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Invasive Species Removal Management Plan for the invasive species Ammophila arenaria and Carpobrotus edulis within the Samoa Dunes and Wetlands Conservation Area

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Invasive Species Removal Management Plan for the invasive species *Ammophila arenaria* and *Carpobrotus edulis* within the Samoa Dunes and Wetlands Conservation Area

Prepared by Rachel Denoncourt, Christopher Jamison, & Kyra Skylark

Humboldt State University

ESM 455: Applied Ecological Restoration Capstone

Prepared for:

Friends of the DUNES

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INTRODUCTION

Coastal sand dunes are invaluable ecosystems throughout the world, as they protect coastal communities (Gomez-Pina, 2002), store sand, and serve as important habitat for unique flora and fauna. Coastal sand dunes are key dynamic "natural structures which protect the coastal environment by absorbing energy from wind, tide and wave action" (AB, 1999). These ecosystems are composed of a beach berm, located closest to the water, then the incipient dune, the foredune(s), and then the backdune(s) (NSW DLWC, 2001). Dynamic systematic sand movement along and between the dune structure is key to a thriving coastal dune ecosystem (U.S. Fish and Wildlife Service, 2020). Coastal dunes aid in preventing coastal water intrusion, flooding, and structural damage through their ability to absorb the impacts of wind and water, acting as a natural barrier against storms and high tides (Gomez-Pina, 2002). They also act as sand storage sites, supplying sand to eroded beaches through their natural movements, and provide critical habitat for a variety of plants and animals (NSW DLWC, 2001).

As humans increased their travel and migration, invasive plant species too became more widespread; two species particularly impactful to the coastal dunes in Humboldt County (California) are *Ammophila arenaria* and *Carpobrotus edulis* (Pickart, 1997). The introduction of invasive *Ammophila arenaria,* also known as European beachgrass, and *Carpobrotus edulis,* or ice plant, among other species, was a direct result of the European colonization of North America (Friends of the Dunes, 2021). Both species were planted intentionally along the west coast of North America, including Humboldt County, as a stabilizing aid. *Ammophila arenaria* was planted along the North Spit of Humboldt Bay to stabilize the sand along the railroad tracks (Pickart, 1997). The colonization of Turtle Island, known today as North and Central America, by both humans and plants has hugely changed and damaged the coastal dunes along the west coast of the United States. From the southernmost coastal dunes of California to the northern dunes in Washington, *Ammophila arenaria* restricts natural dune movements and threatens the native coastal dune mat vegetation (Pickart, 1997). While various other invasive species negatively impact coastal dune ecosystems, the colonizing and stabilizing nature of *Ammophila arenaria* and *Carpobrotus edulis* make their management and removal critical to restoring and rehabilitating invaded coastal dunes such as the Samoa Dunes and Wetlands Conservation Area.

The Samoa Dunes and Wetlands Conservation Area is a 357-acre property that lies within the unceded current and ancestral homeland of the Indigenous Wiyot people (Figure 1) (Friends of the Dunes, 2021). The site is called Twaya't in the native language of the Wiyot people, often referred to in English as the North Spit; and lies between Wigi: the Humboldt Bay and shou'r: the Pacific Ocean (Butler, 2012). Along the Samoa Peninsula, the Samoa Dunes and Wetlands Conservation Area property is directly west of the Samoa Bridge and immediately south of the Manila Dunes Recreation Area (Friends of the Dunes, 2021). The site may be familiar to some local community members as it is on the path of the Kinetic Grand Championship race, and the area includes what was formerly known as Dead Man's Drop Forest and Dog Ranch within its boundaries (Evans, 2021). The property consists of an abandoned home structure, various other outbuildings, a ranch facility, multiple stretches of coastal dune habitats and a rare old-growth coastal dune forest (Greenson, 2020). The acquisition of this property by Friends of the Dunes creates a continuous stretch of over 1,600 acres of native coastal dune habitat, dedicated and protected exclusively for conservation efforts and recreational usage (Kemp, 2020).

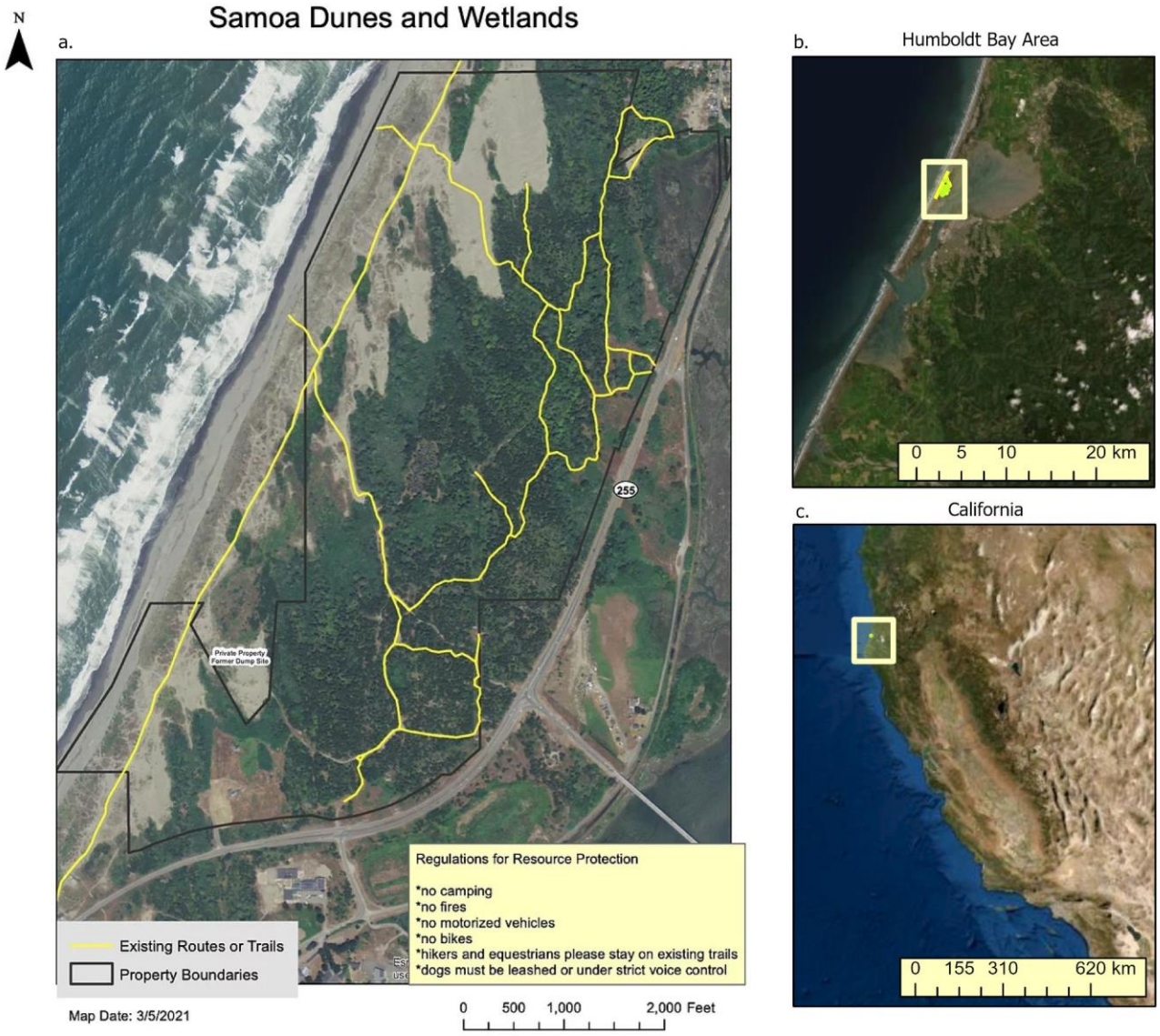

Figure 1. Samoa Dunes and Wetlands Conservation Area map and general location: a). The largest map on the left defines the official property boundary map of the Samoa Dunes and Wetlands Conservation Area. Property boundaries are depicted by the black polygon, main trails are shown in yellow (Source: Friends of the Dunes, 2021). b). The top map to the right depicts the property location in relation to the Humboldt Bay. c). The bottom right map demonstrates the site location along the West Coast of California in the U.S.

The Samoa Dunes and Wetlands Conservation Area property was previously owned by billionaire Rob Arkley, since he outbid Friends of the Dunes and the Humboldt Bay Harbor District for the property in 2005 (Greenson, 2020). It was through the collaboration of three agencies: the California Coastal Conservancy, the California Natural Resources Agency and the California Wildlife Conservation Board, that "12 coastal dune and waterfront parcels" were recently purchased from Security National for around two million dollars" (Evans, 2021). On October 15, 2020 the environmental nonprofit organization Friends of the Dunes became the interim owners and managers of the Samoa Dunes and Wetlands Conservation Area (Friends of the Dunes, 2021).

Friends of the Dunes (FOD), established in 1982, is a non-profit organization dedicated to conserving the natural biodiversity of the coastal dune ecosystems found in Humboldt County. Currently acting as the interim landowner of the Samoa Dunes and Wetlands Conservation Area, Friends of the Dunes further contribute to their role as a land trust in the community. The Dune Ecosystem Restoration Team (DERT) within the FOD organization works with local community members to remove invasive, non-native species from the dunes (Friends of the Dunes, 2021). Some of our data collection methods and recommendations for removal are modeled after FOD's practices. Our data collection took place along the foredunes or, "the series of dunes and ridges paralleling the beach" (Friends of the Dunes, 2021). The property we examined is inundated with invasive plant species and this is inhibiting natural dune movement and threatening the overall native biodiversity and health of the ecosystem. With our examination of the invasive species in the site, we created this invasive species removal and management plan for the Samoa Dunes and Wetlands Conservation Area. The intention of this management plan is to help prepare the next landowner with guidelines and recommendations for restoring the landscape of the conservation area. Funding has already been allocated for the removal of the invasive species at the site with the goal of restoring the area. Once the invasive removal plan is approved, a new owner is found, and a restoration team is established, invasive removal may commence.

Purpose & Need

Friends of the Dunes identified two invasive plant species with high removal priority within the Samoa Dunes and Wetlands Conservation Area: *Ammophila arenaria* (European

beachgrass) and *Carpobrotus edulis* (ice plant). Our project objectives are to: (1) identify and map the spatial distribution of *Ammophila arenaria* and *Carpobrotus edulis* within the Samoa Dunes and Wetlands Conservation Area property boundaries, and (2) recommend species removal strategies for the site. We have included our maps, data analysis, and management recommendations within this invasive species management plan to be reviewed by Friends of the Dunes and implemented by the future property owner. Our goal is to help inform the restoration practice of the future property owner and jump start the process of protecting native and endangered species while enhancing the biodiversity of the site.

BACKGROUND

Study Sites Description

Our study focused on two sections of the Samoa Dunes and Wetlands Conservation Area: the north and south foredunes (Figure 2). As the property boundaries do not include the middle section of the foredunes, this section omitted from our study, but it is also in need of invasive species management. Both the north and south sections consist of the foredune area outlined by the natural boundary line created by the dune escarpment of the European beachgrass, the Friends of the Dunes project boundaries, and the main waterline trail. We conducted our invasive species mapping within the borders of these north and south regions by ground-truthing the area. Photographs of our site are included within Appendix I.

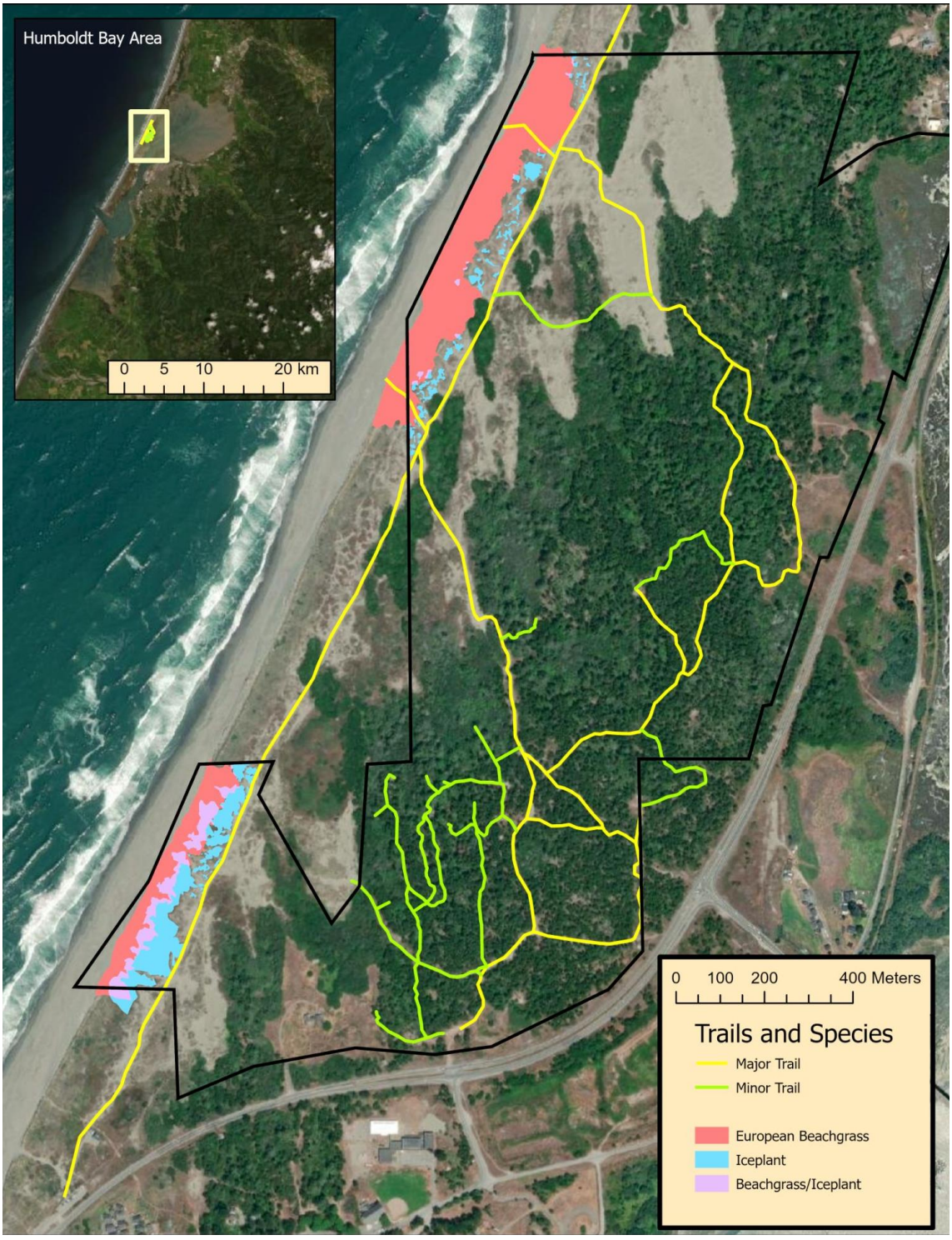

Figure 2. Map of our project area in the Samoa Dunes and Wetlands Conservation Area at the north and south foredunes sites. The upper left corner of the figure includes a locator map defining the location of this area in relation to Humboldt Bay. The property boundary line is shown in black and trails in yellow and lime green.

Focal Invasive Species

Ammophila arenaria (European beachgrass), first introduced to North America in 1868 to manage soil stability, is a naturalized grass species in central and northern California with current populations invading and expanding rapidly in dune ecosystems along the Pacific Ocean in Humboldt County (Buell, 1992; Mills, 2015). In regards to the dune ecosystems of northern California, European beachgrass is a non-native invasive species responsible for reducing the natural biodiversity of these ecosystems. The California Invasive Plant Council categorizes European beachgrass with a high negative ecological impact, as its root system is responsible for creating steep slopes in the foredunes that alter the structure of the interior dunes, while its rapid spread and dense stands allow it to outcompete native species (California Invasive Plant Council, 2021).

The non-native invasive species *Carpobrotus edulis* (ice plant), is a succulent shrub found in dune and beach ecosystems along the coast of California. Ice plant is native to South Africa, but was introduced to the United States in the 1990s as a method of erosion control (D'Antonio, 1993). The California Invasive Plant Council categorizes ice plant with a high negative ecological impact, as the vegetative and seed propagation of this plant easily promotes the formation of dense vegetative mats, making it difficult to remove and manage (California Invasive Plant Council, 2021). These dense mats decrease the survivability of native species of the dunes through smothering them and/or soil alterations in pH, moisture content, stability (Au, 2000).

Endangered Species at the Samoa Dunes and Wetlands Conservation Area

One of the main goals of Friends of the Dunes is to protect and re-establish native species within the Samoa Dunes and Wetlands Conservation Area, with a focus on the conservation of endangered species in the ecosystem. There are three plant species: *Erysimum menziesii* (Menzies wallflower), *Layia carnosa* (beach layia), and *Gilia millefoliata* (dark-eyed gilia) whose presence in the dunes are important to preserve and are severely impacted by the presence of the highly invasive non-native species. *Erysimum menziesii* and *Layia carnosa* are both listed under the federal Endangered Species Act as Endangered, while *Gilia millefoliata* is ranked as a

1B species (species with populations that have declined significantly over the last century) by the California Native Plant Society (California Native Plant Society, 2010).

The Menzies wallflower, beach layia, and dark-eyed gilia are all native species important to dune ecosystem biodiversity that are currently threatened, with limited space and populations. The Menzies wallflower is a succulent member of the mustard family, *Brassicaceae,* whose seedling survivability is low and whose reproduction relies on the pollination of the bee species *Emphoropsis miserabilis* (U.S. Fish and Wildlife Service, 2021). Beach layia, a succulent annual member of the sunflower family, *Asteraceae,* is found in regions of central and northern California. This species is resilient to disturbance and grows in areas of scattered vegetation, but struggles to establish and outcompete against non-native species with high ground cover (USFWS, 2021). *Gilia millefoliata* is an annual herbaceous species of the Phlox family, *Polemoniaceae,* found in dunes along the Pacific Ocean in California and southern Oregon. This plant species population decline is currently influenced by anthropogenic disturbance and the invasion of non-native species (California Native Plant Society, 2010). All three of these species populations are currently threatened and limited by invasive species encroachment, including our invasive focal species, *Ammophila arenaria* and *Carpobrotus edulis*.

Physical Features

Coastal dune systems consist of a beach berm nearest to the ocean, then an incipient dune, the foredune, the middune(s), and then the backdune(s) also known as hind dunes; varying climates and species can impact the structure and movement of these dunes. Coastal dunes are typically comprised of a series of sand dunes between 10 and 45 feet tall extending up to 4 miles inland, where the dune closest to the ocean are called incipient dunes, the next fully formed dunes are called foredunes, the dunes beyond the first two hills are called the "middune," and the dune matrix that are markedly less exposed to sea conditions are called "backdunes," (Pickart, 2007) (Figure 3). The coastal dunes of the Humboldt Bay area are composed of gradually rising sand hills, called incipient foredunes, directly parallel to the ocean, followed by sharply declining recessions called swales (Green, 1999) (Figure 4). However, sharp cliffs where incipient foredunes once resided, called "scarp terraces," or "escarpments," can form when dune stabilizing species such as *Ammophila arenaria* develop deep root systems that prevent natural

dune drift from occurring, leaving 5-15 foot “shelves,” at the edge of the high water line (Pickart, 2014). Images of the escarpments at the southern and northern sections of our site can be found within Appendix I.

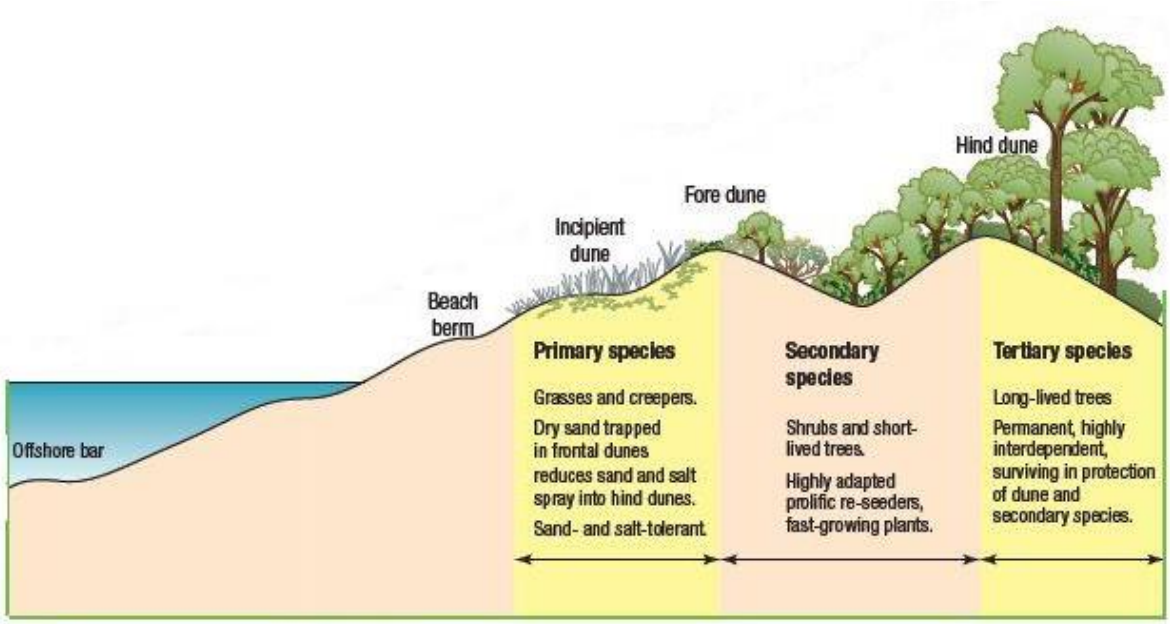

Figure 3: Graphic demonstrating the typical structure of coastal dunes. We surveyed invasive species along the foredunes, not including sections of any incipient dunes, as they do not currently exist at the site due to the sharp escarpment along the shore. Source: https://coastaldunesx.weebly.com/

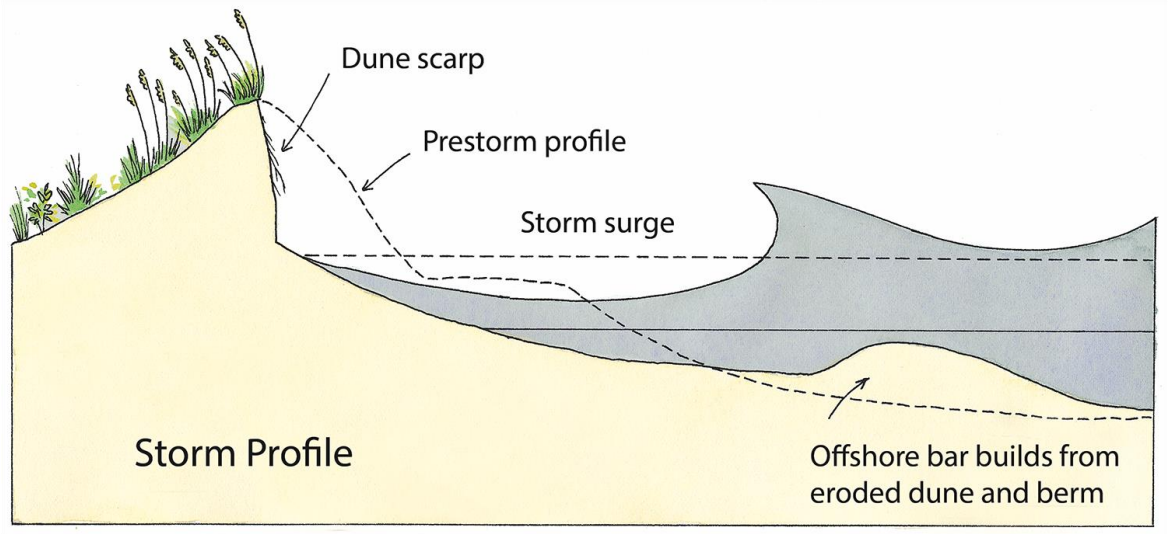

Figure 4: Graphic representation of a coastal dune storm profile including a depiction of a scarp terrace, or dune escarpment. Source: https://ncseagrant.ncsu.edu/coastwatch/previous-issues/2019-2/spring-2019/return-of-the-dunes-the-science-of-post-florence-recovery/

The coastal dunes of Humboldt County are shaped by high water levels, in both atmospheric water and groundwater, influencing the species existing within them as well as the dunes overall structure. The climate for the coastal dunes of Humboldt County is characterized by a long rainy season spanning from October to April, with a mean precipitation of 38-80 inches (Customweather, 2021). The "deflation plane," also known as the dune swale or dune hollow, sits behind the foredune and is prone to seasonal inundation where the swales between dunes fill with water during the rainy season (Evenson, 1959). The high levels of rain leads to the growth of a different set of species within the coastal dunes, especially sedge and other semi aquatic species (Leppig et al., 2007). Groundwater is high at Samoa Dunes and Wetlands Conservation Area as the water table sits between the ocean and the Humboldt Bay; frequently rising up through the sand in the deflation plane during the rainy season at lower levels of elevation such as in the towns of Samoa and King Salmon areas within Humboldt County (Pickart, 2007). This variability among seasons led to the development of vegetative communities that are well-adapted to periods of high precipitation and summer drought stress (Pickart, 2007).

The Humboldt Bay Dunes, denoted as the "Samoa Series," are composed predominantly of Entisols containing dune swales and catchment basins. The Samoa Series are primarily Entisols, composed of well-drained sand and gravel alluvium more than 100 feet thick (Web Soil Survey, 2021). Dune swales typically contain unconfined waters less than 30 feet below the land surface, where both the hydraulic head of the ocean and the brine-freshwater interface of the Humboldt Bay meet (Evenson, 1959). The topography of the dunes forms natural catchment basins, which provide sufficient water for deep percolation, creating a high, localized water level, influencing the development and prevalence of seasonal semi-aquatic species. (Pickart, 2007). Recently, coastal dunes have been the subject of study in sea level rise mitigation, as alluvial sand accumulation and stabilization by vegetative and geomorphic components have shown promise in mitigating against sea level rise associated damage to the coastal communities of the North Coast (Pickart, 2014).

Management Objectives

The infestation of *Ammophila arenaria* and *Carpobrotus edulis* have dramatically reduced native species diversity of sand dune ecosystems along that coast of Humboldt County and diminished the habitat of native endangered plant and invertebrate species (Barger, 2018). Removal of targeted invasive species will increase coastal dune ecosystem resilience to sea level rise and climate change and prevent the further alteration of vegetative communities in the Samoa Dunes and Wetland Conservation Area. Management will focus on the control of *Ammophila arenaria* and *Carpobrotus edulis* in the defined foredune treatment areas and a measurable return of native dune mat community components to the study site.

METHODS

We used a basemap of the 375-acre Samoa Dunes and Wetland Conservation Area property to conduct our field work by mapping the invasive species locations within the foredunes. The basemap included the property boundaries, the primary recreation trails, and the subtrails for the site. In carrying out our fieldwork, we ground-truthed the site, delineating polygons as we walked around each invasive species patch of *Ammophila arenaria* and *Carpobrotus edulis* on the foredunes.

Field work consisted of ground-truthing the previously defined north and south foredune areas, and determining the exact locations of the two focal invasive species *Ammophila arenaria* and *Carpobrotus edulis.* During our field data collection, we utilized the mobile application ArcGIS Collector version 20.2.2, created by Esri, on our smartphones to create polygons defining the locations of the two invasive species. To create these polygons, we downloaded the basemap into our personal cellular devices, setting our accuracy to 10 feet (or lower when possible), and our streaming distance to five feet (when possible). To add the full streamed polygons to the map within Collector we selected the "+" symbol to add a polygon and while streaming walked around each invasive species patch along the foredunes. We also manually entered points while creating the polygons, adding new points each time we changed direction for the best accuracy and detail. We recorded the species mapped, day collected, and collector name for each polygon we created.

RESULTS

The predominant species we recorded in the northern foredune section was European beach grass. There were only small scattered populations of ice plant within the northern area, with very few sections of crossover between the two species. A total of 11 small polygon crossover sections were recorded (Figure 5). The southern foredune section of the property had significantly more ice plant than the northern section (Figure 6). In contrast to the northern section, there was more coverage of ice plant than European beachgrass in the southern section. The southern section was heavily inundated with the two invasive species and has a large section of crossover where both of the species were present.

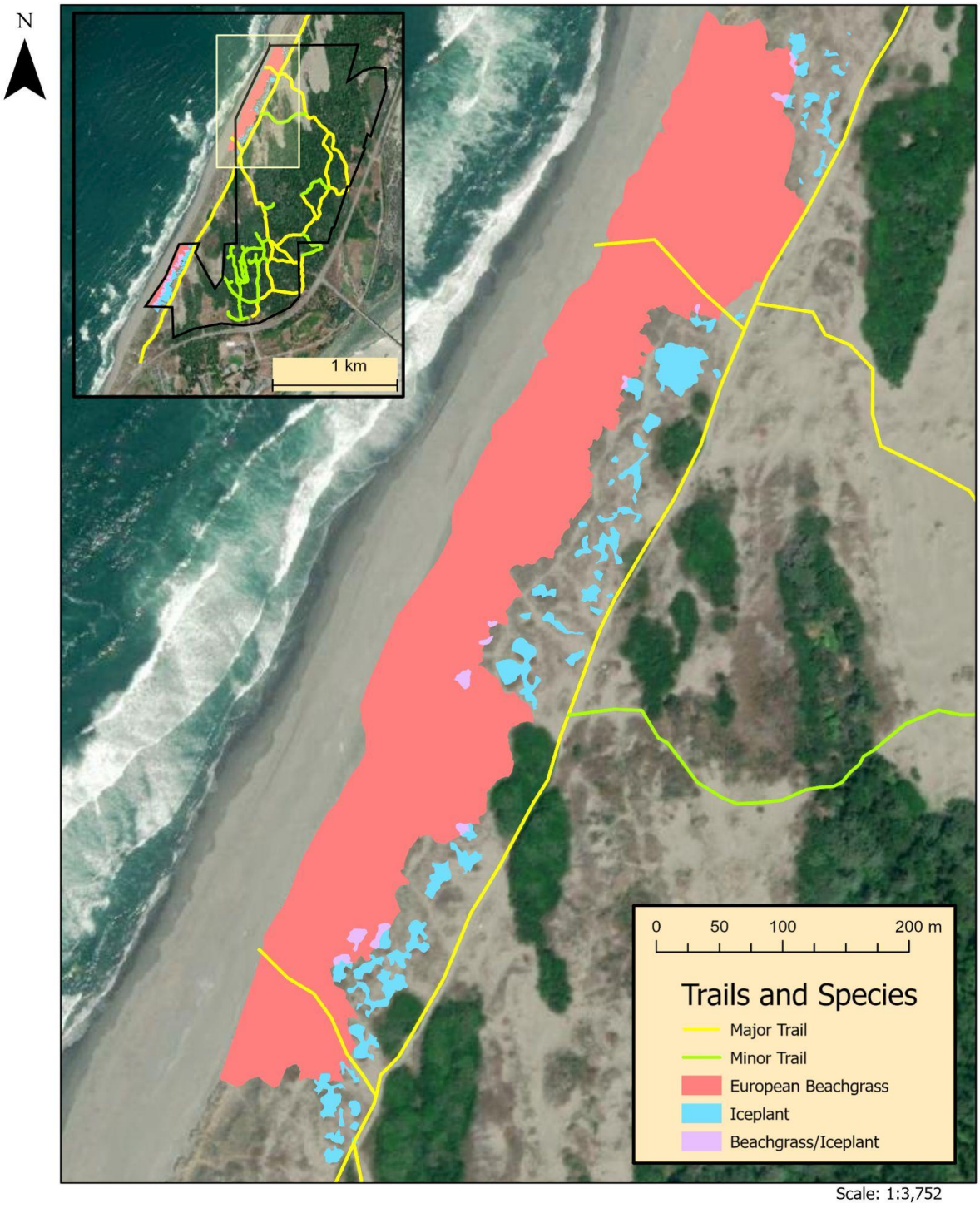

Figure 5. This map depicts the locations of invasive European beach grass and ice plant within the northern foredune site of the Samoa Dunes and Wetlands Conservation Area in March 2021. The upper left corner of the figure includes a locator map defining the location of the northern fordune site within the property boundaries. The property boundary line is shown in black and trails in yellow.

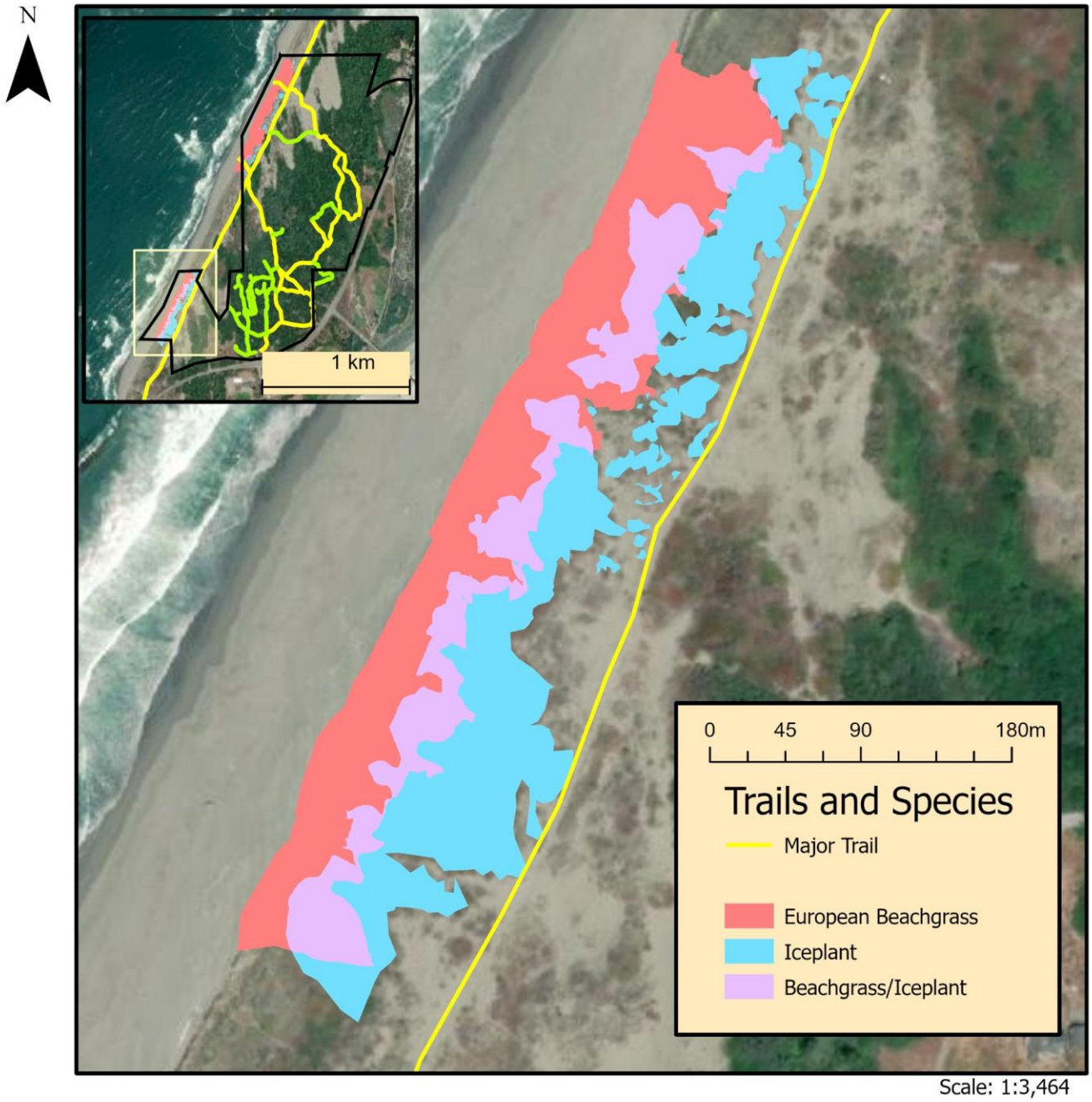

Figure 6. This map shows the locations of invasive European beach grass and ice plant within the southern foredune site of the Samoa Dunes and Wetlands Conservation Area. The upper left corner of the figure includes a locator map defining the location of the northern fordune site within the property boundaries. The property boundary line is shown in black and trails in yellow.

MANAGEMENT RECOMMENDATIONS

Phase 1

Phase 1 management should start with the southern section of the property, then progress to the northern section. Removal of European Beachgrass should begin in March as the dormant season ends, at the start of the growing season, and persist through October (DiTomaso, 2013). The removal of ice plant should occur concurrently with the removal of European beachgrass when possible, with a focus on the removal of invasive species located on the foredunes first (Barger, 2018). The removal of the invasive species on the foredunes is the first priority to eliminate the severe dune escarpment along the shore of the site, as this escarpment is inhibiting dune mobility. Additionally, the foredunes are the most heavily inundated by invasive species in comparison to the rest of the site. The removal of both European beachgrass and ice plant will be the most intense in early spring when seeds are sprouting and young individuals are first appearing (Pickart, 1997). However, start dates for invasive species removal are heavily reliant on labor availability (Barger, 2018). Initial removal during the first growing season will be the most labor intensive, with subsequent treatments occurring for the following three years with decreasing frequencies until reemergence is limited to ensure the weakening rhizome structure and exhaustion of the invasive species seed bank (Pickart, 1997). Ice plant removal should only need to occur once, as post treatment recolonization is unlikely; however, removal areas should be monitored for recolonization in the year following initial treatment (Barger, 2018). Monitoring should persist for as long as funding is available, with flexibility for further removal treatment when necessary. Management of the northern unit will occur following the same protocols after the first year of management of the southern property when funding and labor resources allow.

Invasive species removal recommendations

Removal of *Ammophila arenaria* should be conducted by both manual and mechanical means. Repeated digs of both the above and below ground stems and rhizomes should be conducted; digs should be carried out to a depth of at least 8 inches to remove the rhizomes. Shovels and trowels should be used to assist in the removal of the rhizome (Barger, 2018). Plant debris should then be gathered into piles up to 5x5 feet in area and 5 feet high and placed at least

15 feet apart from one another (Barger, 2018). Burning of these piles should be conducted as soon as they dry, pursuant to local burning regulations and with consideration of air quality, permits and neighboring properties (Barger, 2018). For areas with high degradation, tractors should be used to remove and bury the top layer of soil in order to expose the mineral sand found underneath the beachgrass (U.S. Fish and Wildlife Service, 2020).

Removal of *Carpobrotus edulis* should occur manually where mats of ice plant are rolled up away from the ground surface as roots are cut on the underside (Barger, 2018). Most of the treatment process will occur in this fashion, where lone patches or islands of ice plant will be removed manually in strands. Debris should be gathered into piles in an area no larger than 10x10 feet and either burned or carried off site after drying (Barger, 2018).

Phase 2

Following the recommended removal of *Ammophila arenaria* and *Carpobrotus edulis,* we recommend follow up removal by conducting site visit monitoring and further manual removal when necessary. Once the numerous repeated digs (to a depth of at least 8 inches) of both above and below ground stems and rhizomes for *Ammophila arenaria* are carried out over time, further removal will be needed to eliminate any missed ground stems and rhizomes to eliminate establishment and/or further spread of the colonizing invasive species. As ice plant does not need to be removed as many times, the follow up treatment is less extensive. For ice plant, we recommend future monitoring of the species on the site and removal of missed and/or newly established mats when found. Making sure to remove all debris piles in a timely manner following the original removal will be necessary to prevent future spread; ice plant can establish a new plant from any existing live plant material left over time as they propagate from division, cuttings, or seeds (California Invasive Plant Council, 2021).

Following the completion of the initial and follow up removal of *Ammophila arenaria* and *Carpobrotus edulis,* we recommend the removal of the lower priority invasive species. We categorize lower priority species by their ability to inhibit dune movements, cause damage to the native flora, and overall site coverage. We recommend starting the removal of the lower priority invasive species *Lupinus arboreus* (yellow bush lupine), then moving on to the following species: *Cotoneaster franchetii* (cotoneaster), *Hedera helix* (English ivy), *Genista*

monspessulana (French broom), *Ilex aquifolium* (English holly), *Cortaderia jubata* (pampas grass), *Cytisus scoparius* (Scotch broom), and any others found throughout the removal and monitoring process.

Restoration Considerations

Restoration implementation involving mechanical removal of invasive species has the potential to negatively impact native and endangered species in the area. Management techniques may fail to both remove non-native species and protect the endangered dune species, as user error and heavy machinery could injure or kill off these species. In order to mitigate these effects, mechanical removal processes for European beachgrass should be limited to labor-intensive practices, such as hand and shovel removal, rather than through the use of heavy equipment. Removal of *Ammophila arenaria* through heavy equipment can destabilize the dunes, requiring a longer restoration period and the inclusion of revegetation in the management plan, as well (USFWS, 2020).

We are not recommending any revegetation efforts as previous dune restoration efforts in the area have shown that comprehensive removal of the invasive species is enough for the native dune mat to recover and flourish given time (Walter, 2011). Additionally, the invasive removal process of European beachgrass and ice plant will take multiple years and we recommend that overall efforts, money, and time go to the removal of these two species (Pickart, 2013). Our recommendations take into account the invasive species removal at nearby coastal dune sites: the Lanphere Dunes which was carried out from 1992-1998, and that of the Ma-le'l Dunes where removal took place from 2005-2010 (Pickart, 2013). The use of herbicides to remove European beachgrass is one of the most cost effective and swift ways to eliminate the living species, however it has it's problems. We do not recommend herbicides for this site's management due to the negative impacts of herbicides on the native dune mat flora, and their ability to limit and/or lengthen the native's recovery (Pickhart, 1997). If herbicides were used it would harm the currently existing native flora and would likely mean revegetation of the site would be required, this would raise the cost and time of restoration overall (Pickhart, 1997). Additionally, the removal of the dead plant biomass following the herbicide use still has to be removed from the

site (Pickhart, 1997). Herbicide use on coastal dunes, while faster, often means more steps, more money, and more recovery; therefore we do not recommend their usage (Pickhart, 1997).

MONITORING

In order to confirm the success of the restoration practices, the monitoring process should include annual photo point documentation of vegetation shifts within the Samoa Dunes and Wetlands Conservation Area. This documentation process includes selecting specific points within the plot to revisit and capture these pictures, potentially areas with the highest densities of each high priority invasive species, *Ammophila arenaria* and *Carpobrotus edulis*. Similar to the Friends of the Dunes restoration plan, written by Jess Barger in 2018, the photo point process will include documenting any non-native vegetation appearing between photo sets, and removal processes will be repeated on recurring populations (Barger, 2018). Topographic profile analysis should be used to monitor landscape responses to the restoration, specifically dune stability and erosion along areas where escarpment from European beachgrass is most present. We also recommend measuring the site's regeneration of native species by collecting percent coverage data of any invasive species remaining after removal is completed, contrasted to the percentage cover of native species. We believe that recording the percentage cover yearly for the first five years following the comprehensive removal would be beneficial, and then switching to measuring percentage cover every five years after the first five.

CONCLUSION

Removing *Ammophila arenaria* and *Carpobrotus edulis* within the coastal dune ecosystems of Humboldt County is an integral step in eliminating resource competition with native species, restoring the landscape and increasing coastal dune resilience to sea level rise and climate change. The restoration recommendations outlined in this document will be used to conserve the natural biodiversity of this coastal dune ecosystem within the Samoa Dunes and Wetlands Conservation Area, while providing potential guidelines to coastal dune restoration projects outside of this region. Further research, with reference to our recommendations, can be conducted in order to appropriately remove lower priority invasive species in the conservation area and in similar ecosystems. Proper restoration, management and monitoring of our coastal dune ecosystems are fundamental actions to take in order to protect these coastal environments.

ACKNOWLEDGEMENTS

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APPENDICES

Appendix I: Site Photos

Figure 1. *Carpobrotus edulis* distribution in the southern section of our project area.

Figure 2. *Ammophila arenaria* distribution in the southern section of our project area.

Figure 3. Dune escarpment along the western edge of the southern section of our project area.

Figure 4. Dune escarpment along the western edge of the southern section of our project area.

Figure 5. *Carpobrotus edulis* distribution in the southern section of our project area.

Figure 6: The endangered *Erysimum menziesii* (Menzies wallflower) located on the southern foredunes of the property.