BAIR ADAPTATION SITE PROGRESS REPORT

Humboldt Coastal Resiliency Project

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Introduction

The foredune of the Bair addition to Humboldt Bay National Wildlife Refuge was invaded by *Ammophila arenaria* in the 1970s and progradation since that time built an additional seaward foredune (Pickart and Hesp 2019). *Ammophila* overstabilizes the foredune, disrupts beach-dune sediment budgets, (Hilgendorf et al. 2022) and leads to reductions in biodiversity, including endangered plants (Pickart 2021). In 2019-2020 *Ammophila* was treated on the Bair foredune establishing the Bair Adaptation Site (Fig. 1). The older Lanphere Adaptation Site to the south had established that manual removal of *Ammophila* and planting of native species resulted in establishment of the native dune mat plant community (Pickart 2022), The restored foredune exhibited more resilient properties than a control site of untreated *Ammophila* (Hilgendorf et al. 2022). The Bair Adaptation Site omitted the planting of native species in order to evaluate the necessity of this relatively costly step in restoration, as well as how the lack of planting affects morphodynamics and therefore resiliency.

Methods

Treatment Methods

In early 2019 0.36 ha (0.9 ac) of *Ammophila* at the south end of the Bair Adaptation site was dug by CalFire crews (Fig. 2). The scarped, near-vertical stoss face of the foredune was not treated due to inaccessibility. In September 2019 resprouts and the plants on the stoss face were treated with Imazapyr. In winter 2020 CalFire was conducting a burn of piles from the 2019 dig, and the fire escaped and burned the remaining 0.28 ha (0.7 ac) of the Bair Adaptation site. Resprouts from this burn were sprayed with Imazapyr in June 2021. In September 2021 and July 2022 any remaining live resprouts were re-treated with Imazapyr. Thus, the north and south sections of the Adaptation Site received different primary treatments: First, digging in the south, and one year later, burning in the north. Both areas were sprayed for follow-up treatments.

Monitoring Methods

Monitoring of geomorphic processes is being carried out under a separate contract with UC Santa Barbara and is not reported here. This report focuses on vegetation response and the need for revegetation when restoring foredunes. Vegetation monitoring consisted of the systematic placement of 50 0.5m x 0.5 m gridded quadrats using a random start. Each quadrat had 25 intersections in the grid. The sampler used a pin dropped at each intersection, and the top species of vegetation encountered (or bare sand) was recorded as a “hit.” Thus, there are 25 potential hits in a plot, each representing 4% of the area. Although this slightly reduces precision, it is an objective measure and therefore not subject to the bias

inherent in ocular estimation. Monitoring was carried out in 2018 (pre-treatment) and annually from 2020 through 2024 in July or August. In 2024 monitoring was conducted on August 2 by Jessica Burroughs and Hunter Hawthorne. Additionally, photopoints were established throughout the site to provide a visual record of change (Fig. 2). Photographs were taken at the same time monitoring was carried out.

Figure 1. Location of Bair Adaptation Site.

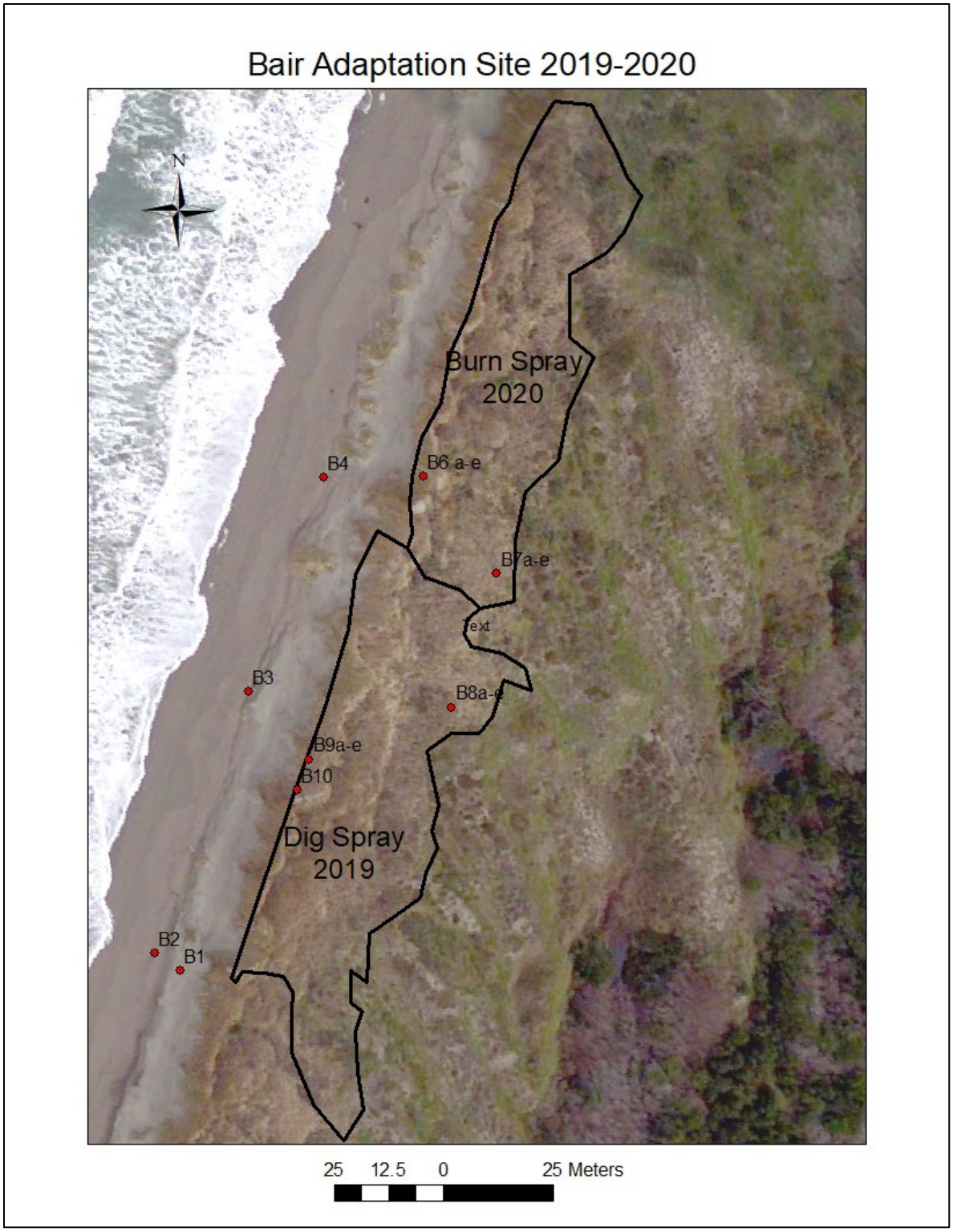

Figure 2. The Bair Adaptation Site prior to treatment showing location of treatments and photopoints. The site is comprised of the 2019 Dig/Spray and 2020 Burn/Spray polygons.

Revegetation

Bare areas in the Adaptation Site were planted in March 2024 with *Elymus mollis* planted 2 culms/hole with spacing of .5 m (Fig. 3). Every fifth plant was a division of *Poa macrantha*.

Figure 3. *Elymus mollis* divisions in August 2024, 5 months after planting

Results

Percent Cover

Change in cover in the categories of *Ammophila*, Dune mat, and Bare sand are shown in Figure 3. *Ammophila* declined steeply, from approximately 77% in 2018 (pre-treatment) to 14% in 2020 and 3% in 2024. Native dune mat increased from 1% pre-treatment to 20% in 2024, a five-year period. In comparison, at the Lanphere Adaptation site, where planting occurred, Dune mat cover reached the target cover of 40% after four years (Pickart 2022). The mean cover of dune mat in reference sites is 40% (Pickart 2013). Mean cover of *Elymus mollis* was less than 1%.

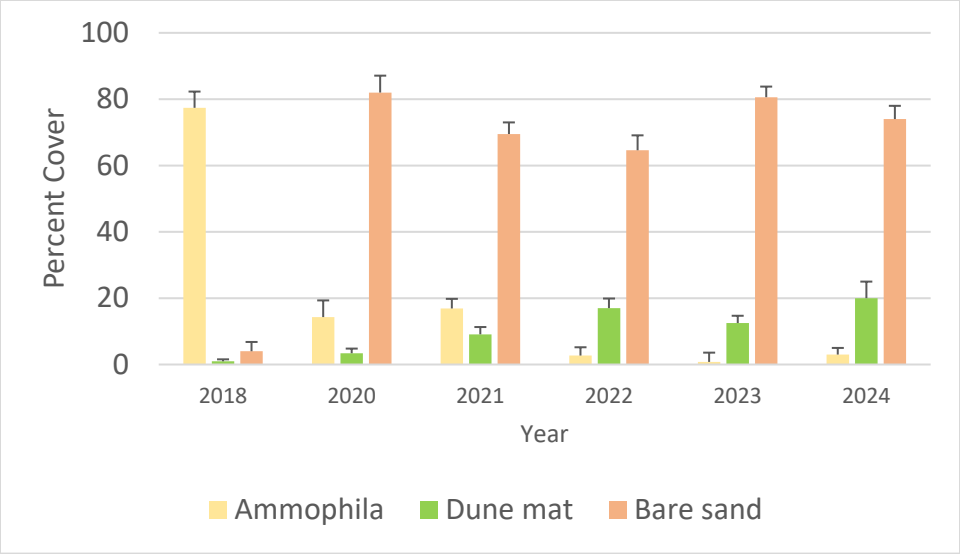

Figure 4. Change in three categories of cover in the Bair Adaptation Site over time (error bars are standard error).

Species Composition

Native species composition continued to diversify in 2024 (Fig. 5), with species richness increasing from 10 in 2023 to 13 in 2024. *Cakile* spp., a common colonizer on foredunes following restoration, continued to be almost absent on the site. The two dominant species were *Solidago spathulate* and *Armeria maritima*. These are two of the more common species found in dune mat adjacent to the site.

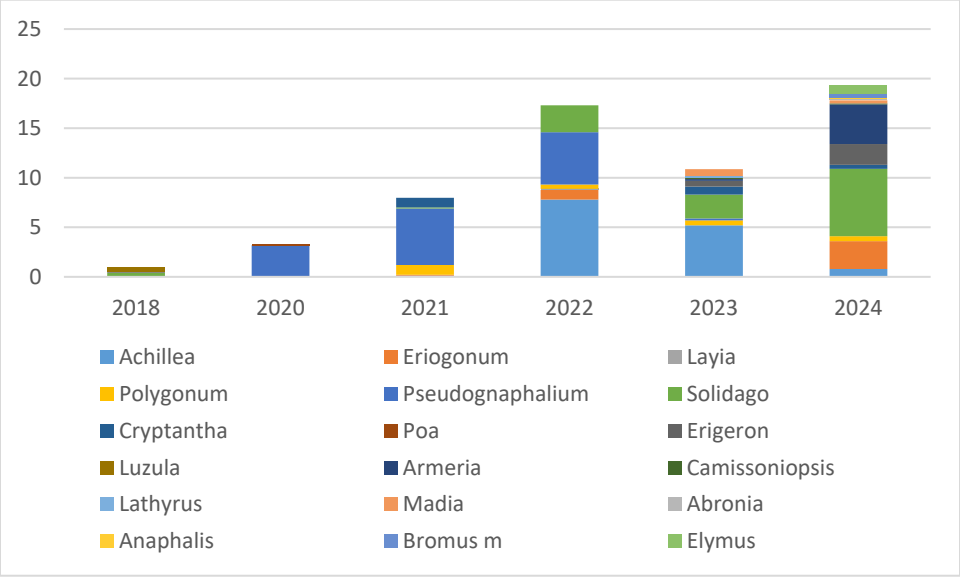

Figure 5. Native species composition (percent cover) over time.

Treatment

The experiment was not set up to test the effect of treatment (dig vs. spray). To do so, samples would need to be randomly assigned to treatments. An Aspen-Welch unequal-variance t-test was run to see if there was any suggestion of treatment effect. Total cover was not significant between treatments (p=.21).

DISCUSSION

Vegetation on the foredune is slowly developing in the direction of the native dune mat community. The main change in the site after five years continues to be that *Ammophila* cover was replaced by bare sand. In the same amount of time at the Lanphere Adaptation Site, which was revegetated, dune mat exceeded 40% cover, which is the percent cover in reference sites. Therefore, the results suggest that revegetation is beneficial in these circumstances. However, there is one caveat. The Lanphere Adaptation Site was surrounded by dune mat species which could easily disperse on to the site, and it was observed that much of the resulting dune vegetation volunteered. The Bair site was mostly surrounded by non-native vegetation. This study cannot tease apart the relative influence of planted vegetation from volunteer vegetation. Survival of *Elymus mollis* was generally high, although there was localized mortality in areas of significant sand burial. Despite the low cover values of *Elymus*, their vertical architecture and deep rhizome system contribute to the desired semi-stable condition of the foredune. Remedial planting is recommended for winter 2024/2025. *Poa macrantha* should be included at a ratio of 4:1 *Elymus:Poa*.

Conclusions

This demonstration site illustrates the desirability of revegetation in areas adjacent to non-native vegetation or bare sand. Revegetation speeds up recovery of native species and contributes to a condition of semi-stabilization. *Ammophila* built foredunes are steeper than native foredunes (McDonald 2020), and when peaked crests of the foredune are de-vegetated, the bare sand may form slipfaces. This may lead to the formation of blowouts, which are a natural feature but are usually limited in width. Wider areas without vegetation are more likely to form transgressive dune forms, rather than the long-walled parabolic dunes typical of this area. Larger transgressive dunes may bury areas of Dune mat and take a longer time to become vegetated.

REFERENCES CITED

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APPENDIX

Photopoints