.8%	10.4%	7.6%	9.7%	19. 4%
February 2024 –UAS Survey	0.4%	3.1%	7.0%	4.9%	6.2%	11.7%

Figure 2-19. Vegetation Cover Comparison Between State Parks Transect Monitoring and UCSB/ASU UAS Surveys for Fall Surveys Only





When comparing surveys conducted within the same season, State Parks results follow a similar pattern as the UAS surveys, with vegetation cover generally increasing over time. TP 3 – Native Seed and Grain Seed is the exception to this trend by showing a decline of cover after 2021 in the State Parks surveys and a decline after 2022 in the UAS surveys. In addition, State Parks showed a decline of cover in TP 2 – Native Seed in 2023 which was not seen in the UAS survey. This inconsistency is likely a result of the State Parks method having a small sample size and a high degree of variability in cover between transects. This is apparent in the wide range of percent cover in the samples compared to the mean.

2.2.5.5 Time-Lapse and Photo Point Monitoring

This section reports on different foredune project photo monitoring methods undertaken UCSB and State Parks.

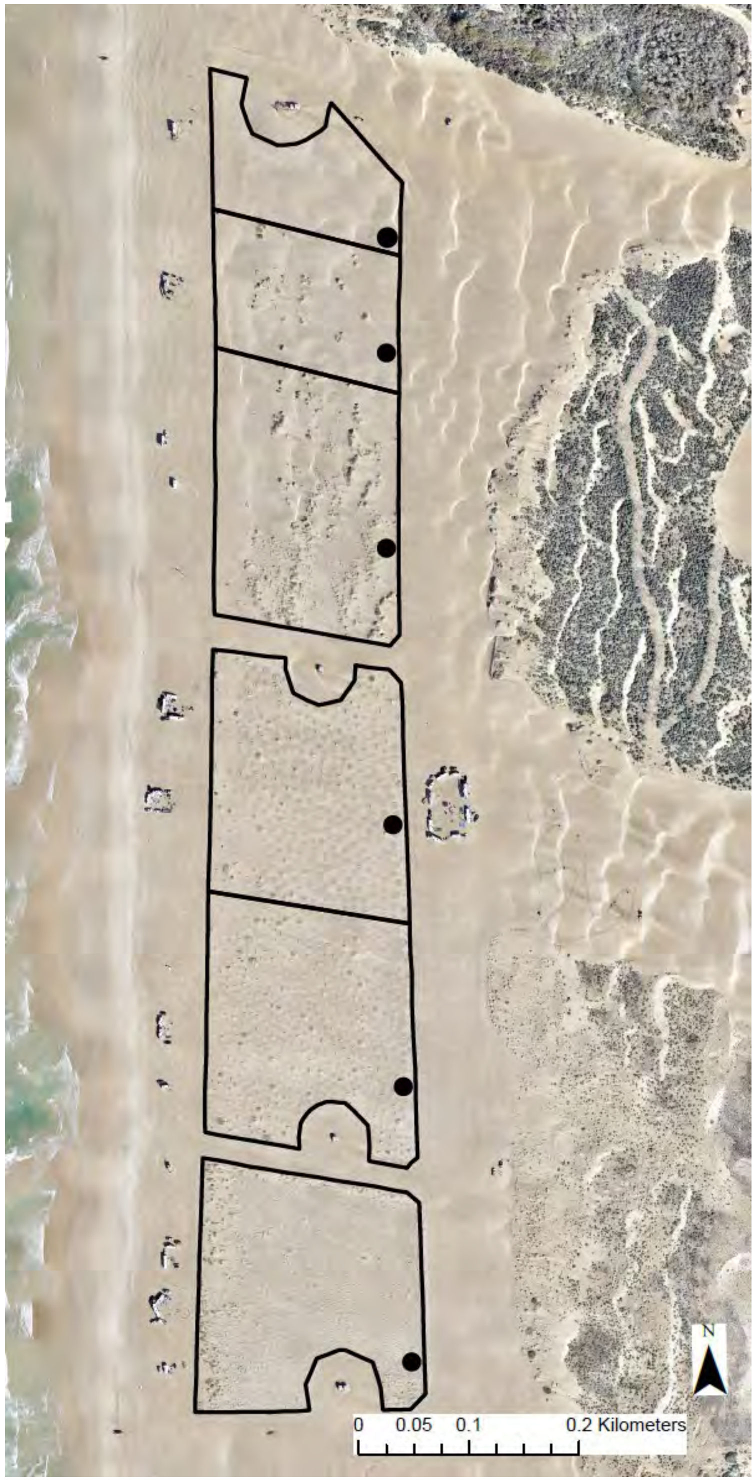
UCSB Time-Lapse Photo Monitoring

Results presented in this section are as reported in State Parks' 2023 ARWP (Section 2.3.6.3 and Attachment 09). As described in Section 2.2.3, these results were not reviewed by State Parks or the SAG prior to approval of the 2023 ARWP due to time constraints. The SAG provided a review and feedback in March 2024 and it was decided collectively with State Parks and the SLOAPCD that no further analyses would be undertaken beyond this proof-of-concept analysis. Refer to Attachment 05 for UCSB's preliminary report on time-lapse photo monitoring and the SAG's comments on this report.

In May 2020, State Parks, in coordination with UCSB, installed time-lapse cameras on each of the six foredune treatment area meteorological monitoring stations (see Figure 2-20). The purposes of the cameras are to observe and examine the development and response of the foredune restoration treatments to wind and sand transport events and characterize various formative events (e.g., sediment transport, plant growth, bedform development and migration, erosion events, etc.) at a relatively high temporal frequency. The time-lapse cameras face upwind, roughly west-northwest, and capture oblique images every 30 minutes from 7:00 AM to 5:30 PM local time.

Since deployment of the cameras in May 2020 to January 2023, over 20,000 images were captured at each restoration treatment area, although not all images were of acceptable quality due to fog, rain, lens fouling, and other factors. UCSB began preliminary analysis of the pre-processed imagery in late 2022, focusing on data collected over one month (January 2023) to test and verify methods of photo image analysis and provide insight into next steps, limitations, and benefits of the imagery for the restoration project.

Figure 2-20. 48-Acre Foredune Project Time-Lapse Camera Locations



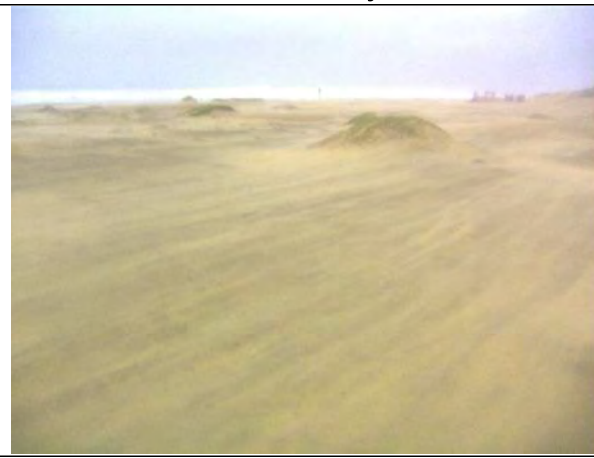
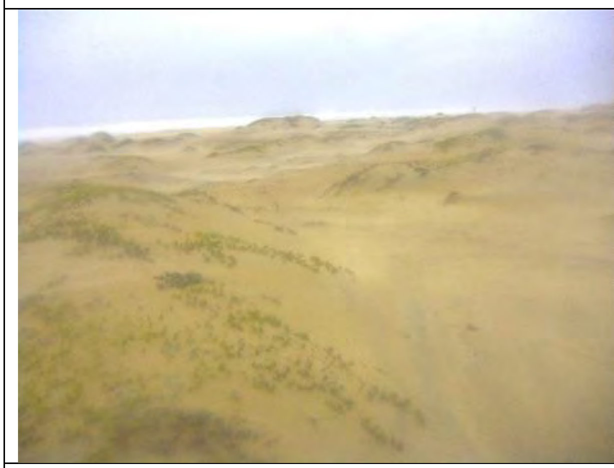
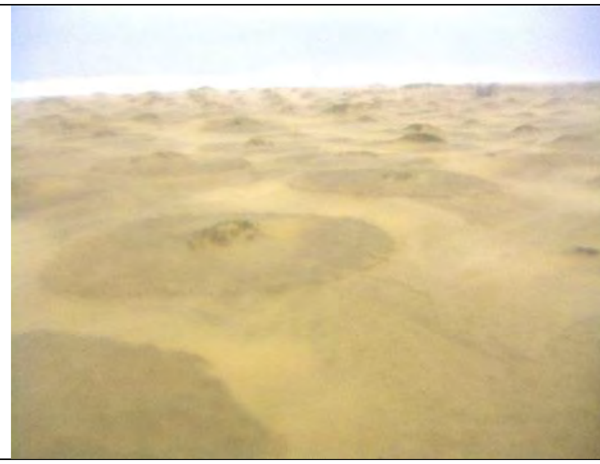
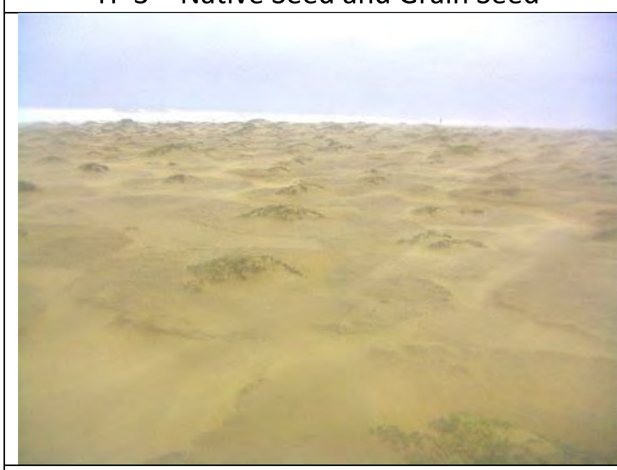
Locations of the meteorological stations (black dots) equipped with time-lapse cameras within each restoration plot. Orthomosaic is from February 2022. The northern-most plot is TP 1 – Control through to TP 6 – Parks' Classic at the south end of the FRA.

This preliminary proof-of-concept analysis focused on a subset of images from January 2023, almost three years after implementation of the foredune restoration treatments. Although January is typically not the most active month for sand transport, compared to later spring months, the data were collected during a very stormy season, which was beneficial for capturing both abundant sand transport events and challenging conditions for quality image capture. Over 17,000 quality images were obtained from each camera station during this interval, of which approximately 3,000 were used to identify various aeolian activity events. An example of imagery obtained from the cameras during a high-magnitude transport event is shown in Figure 2-21.

Images were classified using methods similar to those of Grilliot et al. (2019).[41] Aeolian activity was identified and coded based on visible transport or dune morphological changes between successive images (see Table 2-7). For example, if there was trace activity of aeolian sand transport in sunny dry conditions between two image frames, there would often be associated dune changes such as “dune migration,” “dune building,” “ripple movement,” and/or “surface accretion.” These types of conditions would result in a classification of 1,1,0 (see Table 2-7). The classification resulted in tabular data and time series graphs that were directly compared with the timing of wind events above the sand transport threshold of approximately 6.5 m s^{-1} at 3.5-m height (see Attachment 05). Corresponding wind data (speed and direction) from the same station were used to assess wind conditions and potential sand transport activity for each image. This assessment did not cross-correlate camera observations with on-site saltation measurements.

[41] Grilliot, M.J., I.J. Walker, and B.O. Bauer, 2019. The Role of Large Woody Debris in Beach-Dune Interaction. Journal of Geophysical Research: Earth Surface, 124(12), pp.2854-2876. See also Kalmikov, A., 2017 (see footnote 17); and Hilgendorf, Z., I.J. Walker, A.J. Pickart, and C.M. Turner, 2022. Dynamic restoration and the impact of native versus invasive vegetation on coastal foredune morphodynamics, Lanphere Dunes, California, USA. *Earth Surface Processes and Landforms*, *47*(13), pp.3083-3099.

Figure 2-21. Example Time-Lapse Photography from 48-Acre Foredune Project

	
TP 1 – Control	TP 2 – Native Seed
	
TP 3 – Native Seed and Grain Seed	TP 4 – Low-Density Nodes
	
TP 5 – High-Density Nodes	TP 6 – Parks' Classic

Example of time-lapse photography obtained from camera monitoring stations in foredune TPs. Images show a large sediment transport event on January 9, 2023, at 7:32 AM PST in TP 1 – Control through TP 6 – Parks' Classic.

Table 2-7. Time-Lapse Photo Monitoring Coding Key			
Key[(A)]	**Aeolian Transport**	**Dune Morphological Change**	**Meteorological Conditions**
0	Inactive	No change	Dry, sunny
1	Trace	Dune building, ripple formation/movement, sand accretion	Dry, cloudy, or overcast
2	Active	Evidence of sediment erosion, sand streamers, surface deflation	Fog
3	Widespread	Widespread saltation cloud	Wet or rain
(A) Coding key for monitoring camera image classification and analysis. Aeolian transport and associated dune changes are directly related and receive the same code.			

Results indicated that trace, active, and widespread aeolian events in January 2023 generally occur around the same time, but with some variation in timing and extent across the restoration plots. Events classified as “trace” or “inactive” occurred at nearly the same time across plots, but “active” and “widespread” events had the most variation. Similarly, the visibility of the different events varied across the TPs, with active sediment transport and sand streamers less detectable in plots with more vegetation and dune development, which introduces bias into the detection and interpretation of event activity. As a result, widespread activity was most visible in plots with little to no vegetation and limited nebkha dune development. Some trace transport events were also originally misclassified due to changes in surface moisture content. For instance, as sand surfaces dry out following wind or sun exposure, they often became lighter in color and emerging (dry, light) sand patches were misclassified as transport streamers. Time-lapse videos were used to discern between this type of surface response and actual aeolian sand transport and corrected accordingly.

Overall, there was a general lack of consistency in image quality and capture effectiveness across the TPs and over time due to factors such as changing illumination, sun angle, lens fouling from sea spray or dust films, precipitation, fog, etc. This posed a major challenge for the utility of the datasets to quantify and classify sand transport events. Semi-automated, human-guided “machine learning” (artificial intelligence) analytical methods could be used to more efficiently filter and identify aeolian activity events, although the consistency and quality issues, and related sampling biases, could not be overcome. As indicated above, time-lapse photography monitoring has been suspended and will not be pursued further at this time.

State Parks Foredune Photo Point Monitoring

State Parks has conducted on-the-ground photo point monitoring of the 48-acre foredune project since 2020. Initial photo point monitoring occurred before the installation of the foredune in February 2020. Subsequent monitoring has occurred in May 2020, October 2020, and each subsequent October since 2020. Photo points are located on all four corners of each treatment area. For each photo point, two photos are taken, each with one of the treatment area boundary lines on the outer edge of the photo with the interior of the treatment area centered in the photo. There is also one photo point overlooking the entire 48-acre foredune project area. Select ground photo point monitoring examples are shown in Figure 2-22.

In addition to on-the-ground monitoring, State Parks has also conducted drone, or UAS, aerial photo point monitoring of the foredune project. The initial UAS imagery was captured in May 2020, with subsequent UAS imagery captured in December 2020 and every winter since. Two photo points were taken of each treatment area (one from the east and one from the west for each area). Select aerial photo point monitoring examples are shown in Figure 2-23.

Refer to Attachment 06 for detailed information on State Parks' photo point sampling methodology and results.

Figure 2-22. Example Ground Photo Point Monitoring – Foredune Project

Ground photo point of foredune project TP 5 – High-Density Nodes facing south prior to planting (top photo taken February 4, 2020) and 3.5 years after treatment (bottom photo taken October 24, 2023). Red arrow indicates fixed restroom building for reference.

Figure 2-23. Example Aerial Photo Point Monitoring – Foredune Project

Aerial photo point of foredune project TP 3 – Native Seed and Grain Seed facing east prior to planting (top photo taken May 8, 2020) and four years after treatment (bottom photo taken February 14, 2024).

2.2.6 Backdune Monitoring

As described in Section 2.2.5.3, State Parks monitors changes in vegetation in dust control projects using line-intercept transect sampling and photo point monitoring. This section reports on the line-intercept transection sampling and photo point monitoring conducted in backdune areas during the 2024 ARWP reporting period. Refer to Section 2.2.5.3 for State Parks' report on foredune line-intercept transect sampling and Section 2.2.5.5 for State Parks' report on foredune photo point monitoring.

In general, State Parks uses the same line-intercept transect methods to monitor changes in foredune and backdune areas; however, within backdune habitats, early successional communities (early seral) and climax communities (late seral) can vary considerably in species composition and percent cover. For this reason, both early seral and late seral reference sites were sampled for comparison. In addition, while State Parks samples four 30-m transects in the foredune project and foredune reference site, only three 30-m transects are sampled in the backdune areas.

In October 2023, State Parks sampled the following three backdune vegetation projects east of marker posts 6 and 7 that were planted in 2021 (see Figure 2-2):

- A project near La Grille Hill (2021-VG-02, 4.1 acres);
- A project near the Eucalyptus Tree vegetation island (2021-VG-03, 7.9 acres); and
- A project near the Tabletop vegetation island (2021-VG-04, 5.5 acres).[42]

Each of the backdune project areas that were surveyed showed healthy levels of vegetation cover and had similar vegetation composition compared to the early seral reference site (see Table 2-8). Of the 20 native species present within the early seral reference site, the backdune projects had between 10 and 12 of them and a total richness (including non-native species) of between 14 and 19 species. The dominant species within the early seral reference site, Dune Bush Lupine (*Lupinus chamissonis*), showed similar percent cover between the different backdune projects and the early seral reference site with 24.0%, 31.0%, and 39.8% cover in the project areas and 29.2% cover in the early seral reference site. For overall cover, all project areas had lower percent cover than both reference sites; however, growth is anticipated to continue and percent cover is anticipated to approach the cover of the reference sites within the upcoming growing seasons. Refer to Attachment 06 for detailed information on State Parks' backdune line-intercept sampling methodology and results.

[42] Reference sites were not sampled during the 2024 ARWP reporting period. The late and early seral reference sites were last sampled by State Parks in 2021 and 2022, respectively.

Table 2-8. Summary of Backdune Line-Intercept Sampling Results				
Survey Site	**Age of Planting (Years)**	**Species Richness**	**Mean Percent Cover**	**Range in Percent Cover**
La Grille Hill (2021-VG-02)	2.5	14	48.6%	39.6% - 65.6%
Eucalyptus Tree (2021-VG-03)	2.5	19	44.6%	14.2% - 62.7%
Tabletop (2021-VG-04)	2.5	18	33.2%	0.4% - 65.2%
Reference site – early seral	-	22	68.8%	63.2% - 76.7%
Reference site – late seral	-	15	77.1%	76.2% - 78.7%

On-the-ground and aerial photo point monitoring of backdune projects was conducted using the same methodology described for the 48-acre foredune project. Backdune ground photo monitoring was initiated in 2018 and is usually conducted in the summer and/or fall of each year. In 2023, ground photo monitoring was conducted in the fall only. Backdune photo points are positioned to capture changes within the general areas where backdune projects are located. The number of photos for each photo point and the number of photo points vary at each location to sufficiently capture each area. In total, 41 photo points were monitored in 2023. Select backdune ground photo point monitoring examples are shown in Figure 2-24.

Backdune UAS photo points were initiated in December 2020, with subsequent imagery captures in December 2021 and every winter since, including December 2023. The number of photos for each photo point and the number of photo points vary at each location to sufficiently capture each area. Select backdune aerial photo point monitoring examples are shown in Figure 2-25.

Refer to Attachment 06 for detailed information on State Parks' photo point sampling methodology and results.

Figure 2-24. Example Ground Photo Point Monitoring – Backdune Project

Ground photo point of backdune project 2021-VG-03 (near Eucalyptus Tree vegetation island) facing southwest prior to planting (top photo taken October 17, 2020) and 2.5 years after planting (bottom photo taken October 30, 2023). The red arrow indicates a fixed stake for reference.

Figure 2-25. Example Aerial Photo Point Monitoring – Backdune Project

Aerial photo point of backdune projects near Bigfoot vegetation island (2020-VG-04 and 2021-VG-01) three years after vegetation planting (top photo taken February 16, 2023) and four years after vegetation planting (bottom photo taken February 14, 2024). Note: the darker areas near the top of the project area are established vegetation islands (i.e., not dust control projects).

2.3 REPORT ON PROGRESS TOWARD AIR QUALITY OBJECTIVES

Due to the changes in SOA requirements over time, this 2024 ARWP report on progress toward air quality objectives is different from previous ARWP documents. Whereas prior documents summarized the status of individual project requirements (e.g., status of 48-acre foredune installation), mass emissions reduction requirements (i.e., achieve a 50% reduction in 24-hour PM_{10} mass emissions, as compared to specific 2013 baseline conditions), and concentration-based air quality standard requirements (e.g., 24-hour PM_{10} concentrations), this 2024 ARWP report focuses on the overall improvement in air quality conditions downwind of the ODSVRA and the reduction in mass emissions that has occurred within the ODSVRA pursuant to the SOA's excess emissions methodology. This section provides the following:

- An updated DRI "Increments of Progress" report (Section 2.3.1) that provides the latest information on the relation between wind power, dust control projects, and downwind PM_{10} concentrations. As prior ARWPs also included an "Increments of Progress" report, this section provides some continuity with the information provided in past ARWPs.
- A description of the development, approach, and results for the new excess emissions modeling methodology (Section 2.3.2). While State Parks' 2023 ARWP provided preliminary information on an excess emissions methodology, this methodology was not final. State Parks, in consultation with the SAG and the SLOAPCD, has worked to develop and refine the SOA's excess emissions modeling requirement. Therefore, the results of the excess emissions modeling are new and have not been reported in any previous ARWP document.
- Updated evaluation metrics for the 2023/2024 period (Section 2.3.3).
- A brief report on track-out control (Section 2.3.4), which has remained a requirement of the SOA, as amended, and therefore has been reported on in prior ARWPs.

2.3.1 INCREMENTS OF PROGRESS TOWARD AIR QUALITY OBJECTIVES

As described in Section 2.1, dust control projects such as temporary wind fencing, straw treatments, and vegetation have been used within the ODSVRA to reduce PM_{10} emissions originating from the ODSVRA and to lower the regional PM_{10} burden on the Nipomo Mesa. Since 2013, when there were effectively no dust control projects in place at the ODSVRA, the amount of acreage managed for dust control purposes has increased to 412.2 acres of specific dust control projects and 740.1 acres of total Dust Control Program area (including other operational activities such as the closed nesting exclosure and the seasonally closed foredune beach and corridor areas) as of July 31, 2024 (see Figure 2-2).

The PM_{10} data measured at the CDF and Mesa2 stations and the wind data measured at State Parks' S1 meteorological tower, or at other suitable meteorological network monitoring stations (see Section 2.2.1), can be used to demonstrate that the dust emission system in the ODSVRA produces less PM_{10} now than it did prior to the emplacement of dust controls and that this reduction in PM_{10} scales with the increase in acres managed for dust control purposes. The metric used to evaluate the production of PM_{10} from the ODSVRA is the ratio of TPM_{10} (in µg m^{-3}) and TWPD (in W m^{-2}; see Section 2.2.1) during a set time period. This ratio serves as a metric to evaluate how the dust emission system is changed by modifications to or in the landscape. With no changes to the surface from which the emissions originate, this ratio will reflect the efficiency of the wind and saltation system to produce PM_{10} for the prevailing environmental conditions during the period of interest and should remain stable if the environmental conditions remain stable. If, however, the surface from which the emissions are originating is changing—for example, by removal of the PM_{10} source material or coarsening of the surface sand (i.e., increasing mean grain diameter) or the implementation of dust control projects—the ratio should diminish as dust production by saltation processes becomes less efficient in emitting PM_{10} dust. Conversely, if the ratio increases through time, it indicates that the source area is producing greater amounts of PM_{10} for similar conditions of TWPD.[43]

DRI has prepared an analysis of the relation between the TPM_{10}/TWPD ratio and acres of dust control using data from April to September 2013 to 2023 from the SLOAPCD's CDF and Mesa2 air quality monitoring stations and State Parks' S1 meteorological tower (see Attachment 07). The metric used to evaluate the production of PM_{10} from the ODSVRA is the ratio of TPM_{10} (µg m^{-3}) measured with a BAM PM_{10} monitor operated by the SLOAPCD and TWPD (W m^{-2}) as measured at the S1 tower within the ODSVRA, for winds that are expected to cause saltation and dust emissions during a set period of time, specifically the spring-summer period from April through September, which is typically considered the windy season in the region.

The following constraints were applied for the available environmental data:

1) A wind speed filter was applied based on screening for the conditions where it was most likely that the PM_{10} reaching CDF and Mesa2 was due to the generation of dust by saltation within the ODSVRA. Winds from 248 degrees (°) to 326° were used to ensure, conservatively, that the air flow that reached CDF and Mesa2 had most likely traveled from the ODSVRA.

[43] According to DRI, there is a limit to the explanatory power of this ratio, which is that if winds are at, or close to, the designated threshold speed either at the monitoring location or in the source area for a large part of the record, the value becomes unstable due to a potential paucity of data but also because as wind speed diminishes the strength of the coupling between the wind and the saltation-generated PM_{10} weakens and is subject to influence of PM_{10} from other sources. Thus, the values of the ratio become unreliable at diminished wind speed.

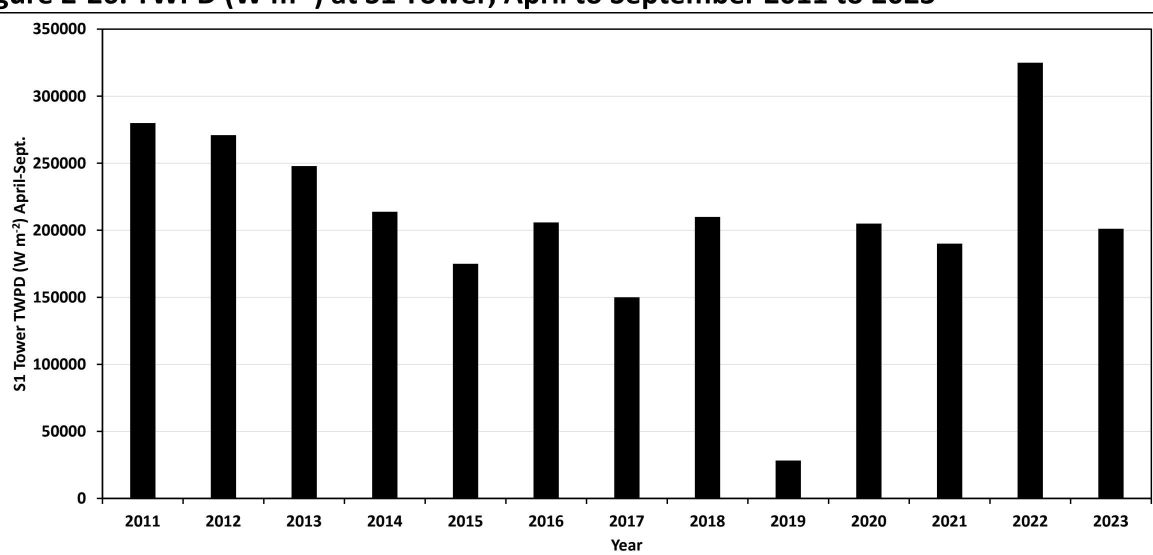
2) Wind speed that indicated the initiation of a relation with increasing PM_{10} at the CDF and Mesa2 sites was determined from data that relate PM_{10} to wind speed measured at each of these two sites.
3) Based on precipitation data for monitoring sites near the ODSVRA, the number of days when precipitation was found to occur prior to the hour of observation was identified. Hours of observation were removed from analysis if precipitation was observed less than three days prior.[44]

To standardize the calculation of TWPD, a lower limit of wind speed is chosen that corresponds with the lowest speed where the relation between increasing wind speed and simultaneous increase in PM_{10} is observed at a monitoring station. As in previous years, a wind speed of 3.5 m s^{-1} at 10 m AGL (WPD = 26 W m^{-2}) for CDF and Mesa2 defines the lowest value for the range over which PM_{10} is summed at these stations to calculate TPM_{10}. TWPD is the summation of the hourly mean wind speed measured at the S1 tower for the hours identified at CDF or Mesa2 that correspond to hourly mean wind speed ≥3.5 m s^{-1} (after screening for the wind direction and precipitation criteria).

2.3.1.1 TWPD, April to September 2011 to 2023

To place the wind conditions into context across the available S1 tower data record, 2011 to 2023, TWPD for the period from April to September in each year was calculated (see Figure 2-26). For 2023, TWPD for the period from April to September is similar to, i.e., within -2% to 5.5% of, the values for 2018, 2020, and 2021. In the 13-year record from 2011 to 2023, 2019 had the lowest observed values and 2022 the highest observed values of TWPD.

Figure 2-26. TWPD (W m^{-2}) at S1 Tower, April to September 2011 to 2023

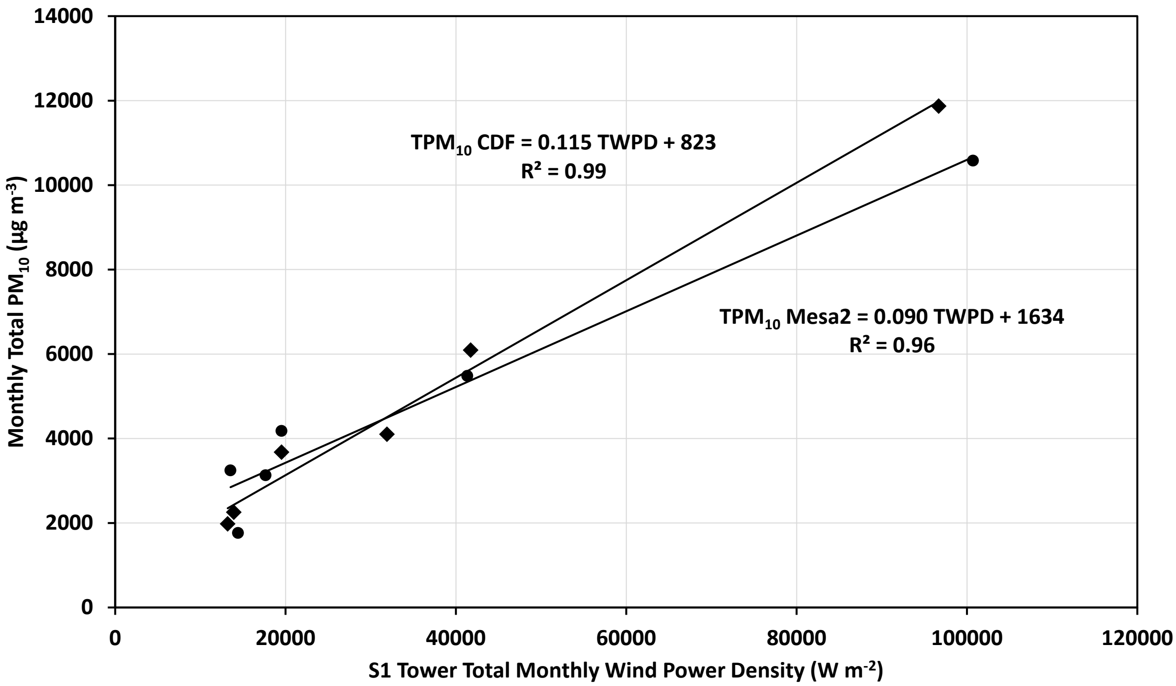


[44] DRI used meteorological data collected at the Oceano Airport to identify rain events in the vicinity of the ODSVRA. DRI selected the three-day window to ensure that the surface was dry following a precipitation event.

2.3.1.2 TPM10 and TWPD, April to September 2013 to 2023, CDF and Mesa2

As shown previously,[45,46,47] TWPD, i.e., the summation of hourly mean wind speed for a defined period, measured at S1 correlates with total PM_{10} at CDF and Mesa2.[48] This relation was also observed for the 2023 data (see Figure 2-27).

Figure 2-27. Relation Between TPM_{10} ($\mu g\ m^{-3}$) and TPWD ($W\ m^{-2}$) at SLOAPCD CDF and Mesa2 Monitoring Stations



The relation between monthly TPM_{10} and monthly TWPD for all hours when the wind direction was from 248° to 326° observed at CDF (diamonds) and Mesa2 (circles), the wind speeds were ≥3.5 $m\ s^{-1}$ (at CDF and Mesa2), and hours wherein there were fewer than three days since the last record of precipitation were removed.

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[45] Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2020. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for State Parks and the SAG. December 2020.

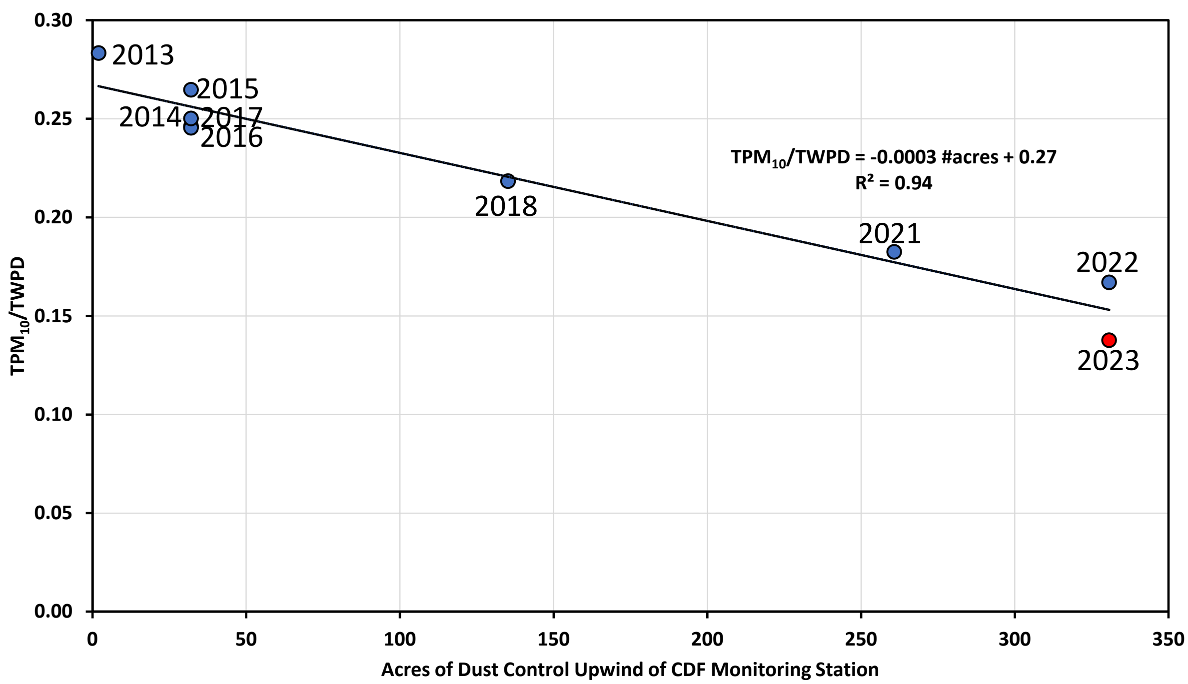
[46] Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2021. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for State Parks and the SAG. December 2021.

[47] Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2022. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for State Parks and the SAG. December 2022.

[48] Gillies et al., 2020 (see footnote 45); Gillies et al., 2021 (see footnote 46); Gillies et al., 2022 (see footnote 29).

Based on the number of acres of dust control that have been established from 2013 through 2023 upwind of CDF, Figure 2-28 shows that at CDF for the period from April through September a downward trend in the TPM_{10}/TWPD ratio with increasing amounts of dust control acreage has been observed. There are, however, two years of data that have not been included. In 2019 there were few hours when the winds exceeded the lower limit of wind speed to define the summation interval (i.e., $\geq$3.5 m s^{-1} at CDF and Mesa2), which due to the paucity of higher wind speeds leads to an unstable ratio condition (see footnote 43). The TPM_{10}/TWPD ratio for 2020 was also not included in the least squares regression as during April through September of that year OHV activity at the ODSVRA was restricted due to COVID-19.

Figure 2-28. Relation Between TPM_{10}/TWPD Ratio Measured at SLOAPCD CDF Monitoring Station and Acres of Dust Control Upwind of CDF

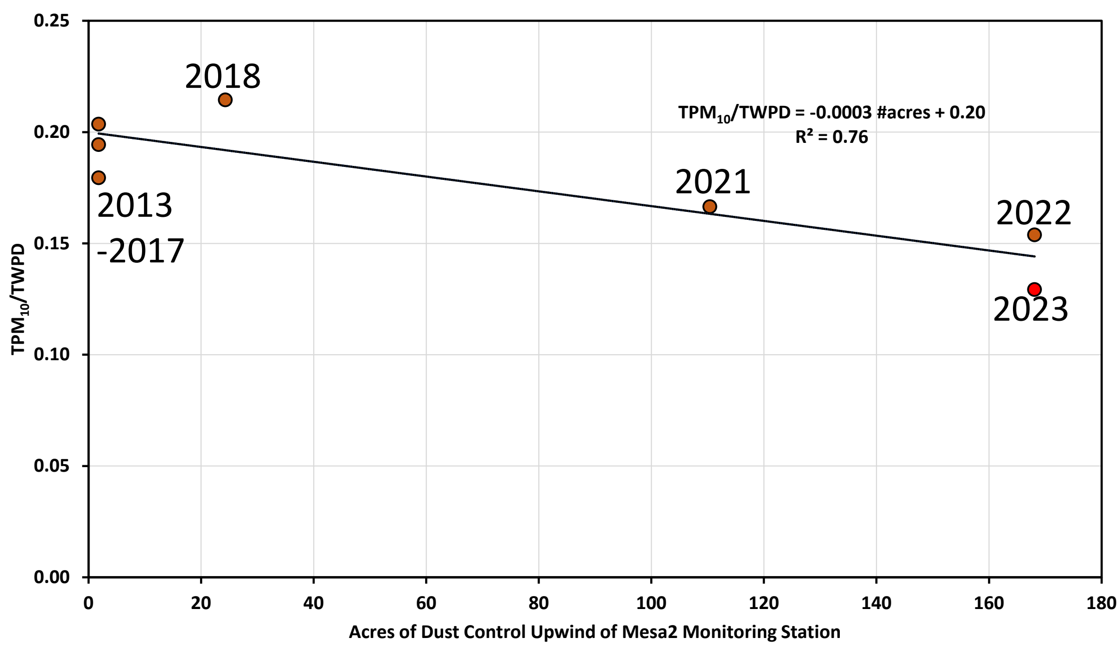


The relation between the TPM_{10}/TWPD ratio measured at CDF and the acres of dust control from 2013 through 2022 placed upwind of CDF in the directional range 270° to 325°. Note: 2014 and 2017 data align on top of each other, and data from 2019 and 2020 were excluded as discussed in this section.

Figure 2-28 indicates that the 2023 CDF TPM_{10}/TWPD ratio value supports the established downward trend in this dust emission metric even though the acres of dust control remained the same in 2023. The percentage change in the TPM_{10}/TWPD ratio from 2022 (0.17) to 2023 (0.15), a decrease of 11%, may be reflective of natural variation in the dust emission system and the transport of PM_{10} from different source areas within the ODSVRA to the receptor site. The distribution of wind direction at the S1 tower is similar between 2022 and 2023, but a shift in wind direction in 2023 favored more westerly directions in April through September, although the shift was not as great as observed at CDF. The continued decrease in the TPM_{10}/TWPD ratio in 2023 at CDF could also be due, in part, to the dust control management strategies having increased their effectiveness due to the maturation of the vegetation within the control areas and due to State Parks maintenance practices. Larger plants and increased cover should increase the degree to which the vegetation absorbs momentum and increases the area sheltered from erosive winds.

The ratio of TPM_{10}/TWPD for Mesa2 and S1 data for the period April through September for the years 2013-2023 as a function of acres of dust control upwind of Mesa2 is shown in Figure 2-29. This figure shows that a downward trend in the TPM_{10}/TWPD ratio is observed with increasing acres of dust control upwind of Mesa2 for the period 2018-2022. Prior to 2018, there was no clear trend in the TPM_{10}/TWPD ratio data as there were few acres of dust control upwind of the Mesa2 monitoring station.

Figure 2-29. Relation Between TPM_{10}/TWPD Ratio Measured at SLOAPCD Mesa2 Monitoring Station and Acres of Dust Control Upwind of Mesa2



The relation between TPM_{10}/TWPD ratio measured at Mesa2 and the acres of dust control from 2013 through to 2023 placed upwind of Mesa2 in the directional range 270° to 305°. Note: for the 2013-2017 data points, some years are aligned on top of one another, and data from 2019 and 2020 were excluded as discussed in this section.

Figure 2-29 indicates that a downward trend in the TPM_{10}/TWPD ratio through time for Mesa2 is supported with the inclusion of the 2023 datum. The data for 2019 and 2020 were not included in the analysis as described above for the CDF site. In 2023, the TPM_{10}/TWPD ratio (0.13) was approximately 15% lower than in 2022 (0.15), a reduction similar to that observed at CDF.

DRI's analysis demonstrates that TWPD is a robust metric for explaining the relationship between wind-driven saltation and the accompanying emission of PM_{10} from the ODSVRA as measured at two key receptor sites, CDF and Mesa2. The TWPD and TPM_{10} measurement-based metric indicates that the PM_{10} originating from the ODSVRA has been reduced by approximately 44.5% at CDF using the two-year (2022 and 2023) mean value of 0.16 for equivalent WPD conditions compared with the baseline year of 2013 when there were few acres of dust control upwind of the CDF station. For Mesa2, the TWPD and TPM_{10} measurement-based metric indicates that the PM_{10} originating from the ODSVRA has been reduced by approximately 21% using the two-year (2022 and 2023) mean value of 0.14 for equivalent WPD conditions compared with the baseline year of 2013 (0.18) when there were few dust controls in place at the ODSVRA.

2.3.2 Excess Emissions Modeling

This section provides background information on the excess emissions modeling methodology developed pursuant to the SOA, as amended; describes State Parks current approach to the excess emissions modeling; and presents the results of the modeling conducted by DRI, in coordination with the SAG, that shows the ODSVRA does not emit dust to a level that is in excess of naturally occurring conditions.

2.3.2.1 Background on Excess Emissions Model Development (2013 to 2023)

As introduced in Chapter 1, the methodology for monitoring progress toward the SOA's primary compliance objective has changed in substantive ways since the original SOA was filed on May 3, 2018. The original SOA required an initial target reduction of 50% in 24-hour PM_{10} emissions based on air quality modeling for the period May 1 through August 31, 2013. By agreement between State Parks, the SLOAPCD, and the SAG, the baseline emissions target was calculated using only the 10 highest emission days in the 2013 period. The wind conditions for these 10 days were modeled using a down-scaled version of CALMET to coincide with the grid cell sizes (21 m by 21 m) in the DRI emission-dispersion model developed as part of State Parks' initial SOA compliance tasks, [49] which incorporated recent topography in the form of a DTM for bottom boundary conditions supplemented with land-cover classification (e.g., bare sand, vegetation, water) to characterize surface roughness conditions. The wind model was calibrated and tested against measurements from multiple locations within the ODSVRA and

[49] Mejia, J.F., J.A. Gillies, V. Etyemezian, and R. Glick, 2019. A very-high resolution (20 m) measurement-based dust emissions and dispersion modeling approach for the Oceano Dunes, California. Atmospheric Environment, 218, 116977, doi: 10.1016/j.atmosenv.2019.116977.

adjoining areas as well as with data from offshore stations and upper air.[50] The dust emission potential (emissivity) of every grid cell was quantified individually on the basis of the CALMET wind output and an interpolated emissivity surface that used PI-SWERL measurements collected during the 2013 campaign. **Following these procedures, the baseline emissions value was set at 182.8 metric tons per day for the ODSVRA, with a target emissions value of 91.4 metric tons per day established according to the 50% reduction prescription.**

A great deal of effort has been devoted to mitigating dust emissions from the ODSVRA as well as to monitoring progress toward the emissions target, as detailed in previous ARWPs. Many of the emissivity hot spots identified in earlier modeling scenarios were subsequently treated with surface covers and vegetation plantings as well as OHV access restrictions. In 2019, another comprehensive set of PI-SWERL measurements was taken, which showed that overall emissivity values across the entire ODSVRA were generally smaller than those collected in 2013 (for reasons that remain unexplained but may be related to a prolonged drought in California that extended through 2013). Accordingly, in coordination with the SAG, subsequent runs of the DRI model (beginning with the 2022 ARWP) used the 2019 PI-SWERL measurements to create the interpolated emissivity grid rather than the 2013 measurements, which reduced the dust emissions estimates from the contemporary landscape scenarios below what may have been anticipated due to land-cover treatments (i.e., dust mitigation projects) alone.

Updated understanding of dust emissions from the ODSVRA informed by multiple years of data collection by State Parks contractors through 2022 led the SAG to make scientific-based recommendations regarding a revised emissions target that required only a 40.7% reduction from the 2013 baseline (rather than the original 50% reduction).[51] **The new target value was set at 108.4 metric tons per day (i.e., to a level that is 59.3% of the 2013 baseline value of 182.8 metric tons per day),** and this revised target was predicated on modeled emissions from a "pre-disturbance" landscape scenario using a 1939 vegetation cover mask.

In October 2022, a second amendment to the SOA was filed that modified the language to describe the emissions targets as those that "eliminate emissions in excess of naturally occurring emission from the ODSVRA" (SOA Amendment Section 3.b.) and "reduce mass-based PM_{10} emissions within the ODSVRA to a level consistent with the pre-disturbance scenario" (SOA Amendment Section 3.c.). This constitutes an important shift in interpretation of how compliance is to be assessed because the emissions target is no longer a hard target based on either the 2013 emissions scenario (91.4 metric tons per day) or the 2019 emissions

[50] Ibid.

[51] The SAG's February 7, 2022, memorandum "Scientific Basis for Possible Revision of the Stipulated Order of Abatement" provides information on the SAG's recommendations for potential revisions to the SOA's emissions targets and information on modeled pre-disturbance conditions. This SAG memo is available for review on the following State Parks' website (under "Commission Meeting: February 17," "Memo: Scientific Basis for Possible Revision of the Stipulated Order of Abatement (SOA)"): https://ohv.parks.ca.gov/?page_id=30832.

scenario (108.4 metric tons per day), but rather a relative target pinned to a "pre-disturbance" scenario that is consistent with "naturally occurring emissions" from the ODSVRA.

2.3.2.2 Current Approach to Excess Emissions Modeling

In the 2023 ARWP, a SAG-proposed conceptual framework for assessing excess emissions was discussed.[52] This potential avenue for assessing compliance is based on a proven relationship between TPM_{10} and TWPD (see Section 2.2.1 and Section 2.3.1). A baseline curve was to be established that characterizes the modeled emissions from the pre-disturbance landscape, against which were to be plotted measurements of contemporary dust events to determine exceedance or compliance.[53] At the request of State Parks and the SAG, a proof-of-concept study was undertaken by DRI,[54] but the framework was ultimately rejected. Discussions between personnel from State Parks, the SLOAPCD, and the SAG leading to the conditional approval of the 2023 ARWP indicated that the proposed approach had many modeling uncertainties and was too complex to implement in a regulatory manner. As a consequence, State Parks, the SAG, and the SLOAPCD worked to refine the approach to, and definition of, excess emissions, and arrived at the current concept of quantifying mass emissions from the ODSVRA using PI-SWERL measurements rather than modeling PM_{10} concentrations at monitoring stations such as CDF and Mesa2. [55] In accordance with these directives, a new approach for quantifying excess emissions was proposed by the SAG for purposes of compliance assessment, and this updated approach was agreed to by State Parks and subsequently approved by the SLOAPCD in February 2024.[56] The SAG-recommended and SLOAPCD-approved approach to quantifying excess emissions is included as Attachment 08 to this 2024 ARWP.

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[52] See State Parks' 2023 ARWP, Section 3.3.1 and Figure 3-2.

[53] This process is described in more detail in the SAG's January 30, 2023, memo "Framework for Assessing "Excess Emissions" of PM_{10} from the Oceano Dunes." See State Parks' 2023 ARWP, Attachment 11-04.

[54] DRI's proof of concept is contained in its April 6, 2023, memo: "Framework for Assessing "Excess Emission" of PM_{10} from the Ocean Dunes – Phase 1: Modeled TPM_{10} for CDF, Mesa2, and S1 Tower, and TWPD for S1 Tower for 1939 (as previously modeled) and 2013 (as previously modeled)." See State Parks 2023 ARWP, Attachment 11-04.

[55] Letter from Dr. Bernard Bauer (Chair, SAG) to Ms. Sarah Miggins (Deputy Director, State Parks) and Mr. Gary Willey (Air Pollution Control Officer, SLOAPCD) dated September 14, 2023. This letter is available on the following SLOAPCD website (under "Fall 2023 Update," "SAG Memo – Summary of Executive Discussion"): https://www.slocleanair.org/air-quality/oceano-dunes-efforts.php.

[56] Letter from Mr. Gary Willey (Air Pollution Control Officer, SLOAPCD) to Ms. Sarah Miggins (Deputy Director, State Parks) dated February 8, 2024. This letter is available on the following SLOAPCD website (under "Winter 2023 Update, Approval of Emissivity Assumptions, February 8, 2024"): https://www.slocleanair.org/air-quality/oceano-dunes-efforts.php.

The current methodology for assessing excess emissions differs from previous approaches in the following fundamental ways:

1) **The ODSVRA is sub-divided into management zones or sub-regions, each of which is assigned a different emissivity power relation based on PI-SWERL samples in that specific zone.** This differs from the previous approach, which characterized surface emissivity across the ODSVRA using a continuously varying interpolated emissions surface. The original interpolated emissions surface used in early modeling scenarios was based on the 2013 PI-SWERL campaign measurements, and this was the most logical approach at the time because:

   a) The 2013 PI-SWERL campaign was the only one available at the time that covered the entire ODSVRA (riding and non-riding areas);

   b) Each of the model grid cells (n = 185,505) in the DRI emission-dispersion model requires an emissivity power relation to quantify mass emissions from each grid cell, whereas the PI-SWERL measurement locations do not cover every grid cell, thus mandating an interpolation surface; and

   c) There was a need to identify emission hot spots for potential priority mitigation projects.

   After the 2019 PI-SWERL campaign was conducted, a decision was made to use the 2019 data (n=531) rather than 2013 data (n=329), and another interpolated emissions surface was created using only the 2019 data for implementation in the DRI model. Again, this interpolation approach made sense at the time because of the need to characterize each of the model grid cells with an emissivity power relation. The newest 2019 data were thought to be more reflective of recent conditions from the ODSVRA than the 2013 data. Moreover, there is no simple, defensible way to combine PI-SWERL data from multiple campaigns (e.g., 2013 and 2019) for purposes of creating a single interpolated surface, so it becomes an "either/or" proposition.

   The current approach avoids the restrictions imposed by an interpolated emissions surface by identifying zones or sub-regions within the ODSVRA for which the land-cover and land-use characteristics are internally homogeneous and distinct from other zones or sub-regions. Each of these areas is characterized by a different emissivity power relation using PI-SWERL measurements taken in only those areas. The boundaries of the zones and sub-regions are established using a GIS, which is subsequently draped over the DRI model domain so as to assign an emissivity power relation to each of the 185,505 grid cells. The model runs are simplified and less computationally intensive because there are only a small number of power relations characterizing the entire ODSVRA (i.e., neighboring grid cells within a specific management zone have identical power relations) rather than needing to create distinct power relations for every grid cell based on the interpolated emissions surface.

The details of the zonation and development of the emissivity power relations appear in the SAG memo in which a thorough analysis of the PI-SWERL data collected from 2013 through 2022 is presented (see Attachment 08).

2) **Use all PI-SWERL data whenever feasible and prudent.** A total of 1,783 PI-SWERL measurement locations, unequally distributed in time and space, were sampled in the ODSVRA between 2013 and 2022. Each sampling location has three measurements of dust emissions (at three speed settings), and this very large dataset provides robust opportunities for statistical analysis of the temporal and spatial variability in emissivity. The nature of this variability is not adequately captured by any single PI-SWERL measurement campaign, and therefore it was agreed by all parties (SAG, State Parks, and the SLOAPCD) that all the available PI-SWERL data should be used whenever possible to characterize the surface emissivity characteristics of the ODSVRA (with some minor exceptions where it is not prudent to do so). In general, then, the emissivity power relations are quantified on the basis of all data collected from 2013 through 2022. Additional PI-SWERL measurements in 2024 and subsequent years will be integrated into the global dataset, and new emissivity power relations will be calculated as new data become available.

3) **Use the MEDIAN rather than the MEAN in the construction of emissivity power relations.** PI-SWERL data for different zones do not follow a “normal” (Gaussian) statistical distribution having equal tails at the low and high ends and symmetry about the mean. The data distributions are invariably “right-skewed” (positive skewness) with most measurements clustering at the low end and a long tail with only a few measurements extending to the high end of the emissivity range. The more appropriate statistical parameter to describe skewed distributions is the median (middle value with equal number of values above and below the median) rather than the mean (average value). The use of the median to quantify the emissivity power relations was recommended by the SAG and agreed to by State Parks and the SLOAPCD.

4) **Use of SigmaPlot rather than Excel to fit curves to the PI-SWERL data to establish emissivity power relations.** Different statistical software programs use different curve-fitting algorithms depending on purpose. Microsoft Excel, which is a very common spreadsheet program, prioritizes computational speed and simplicity, and uses linear regression techniques (which are very fast) to optimize the curve fit to the data. Unfortunately, in order to do so, the data are initially converted into logarithmic values so as to linearize the exponential trends, and after the curve-fitting is optimized, the regression parameters are converted back from logarithms to standard arithmetic format. This has consequences for how the low end and high end of the data range are treated, often

yielding inaccurate curve fits to the large emissivity range (which is arguably of greatest importance to modeling dust emissions). Other statistical software programs (such as SigmaPlot) are less concerned with computational speed and use a non-linear curve-fitting approach applied to the raw data directly. This provides more robust curve fits and better regression parameters for the emissivity power relations. The use of SigmaPlot (or equivalent) was approved by all parties (State Parks, the SAG, and the SLOAPCD).

5) **Identify the parameters of a “pre-disturbance” scenario for which modeled mass emissions can be quantified and used to assess SOA compliance.** This differs from a fixed mass emissions target used in previous assessments and requires characterizing the likely “naturally occurring” emissions from the ODSVRA when it was minimally impacted by OHV riding. Following the recommendations from the SAG, State Parks and the SLOAPCD agreed that the pre-disturbance landscape should be an amalgamation of the numerous zones reflected in the current landscape modeling scenario, with only three primary zones (North, Central, South). The North and South zones are identical to those on the current landscape, referred to as the Dunes Preserve (Non-Riding Area North) and Oso Flaco (Non-Riding Area South), respectively, and both zones will have the same emissivity power relations applied as in the present-day model. In contrast, the Central zone of the pre-disturbance landscape comprises a number of smaller sub-regions in the present landscape (i.e., Non-Riding Area Central, all Riding Areas, Foredune Restoration Area, Plover Exclosure, and Seasonally Exclosed Areas), but the entire pre-disturbance Central zone will be characterized by the emissivity power relation applied to the Non-Riding Area Central zone in the present-day model. In each case, all the data from 2013 to 2022 are to be used.

Zonation of the ODSVRA

As described in the SAG’s recommended approach to quantifying excess emissions (see Attachment 08), the ODSVRA in its current (2024) form is be divided into nine zones or sub-regions, as follows (see Figure 2-30):

1. Riding Area Central-North Sub-Region
2. Riding Area Central-South Sub-Region
3. Non-Riding Area North Zone
4. Non-Riding Area Central Zone
5. Non-Riding Area South Zone
6. Foredune Restoration Area (FRA)
7. Plover Exclosure (PE)
8. Seasonal Exclosures
9. Vegetation Islands and Revegetated Project Areas

This configuration was based on an extensive statistical analysis of all the PI-SWERL data collected between 2013 and 2022, and on consideration of the present land-management areas within the ODSVRA, each of which has different characteristics (e.g., riding/camping access allowed, riding/camping not allowed, riding allowed on a seasonal basis). Figure 2-30 (right) shows the zonation of the current ODSVRA landscape. Each of the zones has a different emissivity power relation applied to it. The Riding Area is divided into two sub-regions (Central-North and Central-South) based on a north-south gradient in emissivity, with the north being more emissive than the south, in part due to grain size differences and likely because of intensity of OHV traffic. All 2013 to 2022 PI-SWERL data were used in compiling the emissivity power relations with the exception of measurements taken in the footprints of the FRA, PE[57], and Seasonal Exclosures[58] during years when managed for seasonal OHV access restrictions (March 1 through September 30). The FRA and PE are parameterized using only 2022 PI-SWERL measurements, as mandated by the SLOAPCD in its conditional approval of the 2022 ARWP. The Seasonal Exclosures use a weighted average of PI-SWERL measurements during riding and non-riding periods, whereas the Vegetation Islands and Revegetated Project Areas (including straw treatment projects) are assessed as having zero emissivity. Additional details on emissivity power relations, including regression parameters for the emissivity power relations, are provided in the SAG's December 19, 2023, memo (see Attachment 08).

[57] For the purposes of this ARWP, the terms Western Snowy Plover nesting exclosure, nesting exclosure (e.g., see Figure 2-1, Plover Exclosure (e.g., see Figure 2-30), and PE all refer to the same general geographic area.
[58] For the purposes of this ARWP, the terms seasonal foredune beach and corridors (e.g., see Figure 2-1) and Seasonal Exclosures (e.g., see Figure 2-30) all refer to the same general geographic area .

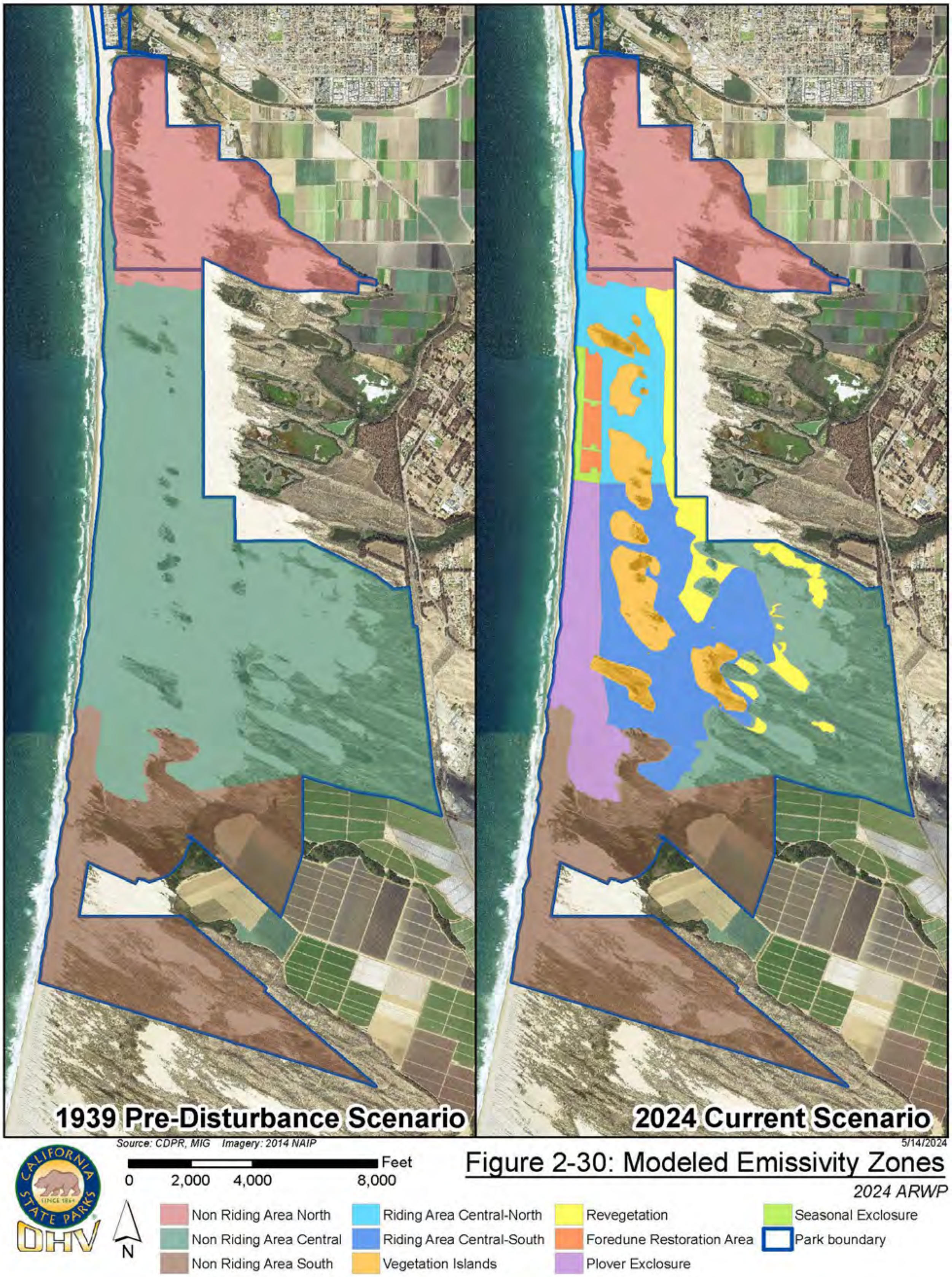


Figure 2-30: Modeled Emissivity Zones

2024 ARWP

For the "pre-disturbance" scenario (see Figure 2-30 left), the Non-Riding Area North and Non-Riding Area South are identical to those in the "current" landscape; however, the Non-Riding Area Central of the "pre-disturbance" landscape is an amalgamation of the footprint of all the remaining areas in the "current" landscape, which are managed for OHV access (Riding Area Central-North, Riding Area Central-South) or for other dust-control purposes (e.g., FRA, Revegetated Treatment Areas, Non-Riding Area Central) and for habitat conservation (e.g., PE, Seasonal Exclosures). None of these management practices existed in 1939, prior to intensive human impact on the landscape, so the emissivity power relation that is applied to this large, central area shown in Figure 2-30 (left) is equivalent to that for the Non-Riding Area Central of the "current" landscape, based on PI-SWERL data from 2013 to 2022.

The final step in creating the modeling scenarios for the "pre-disturbance" (1939) and "current" landscapes was to drape an appropriate vegetation cover mask over the modeling grid. These vegetation cover masks (for 1939 and 2020) were created by personnel from UCSB following detailed analysis of available air-photos.[59] Any grid cell with greater than 50% vegetation cover was classified, in its entirety, as "vegetated" and having zero emissivity, whereas any grid cell with less than 50% vegetation cover was classified, in its entirety, according to the underlying land-management zone and the accompanying emissivity power emissivity relation.

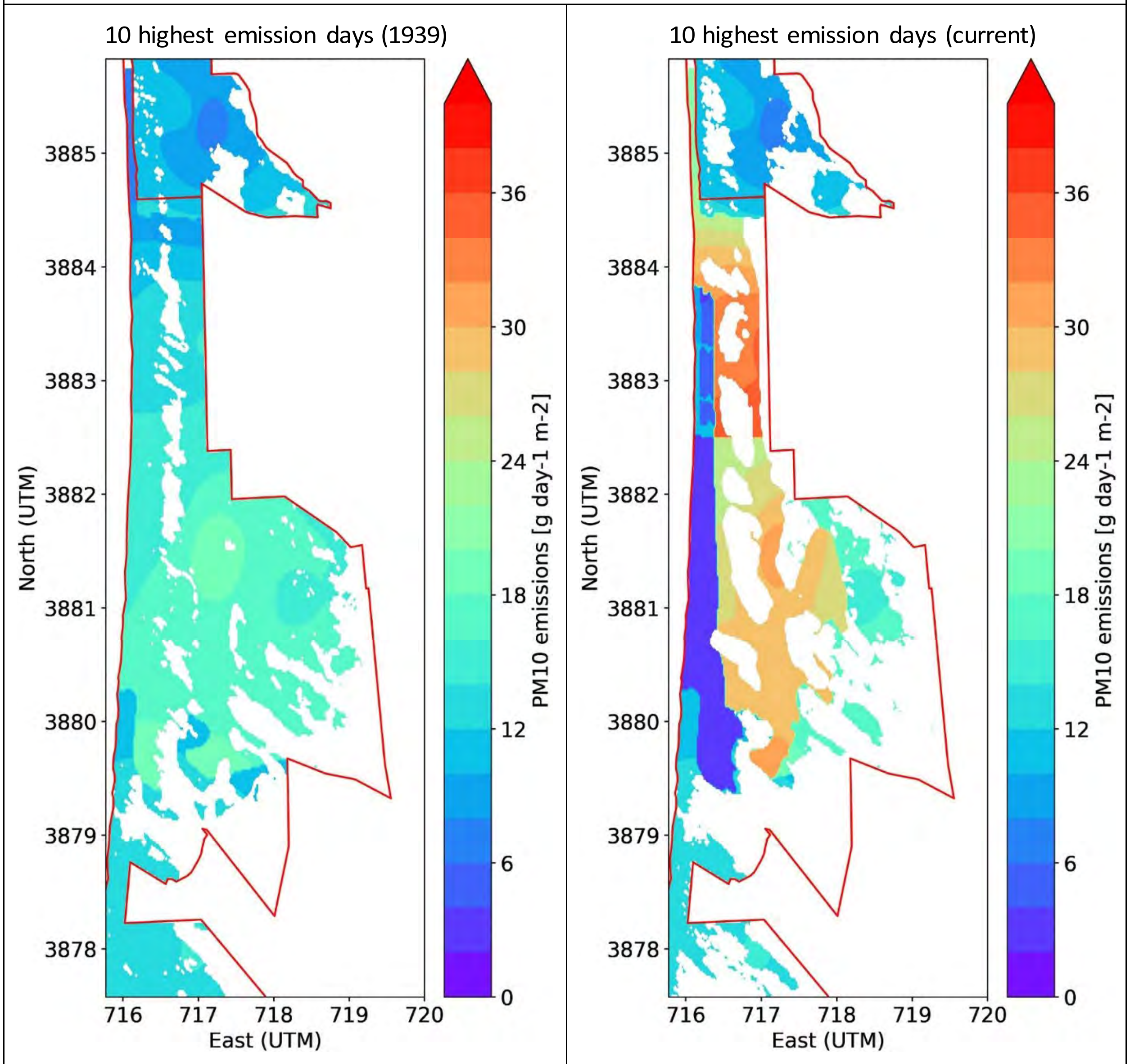
2.3.2.3 Excess Emissions Modeling Results

The DRI model was programmed with the above-mentioned zones and parameters, and emissions scenarios were run for the "pre-disturbance" and "current" landscape conditions. Figure 2-31 shows maps of the spatial distribution of emissions for each of the two scenarios. The "pre-disturbance" emissions map (left panel) indicates relatively uniform emissions with largest values in the Non-Riding Area Central zone and smallest values in the Non-Riding Area North zone (dune preserve). White areas correspond to zero emissions in association with the vegetation cover mask from 1939. For the "current" emissions map (right panel), the white zones include the vegetation cover mask from 2020 as well as the vegetation islands and vegetation dust control projects as of July 31, 2024. The "current" emissions map shows considerable variation in emissions with large values in the sub-regions where OHV riding is allowed. The largest values are in the range of 32 to 36 grams per square meter per day (g m^{-2} d^{-1}), well in excess of those characterizing the "pre-disturbance" scenario. When summed across the entire model domain covering the ODSVRA (see Table 2-9), the total emissions for the 10 highest emissivity days in May 2013 amount to 166 metric tons per day for the "pre-disturbance" scenario, whereas the "current" landscape scenario emits only 148 metric tons per day. The small emissions from the FRA and PE are sufficient to compensate for the large emissions from the riding area, and therefore, **the modeling indicates that the ODSVRA, as**

[59] Swet et al., 2022 (see footnote 32).

currently configured according to management zones and accounting for all treatment projects implemented since 2013, does not emit dust to a level that is in excess of the "naturally occurring" conditions inherent to the "pre-disturbance" scenario. In this respect, there is compliance with the SOA.

Figure 2-31. Spatial Distribution of Emissions for "Pre-Disturbance" and "Current" Landscape Conditions



Spatial distribution of emissions (in g m^{-2} d^{-1}) for the 1939 "pre-disturbance" condition (left panel) and the current year (right panel) based on the meteorology of the 10 highest PM_{10} emission days, May 2013.

Table 2-9. Modeled Pre-Disturbance (1939) and Current (2024) Landscape Total Mass Emissions Estimates

Zone	Total Emissions (Metric Tons per Day for the 10 Highest Emissivity Days, May 2013)[(A)]
Pre-Disturbance (1939) Condition	
Non-Riding Area Central	122
Non-Riding Area North	20
Non-Riding Area South	24
Total	**166**
Current (2024) Condition	
FRA (Foredune Restoration Area)	1
Non-Riding Area Central	18
Non-Riding Area North	16
Non-Riding Area South	16
PE (Plover Exclosure)	4[(B)]
Riding Area Central-North	30
Riding Area Central-South	63
Seasonal Exclosure	1
Vegetation Islands	0
Revegetation	0
Total[(C)]	**148**

Source: DRI, 2024 (see Attachment 09)

(A) The Non-Riding Area North and Non-Riding Area South are of equal area for both the pre-disturbance and current landscape conditions, whereas the Non-Riding Area Central zone in the pre-disturbance condition encompasses all the remaining areas in the current scenario (i.e., the FRA, PE, Riding Area Central-North and Central-South, etc.)

(B) At the request of the SLOAPCD, a supplemental modeling scenario was run for which the emissivity values from the Non-Riding Area Central zone were substituted for the action 2022 measured emissivity values characterizing the PE zone. This resulted in a total dust emission from the PE zone of 22 metric tons per day rather than 4 metric tons per day, indicating that even under this scenario of increased PE emissivity, the ODSVRA would not emit dust to a level in excess of the “pre-disturbance” scenario.

(C) Total may not equal due to rounding.

2.3.3 Evaluation Metrics

State Parks’ 2021 ARWP incorporated a new set of evaluation metrics intended to provide a streamlined dashboard for reporting Particulate Matter Reduction Plan (PMRP) evaluation metrics, tracking Dust Control Program progress, and informing adaptive management strategies at the ODSVRA. The updated evaluation metrics include “Dust Mitigation Targets” that compile specific, measurable endpoints and "Dust Mitigation Indicators" that document progress in key areas that lack a specific, measurable target or endpoint for various reasons. To provide continuity with past ARWP documents, State Parks' summary report on PMRP evaluation metrics is provided below. Refer to Attachment 10 for a detailed summary of evaluation metrics.

2.3.3.1 Dust Mitigation Targets

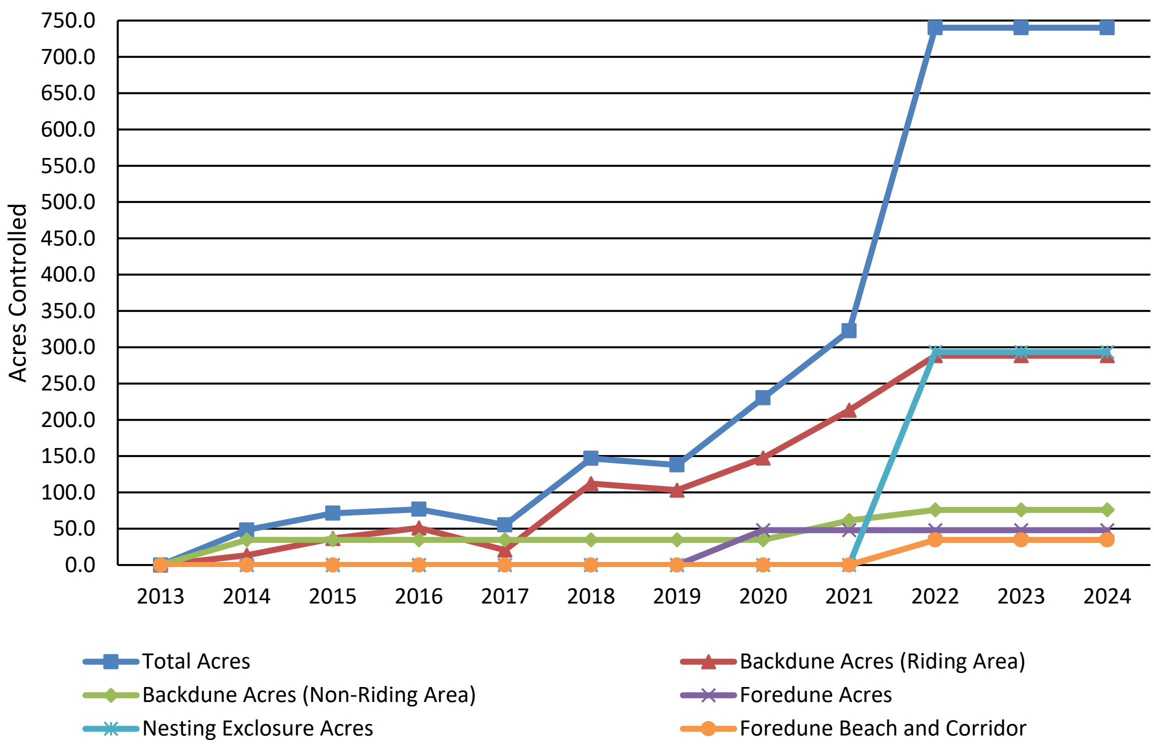
Key dust mitigation targets include the cumulative dust control project acreage at the ODSVRA and the PM_{10} mass emissions reductions achieved from the ODSVRA (as of July 31 of the ARWP reporting year).[60] Mass emissions reductions are compared against metrics in both the original SOA (for reporting continuity purposes) and the October 2022 SOA amendments (see Section 2.3.2).

Dust Mitigation Treatments

Compared to 2013 baseline conditions, when there were no long-term dust control projects at the ODSVRA, State Parks now manages 740.1 acres of land for dust control benefits (see Figure 2-32). Nearly 90% of this managed land is located inside the ODSVRA open riding and camping area. Refer to Section 2.1 for State Parks' detailed report on dust control projects installed at the ODSVRA as of July 31, 2024.

[60] Previous ARWPs also reported on the 24-hour average PM_{10} concentration reductions achieved at the CDF and Mesa2 air quality monitoring stations; however, as described in Section 2.3.2.2, the current approach to the SOA's excess emissions modeling focuses on quantifying mass emissions from the ODSVRA using PI-SWERL measurements rather than modeling PM_{10} concentrations at monitoring stations such as CDF and Mesa2. Accordingly, PM_{10} concentration reductions are not reported in this 2024 ARWP.

Figure 2-32. ODSVRA Dust Mitigation Treatments, July 31, 2013, to July 31, 2024



PM$_{10}$ Mass Emissions (Old Methodology)

As of July 31, 2024, using the original SOA methodology that required a 50% reduction in 24-hour PM$_{10}$ mass emissions as compared to a 2013 baseline period, State Parks was estimated to have achieved an approximately 55% reduction in 24-hour PM$_{10}$ baseline mass emissions. This information was reported in State Parks' 2023 ARWP, Section 3.5.1. Additional modeling pursuant to the original SOA methodology was not conducted for this 2024 ARWP.

PM$_{10}$ Mass Emissions (New Excess Emissions Methodology)

Under the excess emissions framework, as of July 31, 2024, current modeled PM$_{10}$ mass emissions from the ODSVRA (148 metric tons per day) are approximately 18 metric tons per day less than the modeled pre-disturbance condition mass emissions (166 metric tons per day; see Table 2-9). The ODSVRA, therefore, is not in a condition of excess emissions. Refer to Section 2.3.2 for additional information on excess emissions modeling.

2.3.3.2 Dust Mitigation Indicators

Key dust mitigation indicators include the number of high wind days and the number of exceedances of the state and federal ambient air quality standards, the status of the 48-acre foredune restoration project, and the amount of backdune stabilization occurring under the Dust Control Program. Dust mitigation indicators are compared against 2013 baseline conditions where appropriate but do not have a specific measurable target or goal to achieve.

Air Quality Indicators

Between January 1, 2024, and July 24, 2024, the number of high wind event days at the SLOAPCD's CDF air quality monitoring station (51 days) was higher than the number of days for the same period in 2019 (30 days) but lower or the same as those in 2020 (55 days), 2021 (51 days), 2022 (64 days), and 2023 (72 days).[61] However, the number of days in which the 24-hour average PM_{10} California Ambient Air Quality Standard (CAAQS) of 50 µg m^{-3} was exceeded at the SLOAPCD's CDF air quality monitoring station in 2024 (13 days) was lower than the same comparable period in 2019 (16 days), 2020 (30 days), 2021 (28 days), 2022 (54 days), and 2023 (16 days). Likewise, the number of days in which the 24-hour average PM_{10} CAAQS of 50 µg m^{-3} was exceeded at the SLOAPCD's Mesa2 air quality monitoring station in 2024 (11 days) was lower than the same comparable period in 2019 (14 days), 2020 (28 days), 2021 (30 days), and 2022 (38 days), and the same as in 2023 (11 days).[62] There were no exceedances of the National Ambient Air Quality Standard (NAAQS) of 150 µg m^{-3} at either the CDF or Mesa2 air quality monitoring stations during the listed period. The last exceedance of the NAAQS occurred at the CDF air quality monitoring station in 2013.

Foredune Restoration

Based on UCSB UAS survey results (see Section 2.2.5.1), net surface volume changes since the October 2019 to February 2020 baseline survey (see Table 2-3) suggest beach erosion has dominated in front of the northern plots (TP 1 – Control to TP 3 – Native Seed and Grain Seed) while deposition prevails at the southern plots (TP 4 – Low-Density Nodes to TP 6 – Parks' Classic). In general, net deposition has occurred across all FRA TPs, with some deviations. Most plots saw distinct negative (erosional) responses from February to October 2023 (except for TP 6 – Parks' Classic) (see Figure 2-15 and Table 2-3), but trends shifted to positive in all but one treatment (TP 6 – Parks' Classic) in the most recent interval.

[61] Since 2021, State Parks' ARWPs have, in coordination with the SAG, defined "high wind event day" as any day when the 3:00 PM PST hourly wind speed at the CDF air quality monitoring station exceeds 8 miles per hour and the 1:00 PM PST hourly wind direction is between 290° and 360°. Resultant wind speed data for CDF (USEPA Air Quality System ID #060792007) are from the California Air Resources Board (CARB) Air Quality and Meteorological Information System website: https://www.arb.ca.gov/aqmis2/aqmis2.php?_ga=2.46929383.1773760890.1688103838-837133623.1674194586. Data may be preliminary. The ARWP high wind event definition may differ from the definition used by the SLOAPCD in SLOAPCD reports and studies.

[62] The 2024 estimate of the number of days above the CAAQS at the CDF air quality monitoring station is based on standard conditions for daily average PM_{10} BAM data for the CDF (USEPA Air Quality System ID #060792007) and Mesa2 (USEPA Air Quality System ID #060792004) air quality monitoring stations are from CARB's Air Quality and Meteorological Information System website: https://www.arb.ca.gov/aqmis2/aqmis2.php?_ga=2.46929383.1773760890.1688103838-837133623.1674194586. Data may be preliminary.

After its fourth growing season (2023), UCSB UAS surveys identified that percent plant cover (normalized by total area of each TP; see Table 2-4) increased between spring 2023 and spring 2024 in TP 1 – Control and TP 2 – Native Seed and decreased between spring 2023 and spring 2024 in TP 3 – Native Seed and Grain Seed, TP 4 – Low-Density Nodes, TP 5 – High-Density Nodes, and TP 6 – Parks' Classic. State Parks' line-intercept transect sampling identified an increase in mean vegetation cover (compared to 2022 results) in foredune TP 2 – Native Seed, TP 4 – Low-Density Nodes, TP 5 – Native Seed and Grain Seed, and TP 6 – Parks' Classic, and a decrease in mean vegetation cover in TP 3 – High-Density Nodes (see Table 2-5). There was no change in mean vegetation cover in TP 1 – Control. State Parks' line-intercept transect sampling also showed that total species richness (i.e., native and non-native species) increased (compared to 2022 results) for TP 1 – Control, TP 2 – Native Seed, TP 3 – Native Seed and Grain Seed, and TP 4 – Low-Density Nodes, while total species richness remained the same for TP 5 – High-Density Nodes and TP 6 – Parks' Classic (see Table 2-5). Refer to Section 2.2.5 for detailed information on State Parks' foredune vegetation monitoring activities.

Backdune Stabilization

Compared to 2013 baseline conditions, when there were no long-term dust control projects at the ODSVRA, State Parks continues to manage 740.1 acres of land for dust control benefits, including the 293.3-acre Plover Exclosure and 34.6-acre seasonal foredune beach and corridor area. Excluding these areas, State Parks has installed 412.2 acres of total dust control projects at the ODSVRA. The total dust control acreage remains unchanged since 2022, though all temporary wind fencing and all but 12.3 acres of straw treatments have been converted to vegetation projects. As of July 31, 2024, there are 364.2 total acres of backdune stabilization measures in the ODSVRA, consisting of 351.9 acres of vegetation and 12.3 acres of straw treatments. Refer to Section 2.1 for State Parks' detailed report on dust control projects installed at the ODSVRA as of July 31, 2024.

2.3.4 Track-Out Control

Condition 1.c of the original 2018 SOA required State Parks to install SLOAPCD-approved sand track-out control devices at the Grand Avenue and Pier Avenue entrances to the ODSVRA. This requirement was not modified by the November 2019 or October 2022 SOA amendments. State Parks completed the construction of the Grand Avenue track-out control project in November 2022.[63] State Parks has not proceeded with the construction of Pier Avenue track-out control project due to the uncertain future of this entrance; however, State Parks continues to use temporary rubber track-out mats at this entrance. The temporary mats were originally installed in 2019 and are regularly cleaned when the beach is open to public vehicle activity. State Parks

[63] Refer to State Parks' 2021 ARWP, Attachment 05 (Sediment Track-out Prevention Measures), for detailed plans for track-out control at Grand Avenue.

also continues to conduct ongoing street sweeping activities on Pier and Grand Avenues at a minimum of three times per week.

2.4 OTHER DUST CONTROL PROGRAM ACTIVITIES

State Parks, the SAG, and the SLOAPCD may undertake activities to further support and inform the overall adaptive management approach to dust control at the ODSVRA. State Parks' report on other Dust Control Program-related activities is provided below.

2.4.1 SAG Reviews of Study Reports

Report: Increments of Progress Towards Air Quality Objectives – ODSVRA Dust Controls 2023 Update

Author: DRI (J. Gillies, G. Nikolich, and E. Furtak-Cole)

Draft Date: November 27, 2023

Date State Parks Requested SAG Review: December 8, 2024

SAG Response Date: January 30, 2024 (see Attachment 07)

Final Publication Date: February 15, 2024 (see Attachment 07)

Report: Foredune Restoration UAS Survey Report (UCSB 2022-2023 ODSVRA)

Author: UCSB (Z. Hilgendorf, I. Walker, N. Swet, and M. Heffentrager)

Draft Date: June 2023 (see Attachment 04A)

Date State Parks Requested SAG Review: February 27, 2024

SAG Response Date: March 8, 2024 (see Attachment 04A)

Final Publication Date: Not Applicable – SAG comments addressed in forthcoming 2023-2024 report

Report: Foredune Restoration UAS Survey Report (UCSB 2023-2024 ODSVRA)

Author: UCSB (Z. Hilgendorf, I. Walker, and M. Heffentrager)

Draft Date: June 14, 2024

Date State Parks Requested SAG Review: June 19, 2024

SAG Response Date: July 3, 2024 (see Attachment 04B)

Final Publication Date: July 17, 2024 (see Attachment 04B)

Report: Preliminary Analysis of Time-Lapse Photo Monitoring at the Ocean Dunes Foredune Restoration Site

Author: UCSB (M. Heffentrager, I. Walker, N. Swet, and Z. Hilgendorf)

Draft Date: June 2023 (see Attachment 05)

Date State Parks Requested SAG Review: February 27, 2024

SAG Response Date: March 8, 2024 (see Attachment 05)

Final Publication Date: Not Applicable – State Parks and the SAG agreed not to prepare a final report.

Report: Report of Findings: ODSVRA Meteorological and PM_{10} Monitoring Network, 2023

Author: Desert Research Institute (J. Gillies and G. Nikolich)

Draft Date: May 2024

Date State Parks Requested SAG Review: May 14, 2024

SAG Response Date: May 28, 2024 (see Attachment 03)

Final Publication Date: June 20, 2024 (see Attachment 03)

2.4.2 SAG-Generated Reports and Memos

During the 2024 ARWP reporting period (August 1, 2023, through July 31, 2024), the SAG generated the following reports and memoranda:

- **September 14, 2023:** ***Summary of Discussion on September 14 – Re Excess Emissions.*** Memo from SAG Chair, B. Bauer to State Parks and the SLOAPCD summarizing the discussion regarding the agreed-to strategy that will focus efforts on mass emissions from the ODSVRA.
- **October 27, 2023:** ***SAG Reply to Jim Suty in respect of additional members added to SAG***. Memo in response to a request by Friends of Ocean Dunes to add another member.
- **December 19, 2023**: ***SAG Updated Emissivity Grid Recommendations – Cover Memo***. Memo sent to State Parks and the SLOAPCD making recommendations regarding establishing emissivity grids for modeling of pre-disturbance conditions and future excess emissions reductions (see Attachment 08).

- **December 19, 2023: *Updated SAG Recommendations for Establishing Emissivity Grids to be used in Modeling of Pre-Disturbance Conditions and Future Excess Emissions Reductions***. Report that analyzes all PI-SWERL measurements since 2013 with recommendations on how to parameterize dust emissions from the ODSVRA (see Attachment 08).
- **December 19, 2023: *Reply to Comments from SLOAPCD and State Parks on SAG Proposed Emissivity Grids Document of June 21, 2023***. Memo that responds to suggestions and critique of the original draft SAG proposal (June 21, 2023) for emissivity grids.
- **March 11, 2024: *SAG Recommendations for Reporting Mass Emission Values Leading to SOA Compliance Assessment***. Memo sent to State Parks and the SLOAPCD regarding protocols for reporting mean mass emission values from the DRI simulation model.

2.4.3 SAG Participation In Meetings

During the 2024 ARWP reporting period (August 1, 2023, through July 31, 2024), the SAG participated in a number of important meetings and made several presentations to stakeholder groups. In addition to those highlighted below, there were numerous regularly scheduled and ad hoc meetings between SAG members and other individuals on topics related to dust emission measurement/modeling and SOA compliance assessment. Meetings and presentations include the following:

- SAG Monthly Online Meeting, August 7, 2023, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, September 14, 2023, via Zoom (all SAG members present)
- OHMVR Division Commission Meeting, September 29, 2023, via CalSpan (SAG Chair B. Bauer in attendance)
- SAG Semi-Annual In-Person Meeting, October 11-12, 2023, Arroyo Grande and Oceano, California (all SAG members present)
- SLOAPCD Hearing Board Meeting, October 13, 2023, San Luis Obispo (presentation by SAG Chair B. Bauer)
- OHMVR Division Commission Meeting, October 26, 2023, via CalSpan (SAG Chair B. Bauer in attendance)
- SAG Monthly Online Meeting, November 16, 2023, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, December 14, 2023, via Zoom (all SAG members present)

- State Parks' Executives Meeting, January 8, 2024, via Teams (presentation by SAG Chair B. Bauer)
- SAG Quarterly Online Meeting, January 18, 2024, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, February 15, 2024, via Zoom (all SAG members present)
- State Parks' Executives Meeting, February 21, 2024, via Teams (presentation by SAG Chair B. Bauer and SAG Member J. Hand)
- SAG Monthly Online Meeting, March 21, 2024, via Zoom (all SAG members present)
- SAG Semi-Annual In-Person Meeting, April 18-19, 2024, Oceano, California (all SAG members present)
- SLOAPCD Board Meeting, May 15, 2024, San Luis Obispo, California (presentation by SAG Chair B. Bauer)
- OHMVR Division Commission Meeting, May 16, 2024, Arroyo Grande, California (presentation by SAG Chair B. Bauer)
- SAG Monthly Online Meeting, June 20, 2024, via Zoom (all SAG members present)
- Bi-weekly meetings with State Parks, August 2023 through July 2024, via Teams (SAG Chair B. Bauer and Dust Control Program Manager J. O'Brien)
- Bi-weekly meetings with SLOAPCD Management, August 2023 through July 2024, via Zoom (SAG Chair B. Bauer and Assistant Air Pollution Control Officer K. Tupper)
- Bi-weekly ARWP meetings with State Parks project personnel, August 2023/June-July 2024, via Teams (SAG Chair B. Bauer, SAG Vice-Chair C. Scheidlinger, SAG Member J. Hand, Program Manager J. O'Brien, Senior Scientist R. Glick)

2.4.4 Updated Scientific Review Process

A Scientific Review Process for the ODSVRA Dust Control Program was put in place in August 2021 by mutual agreement between State Parks and the SAG.[64] In April 2024, State Parks and the SAG entered into discussions leading to an update of the protocols, with specific focus on relative roles and anticipated timelines in the handling of reports from third-party contractors. The over-riding objective of the scientific review process continues to be streamlining and standardizing the manner in which certain reports are reviewed to ensure that scientific findings are robust and as defensible as possible before they enter the public domain. Refer to Attachment 11 for the updated scientific review process agreed to by State Parks and the SAG.

[64] Refer to State Parks' 2022 ARWP, Attachment 07, for the original scientific review process document.

2.4.5 Public Relations Campaign

State Parks' public relations campaign is intended to educate the public on regional air quality issues in southern San Luis Obispo County surrounding the ODSVRA, how they are being addressed, and how the public can be part of the solution.[65] During the reporting period, State Parks continued to host a digital two-page flyer that explains the basics about sand movement in a dune system, a video that provides a broad overview of the Oceano Dunes Air Quality Management Program, and a Frequently Asked Questions (FAQ) document with specific information about air quality and the dust mitigation activities on the ODSVRA's Particulate Matter Information website: https://ohv.parks.ca.gov/?page_id=26918. In addition, State Parks has created social media posts focusing on the Dust Control Program and educating the public on the things they can do to help.

2.4.6 Coastal Commission Coordination

During the reporting period (August 1, 2023, to July 31, 2024), State Parks communicated with the California Coastal Commission on the 2023 ARWP Primary Work Plan, which included the conversion of 32.5 acres of wind fencing and 5.0 acres of straw treatments to native dune vegetation. Since these activities would occur in project areas that had already been permitted previously, the Coastal Commission determined that the activities under the 2023 ARWP were not subject to a new or amended Coastal Development Permit (CDP). All activities were found to be consistent with CDP 3-12-050, as amended.

[65] Refer to State Parks 2023 ARWP, Attachment 12, for State Parks' public relations campaign details.

3 WORK PLAN (AUGUST 1, 2024, TO JULY 31, 2025)

This chapter of the ARWP proposes activities that State Parks will undertake to sustain the progress the Dust Control Program has made in reducing current PM_{10} emissions to a level that is not in excess of the naturally occurring conditions inherent to the modeled 1939 pre-disturbance condition. State Parks' Work Plan emphasizes and focuses on activities associated with converting the last remaining existing temporary dust control projects to vegetation, providing supplemental planting, and refining the excess emissions modeling methodology. For the period of approximately August 1, 2024, to July 31, 2025, State Parks is proposing the following Dust Control Program activities:

- Convert 12.3 acres of existing straw treatments to long-term vegetation measures
- Provide supplemental vegetation planting in 28.9 acres of previous vegetation treatment areas
- Continue Dust Control Program field monitoring and air quality modeling activities
- Continue SAG consultation, including updating the approach to evaluating Dust Control Program progress
- Continue to implement the Dust Control Program public relations campaign
- Coordinate with the California Coastal Commission on 2024 ARWP permitting requirements, if needed

State Parks' description of proposed Dust Control Program projects and activities is provided below.

3.1 DUST CONTROL PROJECTS PROPOSED FOR AUGUST 1, 2024, TO JULY 31, 2025

3.1.1 CONVERSION OF EXISTING TEMPORARY DUST CONTROL PROJECTS TO VEGETATION

State Parks proposes to convert a total of 12.3 acres of existing temporary dust control projects to native dune vegetation, as follows:

- **Existing Straw:** State Parks proposes to convert the lone remaining temporary straw treatment project at the ODSVRA to vegetation (2022-ST-01, 12.3 acres; see Figure 2-2 and Figure 3-1). This project is located in the northeast corner of the ODSVRA's open riding and camping area.

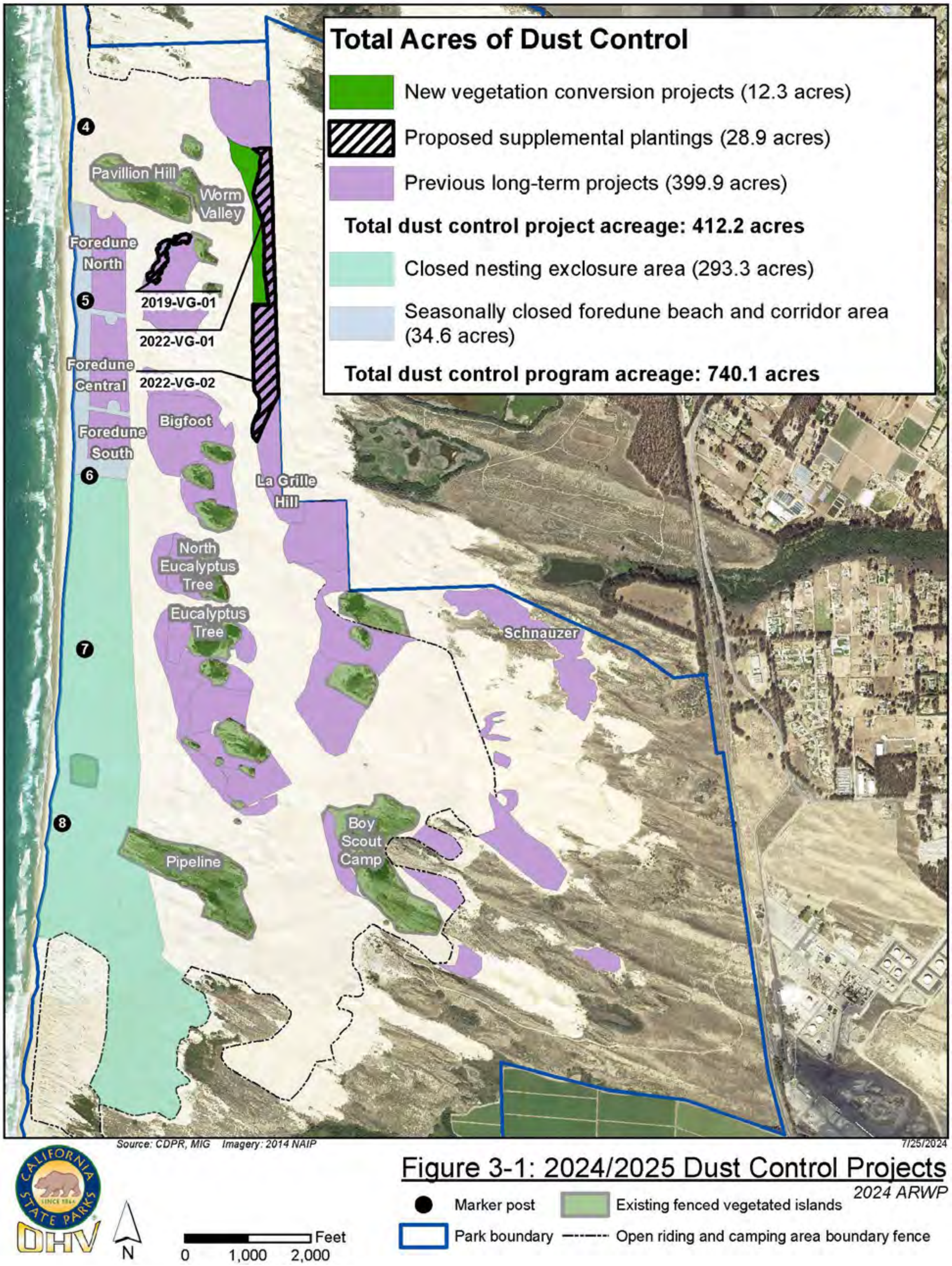


Figure 3-1: 2024/2025 Dust Control Projects

3.1.2 Supplemental Planting

State Parks proposes to perform supplemental planting and seeding activities on three previously installed vegetation projects totaling approximately 28.9 acres (2019-VG-01, 3.0 acres; 2022-VG-01, 14.6 acres; and 2022-VG-02, 11.3 acres, see Figure 3-1). Three acres on the western edge of the treatment area at BBQ Flat (2019-VG-01) are proposed for supplementation because this area has had significant sand inundation resulting in burial and loss of vegetation cover. This area had originally been treated with straw, container plants and native seed, and sterile grain seed. Two projects in the northeast corner of the ODSVRA open riding and camping area (2022-VG-01 and 2022-VG-02) had previously been treated with seed only and not container stock, resulting in slow vegetation recruitment and low vegetation cover. To improve vegetation cover and species diversity, supplemental planting is proposed in these areas including installation of straw, native container plants, native seed, and sterile grain seed.

State Parks will, in coordination and consultation with the SAG, continue to evaluate and monitor backdune vegetation projects and conduct supplemental planting activities in areas where vegetation has not yet become established.

3.1.3 Planting Palette/Estimate of Plants and Seed Needed for Dust Control Projects

State Parks will coordinate with the SAG to prepare a planting palette with targets for container stock and native seed needed for dust control projects over the next year. As of August 1, 2024, State Parks estimates up to approximately 33,644 plants and 138 pounds of native seed would be required to complete the conversion of approximately 12.3 acres of temporary dust control projects to native dune vegetation. Additional plants (85,007) and native seed (374 pounds) would also be required for State Parks' proposed supplemental planting activities. Thus, State Parks estimates a total of up to approximately 118,651 plants and 512 pounds of native seed would be required to complete all proposed 2024 Dust Control Program vegetation planting activities.

Refer to Attachment 12 for estimates of planting and seeding activity associated with State Parks' proposed 2024 Work Plan.

3.1.4 Logistical Considerations

Following removal of existing dust control projects and/or preparation of treatment areas for vegetation plantings (e.g., reapplication of straw along upwind edges that may have become inundated with sand), State Parks will restore the project areas. State Parks' restoration methods are described in Chapter 6 of the June 2019 Draft PMRP. State Parks will schedule conversion efforts to occur as late as possible, given other park operations requirements and the need to ensure sufficient planting time. For restoration work, State Parks will maintain a perimeter fence to prohibit OHV activity and camping in the restoration area.

State Parks is contracted with California Polytechnic State University (Cal Poly), San Luis Obispo for horticulture work through December 2026 to support the sustained success of the Dust Control Program.

3.1.5 Habitat Conservation Plan (HCP) – Implications for Dust Management

Federal- and state-listed endangered or threatened species occur or potentially occur within the ODSVRA, including Western Snowy Plover (*Charadrius nivosus nivosus*), California Least Tern (*Sternula antillarum browni*), California Red-Legged Frog (*Rana draytonii*), and Tidewater Goby (*Eucyclogobius newberryi*), as well as six listed plant species. Two additional species that are federally proposed as threatened, Southwestern Pond Turtle (*Actinemys pallida*) and Western Spadefoot (*Spea hammondii*), are not known to be present but have the potential to occur on the property. Therefore, State Parks has prepared a draft HCP[66] as part of its application for an incidental take permit (ITP), authorized under Sections 10(a)(1)(A) and 10(a)(1)(B) of the FESA. The HCP identifies the activities that State Parks has responsibility for within the HCP area that could result in take of covered species. These activities include but are not limited to public use/recreation management, natural resources management, and park/beach management. The HCP would not result in changes to park visitation or vehicle use levels, and many of the operational activities proposed for HCP coverage are already existing and ongoing. State Parks will continue to coordinate with the SAG on the potential for HCP activities to affect specific emissivity monitoring protocols, near- and long-term excess emission modeling exercises, and adaptive management of the Dust Control Program.

3.2 AIR QUALITY MODELING ACTIVITIES

State Parks, in coordination with DRI and the SAG, proposes to conduct the air quality modeling activities described below from August 1, 2024, to July 31, 2025.

3.2.1 Prediction of Future Excess Emissions Reductions

As summarized in Section 2.3.2.3, the results of the excess emissions modeling conducted by DRI indicate the ODSVRA, as currently configured according to management zones and accounting for all treatment projects implemented since 2013, does not emit dust to a level that is in excess of the “naturally occurring” conditions inherent to the “pre-disturbance” scenario and, therefore, is in compliance with the SOA. Accordingly, an estimate of the amount of additional dust control projects needed to comply with the SOA, and predictions of future excess emissions reductions that would occur with new dust control projects, are not necessary at this time.

[66] California State Parks, 2020. *Draft Habitat Conservation Plan for the California Department of Parks and Recreation Oceano Dunes District*. November 2020. Available on the following website: https://www.oceanoduneshcp.com/files/managed/Document/60/ODD%20HCP_Posted%20Nov%202020_Redlined%20From%20February%20Draft.pdf.

3.2.2 Model Refinements

As described in Section 2.3.2, a significant number of updates were recently made to the DRI model used to estimate total mass emissions from the ODSVRA for the purposes of this 2024 ARWP. These include the use of emissivity zones rather than an interpolated emissivity grid, the use of all PI-SWERL data (2013-2022) whenever prudent, the use of medians to describe data distributions instead of means, and the identification of a pre-disturbance scenario for purposes of calculating mass emissions from a "naturally occurring" landscape state. Details about the many technical steps that were necessary to successfully run the model are contained in Attachment 09 to this ARWP. In the course of overcoming many of these technical challenges, a series of new changes to the model have been identified as necessary to properly inform the SOA compliance assessment objectives for the future.

It became apparent that the extent of the model grid, as currently configured, does not cover the entire area of the ODSVRA. There are small sections on the north and south extremities of the ODSVRA that are not captured in the model grid. There are two explanations that have to do with inherent model code constraints and with the original purpose of the DRI emission-dispersion model. The CALMET model, which is used to simulate wind conditions across the ODSVRA, is an old FORTRAN-based code that has restrictions on the number of grid cells that can be implemented in the model. Moreover, the model grid has to be rectangular, which is a challenge for free-form boundaries similar to those of the ODSVRA. These are software constraints unrelated to computational capacity. Since the original objective of the model was to predict PM_{10} concentrations at monitoring stations downwind of the ODSVRA (i.e., CDF, Mesa2, Oso Flaco), a decision was made to exclude areas to the far north and far south of the ODSVRA that have no bearing on conditions at CDF and Oso Flaco (because of the directional window of the prevailing winds). This allowed for a smaller cell size (21 m by 21 m) in the grid, which was thought to be advantageous at the time. Now, however, there is a need to know the mass emissions from the entire ODSVRA (as opposed to predicting PM_{10} concentrations downwind of the ODSVRA), and the model grid has to be extended north and south. Unfortunately, this comes with several technical challenges.

The CALMET model code cannot be easily modified at this stage to accommodate a larger number of grid cells, so in order to cover the north and south extremities of the ODSVRA, a revised model grid needs to be created. The latitudinal and longitudinal extents of the new grid have been identified, and CALMET will need to be run to create the revised grid, which will have larger cell sizes (perhaps 25 m by 25 m). The challenge with this is that the new grid will need to be "meshed" with the emissivity zones in the "current" landscape scenario, and this can only be accomplished using a GIS and importing those results into the DRI model. To accomplish this, the following steps are necessary:

1) Use the X, Y coordinates of the new underlying model grid (e.g., 25-m-by-25-m grid

cells) in associated tabular data from the CALMET/DRI emission model, and create a projected point file in WGS1984 UTM Zone 10 N so that the points are equidistant.

2) Create a polygon file and "snap" the edges to the four distal corners of the domain grid to create a single large rectangle.

3) Identify the center point for each 25-m-by-25-m square, and use the "fishnet" tool in ArcGIS Pro to create a set of identical square polygons that fill the entire large rectangular polygon of the domain grid (from Step 2).

4) Use the "spatial join" tool in ArcGIS to label each square grid cell with associated tabular data (e.g., emissivity coefficients, dust control status, etc.) for the point coordinates from the DRI emission model to create a shapefile.

5) Create the SAG-defined emissivity zones for the current and 1939 landscapes, and associate them with the square grid cells using the "intersect" tool in ArcGIS Pro.

6) Identify grid cells that are divided at the borders of the ODSVRA, and assign them as either interior or exterior using the following rule: If a grid square, by area, was ≥50% within the defined boundary that cut across the square, the square was considered to be in the ODSVRA and within its specified zone.

7) Identify grid cells that are covered in vegetation using the vegetation cover masks (1939 and 2020) provided by UCSB and as modified by the SAG. Using the "intersect" tool in ArcGIS Pro, estimate the percent cover in each square grid. If a grid square, by area, is ≥50% covered by vegetation it will be considered to be non-emitting. If a grid square is <50% covered it will be assigned the emissivity of the zone within which it resides. This 50% grid square area threshold has been used in previous reports and tested for uncertainty.

8) Export the fully attributed grids (i.e., zones, vegetation, dust control areas, etc.) from ArcGIS Pro in the form of a shapefile and comma-separated values (CSV) that could be used within the DRI emission model.

Once the base model grid is created and assigned various characteristics (e.g., roughness length, surface cover), the CALMET model can be run to simulate wind conditions in the ODSVRA. This will require an extended topographic map in the form of a DTM and expanded information on land-cover characteristics that include the north and south extremities (not currently included in the model). The output of the new CALMET model with coarser grid cells will need to be verified against measured data collected in the ODSVRA and at other locations downwind. Only then can the model be run to recalculate the wind conditions for the 10 highest emissivity days of May 2013 that are used to drive the emissivity estimates.

On an ongoing basis, the DRI model will need to ingest updated information on surface emissivity based on the most recent PI-SWERL campaign. DRI has collected a comprehensive dataset in May 2024 covering most of the ODSVRA except those areas that were inaccessible due to nesting and rearing of protected bird species (i.e., Plover Exclosure, FRA, Seasonal Exclosure areas). In addition, some areas that were desirable for PI-SWERL sampling in terms of achieving broad spatial coverage were not accessible due to complex topography that limited access and sampling due to safety concerns for personnel and equipment. The most recent data will have to be integrated into the global dataset of PI-SWERL measurements (2013 to 2022), and new emissivity power relations will need to be calculated using established protocols. These new power relations will then be assigned to the model grid cells according to the SAG-defined emissivity zones. This process of updating the power relations will be an ongoing effort as additional PI-SWERL campaigns are undertaken in the future (e.g., in October 2024 to characterize the areas not accessed in May 2024). In addition, any other changes to the extent of vegetation cover or alteration of the size of dust control areas will need to be incorporated into the DRI model prior to estimating mass emissions from the ODSVRA for purposes of compliance assessment.

3.3 FIELD MONITORING ACTIVITIES

State Parks, in coordination with DRI and the SAG, proposes to conduct the field monitoring activities described below from August 1, 2024, to July 31, 2025. While field monitoring activities would generally continue in a manner similar to previous years' efforts, State Parks, in consultation with the SAG, would cease time-lapse photography monitoring activities (see Section 3.3.5.4).

3.3.1 METEOROLOGICAL AND PM_{10} MONITORING

State Parks' meteorological and PM_{10} monitoring network was re-established in April 2024, including the northern dune preserve station that was not in operation in 2023. The monitoring network of stations will be maintained through September 2024 and re-established in April 2025.

As has been done previously by DRI, the MetOne 212 particle profiler instruments were calibrated against a BAM PM_{10} monitor in DRI's dust chamber prior to deployment in April 2024 and will be calibrated upon removal from the field in fall 2024 and prior to deployment in spring 2025.

3.3.2 UAS SURVEYS

Consistent with previous years (see Section 2.2.2), UAS surveys for the 2024 ARWP Work Plan (August 1, 2024, to December 1, 2025) will occur in October 2024, February 2025, and October 2025. UAS surveys will involve both RGB and multispectral bands, as in the previous period, although use of a single payload—the Micasense RedEdge-P with red, green, blue, RE, NIR, and Pan bands—is under consideration. Flying a single sensor will reduce field acquisition time (fewer flights, less likelihood of weather or wind delays), reduce post-processing time, and reduce wear and maintenance on the sensors and UAS. This will result in a slight coarsening of spatial resolution from ~1.5 cm/pixel to ~3.5 cm/pixel with Pan sharpening, but the implications of this for landscape-scale vegetation mapping and DTM generation are minimal. The same data products mentioned in Sections 2.2.5.1 and 2.2.5.2 will be produced (georeferenced orthophoto mosaics, DTMs, geomorphic change maps, vegetation maps) and used to interpret changes in geomorphology, dune development, sediment budgets, and vegetation percent cover across the TPs.

3.3.3 Saltation Monitoring

State Parks will continue to operate and maintain the existing saltation monitoring instruments deployed at the ODSVRA.

3.3.4 PI-SWERL Surveys

State Parks will coordinate with DRI to undertake additional PI-SWERL sampling in the areas of the ODSVRA that could not be accessed in May 2024, including the nesting exclosure and seasonally closed foredune beach and corridor areas. This additional PI-SWERL sampling is anticipated to occur in October 2024, after the bird nesting season is complete. Following completion of this PI-SWERL campaign, State Parks will coordinate with DRI complete the review, validation, and evaluation of the May and October 2024 PI-SWERL data, and determine and provide to the SAG the emissivity (mg m^{-2} s^{-1}) for each PI-SWERL test for the three shear velocity (u_*) set points to add to the PI-SWERL emissivity database for each established pre-disturbance and current landscape zone. Using SigmaPlot, the SAG will update the emissivity relations for the identified zones (see Figure 2-30 and Table 2-9). These updated emissivity relations and any other updated model input data (e.g., current vegetation cover, changes in dust control areas, etc.) will be used to determine if compliance with the SOA excess emissions target is achieved for the 2024/2025 conditions.

In consultation with DRI, State Parks will work with the SAG to determine whether additional useful PI-SWERL measurement campaigns should be carried out in 2024/2025 (beyond the planned October 2024 campaign) to further the current understanding of the dust emissions system and inform air quality modeling and management of dust emissions at the ODSVRA. Any new measurements would be incorporated into the global dataset of PI-SWERL measurements used in the excess emissions modeling.

3.3.5 Foredune Monitoring

State Parks and UCSB propose to conduct the foredune monitoring activities described below from August 1, 2024, to July 31, 2025.

3.3.5.1 Foredune Restoration Area Morphological Changes

As described in Sections 2.2.5.1 and 3.3.2, interpretation of geomorphic changes within the FRA TPs will continue.

3.3.5.2 UAS Vegetation Coverage

As described in Sections 2.2.5.2 and 3.3.2, interpretation of plant cover changes within the FRA TPs will continue.

3.3.5.3 Line-Intercept Transect Sampling

State Parks will conduct foredune line-intercept transect sampling in winter 2024. It is anticipated that the same methodology and the same foredune project transects described in Section 2.2.5.3 will be evaluated again.

3.3.5.4 Time-Lapse and Photo Point Monitoring

As described in Sections 2.2.5.5, based on feedback from the SAG, State Parks, and the SLOAPCD, it was decided that no further analyses of the time-lapse imagery from the monitoring stations within the FRA would be undertaken beyond the initial proof-of-concept analysis.

State Parks will conduct foredune ground and aerial photo point monitoring using the same methodology described in Section 2.2.5.5.

3.3.6 Backdune Monitoring

State Parks will conduct backdune line-intercept transect sampling and ground and aerial photo point monitoring using the same methodologies described in Section 2.2.6; however, due to the amount of backdune vegetation projects installed at the ODSVRA (36 projects, see Table 2-1), State Parks anticipates different backdune projects will be sampled and monitored.

3.4 OTHER DUST CONTROL PROGRAM ACTIVITIES

3.4.1 SAG Activities

Pursuant to the SOA, as amended, State Parks will continue to utilize the SAG for consultation and evaluation. Priority areas for State Parks consultation with the SAG in 2024/2025 include, but are not limited to, excess emissions model refinements (see Section 3.2.2).

The SAG will continue to exercise its independent advisory role by preparing scientific reports and reviews that inform the implementation and monitoring of ODSVRA dust mitigation activities. The SAG may consult with State Parks and the SLOAPCD to ensure access to relevant context and information in preparing such reports and reviews. To ensure independence, however, the content and timeline for the final publication of SAG reports and reviews will be at the sole discretion of the SAG, although the SAG will consider timeline considerations from either agency.

The SAG anticipates the following meeting and workshop activities in 2024/2025:

- Biannual full-day meetings at the ODSVRA, with the participation of State Parks and SLOAPCD staff
- Quarterly half-day SAG meetings, with the participation of State Parks and SLOAPCD staff as needed
- Regular monthly calls among the full SAG, with State Parks and SLOAPCD staff as needed
- Additional ad hoc calls among subgroups of the SAG to address specific work tasks with State Parks and SLOAPCD staff as needed
- SAG presentations at public meetings and workshops, as requested by State Parks and the SLOAPCD

3.4.2 Public Relations Campaign

As described in Section 2.4.5, State Parks has finalized a public relations campaign to educate the public on regional air quality issues in southern San Luis Obispo County surrounding the ODSVRA, how they are being addressed, and how the public can be part of the solution. State Parks will continue to implement aspects of this campaign, including social media posts, in 2024/2025.

3.4.3 Coastal Commission Coordination

Some of State Parks' proposed Dust Control Program activities for the August 1, 2024, to July 31, 2025, period (e.g., installing monitoring equipment, etc.) may constitute development under the California Coastal Act. Therefore, these activities may require a CDP from the California Coastal Commission. In September 2017, the Coastal Commission approved CDP 3-12-050 to implement a five-year adaptive management Dust Control Program at the ODSVRA. This permit is subject to certain conditions, including, but not limited to, the type and amount of Dust Control Program activities, the area in which Dust Control Program activities may occur, and the need for annual review of Dust Control Program activities at the ODSVRA. State Parks will coordinate with Coastal Commission staff on the appropriate CDP process for the proposed

2024 ARWP activities. The appropriate process may include an amendment to CDP 3-12-050.[67]

If necessary, State Parks will submit a formal CDP application to the California Coastal Commission by November 1, 2024, pending SLOAPCD approval of the 2024 ARWP by October 31, 2024. State Parks will coordinate weekly with a representative from the Coastal Commission to track the progress of this application and answer questions or concerns that arise during the review of the application materials. The goal is to have an approved CDP for the 2024 ARWP activities no later than February 2025. This timeline is tentative and subject to change based on the final approved 2024 ARWP and issues outside the control of State Parks, including Coastal Commission staff workload and other complex Coastal Act issues.

3.5 ADAPTIVE MANAGEMENT

As noted in Section 2.3.2, there have been substantive changes to the manner in which progress toward dust emissions targets for the ODSVRA is assessed, as evident in the language used in the original SOA issued in 2018 relative to the phrasing in the second amendments to the SOA issued in 2022. These modifications to the SOA can be confusing to interpret, but they are, in fact, consistent with principles of adaptive management, which require occasional reconsideration of management objectives and approaches as new evidence is collected.

State Parks' Draft PMRP[68] prepared under the original SOA defined "adaptive management" as:

> *A type of natural resource management in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices.*

The history of dust mitigation efforts in the ODSVRA has been detailed in prior ARWPs and is summarized in the sections above. The progress made since 2013 is testimony to the successful and effective implementation of adaptive management by State Parks, not only in terms of the many projects that were completed that reduced dust emissions but also with respect to the sophistication of the modeling effort that informs the air quality program and the shift in management approach regarding compliance assessment.

A key element of the overall strategy was to use measurements of meteorological conditions and dust concentrations within the ODSVRA and from nearby stations (e.g., CDF, Mesa2, Oso

[67] In March 2021, the California Coastal Commission voted to ban OHV recreation and limit street-legal vehicle use and camping at the ODSVRA by 2024. This action is subject to several ongoing lawsuits. State Parks will continue to operate the ODSVRA in a manner that supports OHV recreation and the Dust Control Program for the immediate future.

[68] State Parks' Draft PMRP is available on the following SLOAPCD website (under "June 11, 2019 Update," "Important Documents," "Particulate Matter Reduction Plan – June 2019"): https://www.slocleanair.org/air-quality/oceano-dunes-efforts.php.

Flaco) collected since 2013 to monitor changing conditions and to drive the DRI emission-dispersion model that was created specifically for the ODSVRA. The model results, in turn, were used to identify hot spots of dust emissions, which were targeted for immediate treatment. Those treatments led to reductions in dust emissions and PM_{10} concentrations at the CDF and Mesa2 monitoring stations (as documented in prior ARWPs). Subsequent modeling scenarios and treatment projects have led to additional dust mitigation benefits, documenting a continually decreasing trend in normalized, cumulative PM_{10} concentrations (TPM_{10}/TWPD) at CDF (see Figure 2-28) as a function of increasing acreage in dust control treatments immediately upwind of the monitoring station between 2013 and 2023 (see also Section 2.3.1).

Between 2013 and 2017, the dust control projects amounted to fewer than 45 acres, but there was a perceptible decline in the TPM_{10}/TWPD ratio. Large areas were treated between 2017 and 2022, leading to significant and steady declines in the TPM_{10}/TWPD ratio (see Figure 2-27 and Figure 2-28). Although no additional acreage was closed to public access in the open riding and camping area between 2022 and 2023, the ratio still declined to its lowest value of about 0.15. One possible explanation is that recently planted vegetation in treatment areas may be taking root and spreading, thereby preventing dust emissions and also trapping saltating sediments that enter the treatment areas from open sand areas upwind. Additional measurements in 2024 will yield more insight. Despite highly varying wind conditions from year to year (see Figure 2-26), the downward trend in the TPM_{10}/TWPD ratio is consistent with other metrics of dust emission reductions in the ODSVRA. For example, the SLOAPCD reports a decreasing trend in violations of Rule 1001, with a maximum of 63 in 2017 to a minimum of 14 in 2023.[69] Thus, significant progress has been made in mitigating dust emissions from the ODSVRA due to the adaptive management strategy adopted by State Parks.

The mobile sand-dominated landscape of the ODSVRA is a dynamic one that is complex in its geologic history, contemporary geomorphology, evolving biogeography, varying meteorology and climatology, and sensitivity and responsiveness to human influences. Consequently, **long-term monitoring is essential to improve understanding of the key processes at work and, more importantly, to provide critical indicators of the relative success of dust-mitigation efforts.**

For 2024 and beyond, there will be continuing field monitoring of relevant meteorological and dust-related parameters and foredune evolution to gauge progress toward the SOA objectives. This will include updating the PI-SWERL emissivity grid and implementing model refinements as appropriate and consistent with the evolving understanding of the dynamics of sand transport and dust emissions within the ODSVRA. The shift in focus of the SOA from a "hard" target (e.g., reduction in dust mass emissions by 50% from the 2013 baseline) to a "relative" target (i.e.,

[69] Tupper, K., 2024. *Oceano Dunes Air Quality Update, May 15, 2024.* Presentation to the SLOAPCD Board.

reduction in dust mass emissions to levels consistent with or below the “pre-disturbance” scenario) is consistent with the notion of adaptive management because the changing circumstances of the ODSVRA can be more appropriately accommodated for purposes of compliance assessment.

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4 BUDGETARY CONSIDERATIONS

State Parks' estimated budget to develop and implement the 2024/2025 Work Plan described in Chapter 3 is $3,784,395. A detailed breakdown of this estimated budget is provided in Table 4-1. This budget covers all activities from July 1, 2024, through June 30, 2025, including existing contracts with SAG members. The approximately $3.78 million budget shown in Table 4-1 is lower than the costs that State Parks identified for proposed activities in the 2023 ARWP ($4.52 million) due to changes in contracts.

Table 4-1. Estimated 2024/2025 Work Plan Budget

Dust Control Activity	Third-Party Contract Costs	Other Costs	Total Costs(A)
Vegetation Plantings (Conversion of Wind Fencing, Foredune, and Supplemental Plantings)			
Labor	$702,000	$330,000	$1,032,000
Materials	$0	$165,000	$165,000
Equipment	$220,000	$0	$220,000
Greenhouse facilities	$329,000	$0	$329,000
Subtotals	$1,251,000	$495,000	$1,746,000
Maintenance and Installation of Wind Fencing			
Labor	$0	$0	$0
Materials	$0	$0	$0
Equipment	$0	$0	$0
Subtotals	$0	$0	$0
Monitoring (Sand Flux, Air Quality, Meteorological, UAS, and Other Monitoring) and Modeling			
Instrument operations	$115,000	$40,000	$155,000
Data analysis	$674,000	$0	$674,000
Subtotals	$789,000	$40,000	$829,000
Dust Control Project Design and Technical Assistance			
Scientific expertise (DRI)	$200,000	$0	$200,000
SAG Costs			
Scientific expertise	$294,000	$0	$294,000
Other Items of Expense			
Miscellaneous(B)	$700,395	$15,000	$715,395
TOTAL COSTS	**$3,234,395**	**$550,000**	**$3,784,395**

(A) The cost estimate does not include permanent State Parks staff positions assigned to these duties but includes seasonal staff time and overtime for permanent staff.
(B) Miscellaneous costs include contracts for greenhouse assistance, fuel, equipment repairs, purchases, and other Dust Control Program support costs.

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5 IMPLEMENTATION SCHEDULE

Table 5-1 through Table 5-5 below present schedules for implementing the dust control activities identified in Chapter 3. The tables cover an approximately 14-month period from June 2024 to July 2025.

Table 5-1. Conversion of Existing Straw Treatments to Vegetation

State Parks Task/Activity[(A)]	2024							2025						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Consult with SAG on project selection		O	→	→	X									
Collect native seed and plants, cultivate growth, procure additional plants from nurseries	→	→	→	→	→	X								
Distribute straw mulch					O	→	X							
Initiate seeding and planting							O	→	→	X				
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

(A) The conversion of existing temporary dust control projects to vegetation includes both primary and secondary Work Plan components, including the conversion of the nesting exclosure to vegetation.

Table 5-2. Continued Foredune Monitoring and Assessment by State Parks Staff

State Parks Task/Activity	2024							2025						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Consultation with SAG on monitoring		O	→	X									O	→
Transect sampling				O	→	→	→	→	X					
Photo point monitoring					O X									
Data analysis										O	→	X		
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

Table 5-3. Supplemental Planting in Previous Treatment Areas														
State Parks Task/Activity	**2024**							**2025**						
	June	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**
Collect native seed and plants, cultivate growth, procure additional plants from nurseries	→	→	→	→	→	X								
Initiate seeding and planting							O	→	→	X				
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

Table 5-4. Field Monitoring and Air Quality Modeling Activities														
State Parks Task/Activity	**2024**							**2025**						
	June	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**
Meteorological, PM_{10}, and saltation data acquisition	→	→	→	→	→	→	→	→	→	→	→	→	→	→
PI-SWERL surveys and data analysis				O	→	→	X							
UAS surveys					O X				O X					
Improvement of DRI air quality model performance	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

Table 5-5. Continued SAG Consultation and Evaluation

State Parks Task/Activity	2024							2025						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Consultation with SAG on 2024 ARWP	O	→	→	→	X									
Refinement of excess emissions modeling	→	→	→	→	→	→	→	→	→	→	→	→	→	→
SAG quarterly meetings			X		X				X			X		
Consultation with SAG on 2025 ARWP											O	→	→	→
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

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