succession ecology

Wara Wayingga Tennyson Dunes

Vegetation Condition Change Assessment

DOCUMENT SPECIFICATION

Client:	Green Adelaide Board
Client contact:	Warrick Barnes
Client email:	warrick.barnes@sa.gov.au
Succession Ecology contact:	Dr Sabine Both
Succession Ecology email:	sabine@successionecology.com.au
Prepared by:	Dr Andrea Stiglingh and Abhishek Gopalakrishnan
Document #:	ES0723-09
Citation:	Succession Ecology (2023). Tennyson Dunes Vegetation Condition Change Assessment. Succession Ecology report ES0723-09 prepared for Green Adelaide Board.

DOCUMENT HISTORY

Version	Issue Date	Prepared By	Reviewed By	Status
1	31/07/2023	Dr Andrea Stiglingh and Abhishek Gopalakrishnan	Dr Sabine Both	Draft
2	29/08/2023	Dr Andrea Stiglingh and Abhishek Gopalakrishnan	Dr Sabine Both	Final

ACKNOWLEDGEMENT OF COUNTRY

Succession Ecology acknowledges and pays respect to the past, present and future Traditional Custodians and Elders of this nation and the continuation of cultural, spiritual and educational practices of Aboriginal and Torres Strait Islander peoples.

LIST OF ABBREVIATIONS

ALA Atlas of Living Australia

ALOP Appropriate Level of Protection (Dept. of Agriculture, Fisheries and Forestry)

BAM Bushland Assessment Methodology

BDBSA Biological Database of South Australia

DEW Department for Environment and Water

EPBC Environment Protection and Biodiversity Conservation (Commonwealth legislation)

IBRA Interim Biogeographical Regionalisation of Australia (IBRA)

LSA Landscape South Australia (SA legislation)

NPW National Parks and Wildlife (SA legislation)

succession ecology

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 EXECUTIVE SUMMARY

The Wara Wayingga Tennyson Dunes Reserve experienced both positive and negative changes to vegetation condition between 2020 and 2023. A total of 60 native species were observed and native species diversity increased in half of the management zones (Zone 1, Zone 3b, Zone 5a, Zone 5b, Zone 7a and Zone 7c) since 2020. The state rare Hawkweed Picris (*Picris squarrosa*) increased in abundance and cover and was observed within six of the management zones. A total of 59 weed species were observed, however, the weed species richness decreased in nine of the twelve management zones (Zone 1, Zone 2a, Zone 2b, Zone 3a, Zone 4, Zone 5a, Zone 6, Zone 7b, and Zone 7c). Despite this decline in weed diversity, the overall weed cover and weed understorey biomass increased, resulting in an overall decrease in vegetation condition score in 10 of the 12 management zones assessed. The overall vegetation condition score improved for two management zones: Zone 1 (foreshore) and Zone 5a (revegetation zones).

A total of 23 out of the 25 priority weed species listed in the 2006 Vegetation Management Plan were observed during the 2023 vegetation assessment, including nine declared weed species. Of the declared weeds, Bridal Creeper (*Asparagus asparagoides*) was the most common and observed in eight of the 12 management zones.

The observed decline in vegetation condition within the Wara Wayingga Tennyson Dune Reserve since 2020 suggests that the current extent of weed control implemented is not sufficient for maintaining vegetation condition. The current weed management approach should be reviewed and altered to address the key weed problems identified within this report, particularly the control of declared and priority weed species.

2 INTRODUCTION

2.1 Project Overview

In the Adelaide and Mount Lofty Ranges (AMLR) region there are 4,627 km^2 of marine waters and 333 kilometres of coastline stretching from Middleton Beach on the Fleurieu, to Mallala north of Adelaide (Natural Resources SA 2019). The Tennyson Dunes are the most significant patch of pre-European coastal dunes left along the Adelaide metropolitan coastline, and includes a number of plant species with regional conservation significance (T&M Ecologists 2020). These dunes range in width from 200-300 m and are up to 15 m in height. The Tennyson Dunes Conservation Reserve is a 1.5 km stretch of coastline which was established in September 2015 under the Crown Land Management Act 2009. The broader area is often referred to as Wara Wayingga - Tennyson Dunes precinct. The adjoining coastal reserves located immediately to the north and south of the project area are under the care and control of the City of Charles Sturt and provide opportunities to develop biodiversity linkages between these coastal environments. A number of environmental/community groups are active within the Tennyson Dunes Reserves, including the Tennyson Dunes Group (a volunteer-based coast care organisation), resulting in a strong sense of community ownership and community driven action within the project area.

In 2015, a Biodiversity Action Plan for the Tennyson Dunes (EAC Ecological Evaluations 2015) was implemented, which includes regular assessment of vegetation condition and change. Vegetation condition assessments were conducted at 11 sites in August-September of 2014 and again in January 2020 (T&M Ecologists 2020), with the next reassessment due in 2023.

2.1.1 IBRA Region

The Tennyson Dunes site lies within the St Vincent (EYB02) subregion of the Eyre Yorke Block bioregion according to the Interim Biogeographic Regionalisation for Australia (IBRA). In the National reserve system, 15-30% of land is protected and retained for environmental or cultural purposes (Department of Agriculture, Water and the Environment 2020). The site is within a low-lying area of Port Adelaide with a mean elevation of approximately 3-5 m based on the Australian Height Datum (AHD). The Southern, South-eastern, and Eastern areas are mounded approximately 1-2 m higher than the Western and Northern areas.

The climate of the Eyre Yorke Block bioregion is typically semi-arid. Tennyson Dunes typically records an average annual rainfall of 414 mm (Bureau of Meteorology [BOM]). Rain is often sporadic and highly variable according to the long-term average recorded at the Seaton station, Adelaide (BOM). Annual rainfall for the vegetation survey years and the years prior to vegetation assessments were 459 mm (2013), 466 mm (2014), 347 mm (2019), 430 mm (2020), and 551 (2022).

Table 1: IBRA subregion description (Thackway and Cresswell 1995).

Characteristics	Eyre Yorke Block (EYB)
Landform	Low limestone dune ridges; small granitic islands with dunes
Geology	Ripon Calcrete; Loveday soil in aeolian sand sheets, dune sand and red soils (terra rossa)
Soil	Sandy soils of minimal pedologic development. Brown calcareous earths, brown sand soils, shallow red brown sandy soils and sandy soils with yellow clayey mottled subsoil.
Vegetation	Mallee woodland and shrubland
Climate	Mediterranean climate with drier, cooler winters with less growth

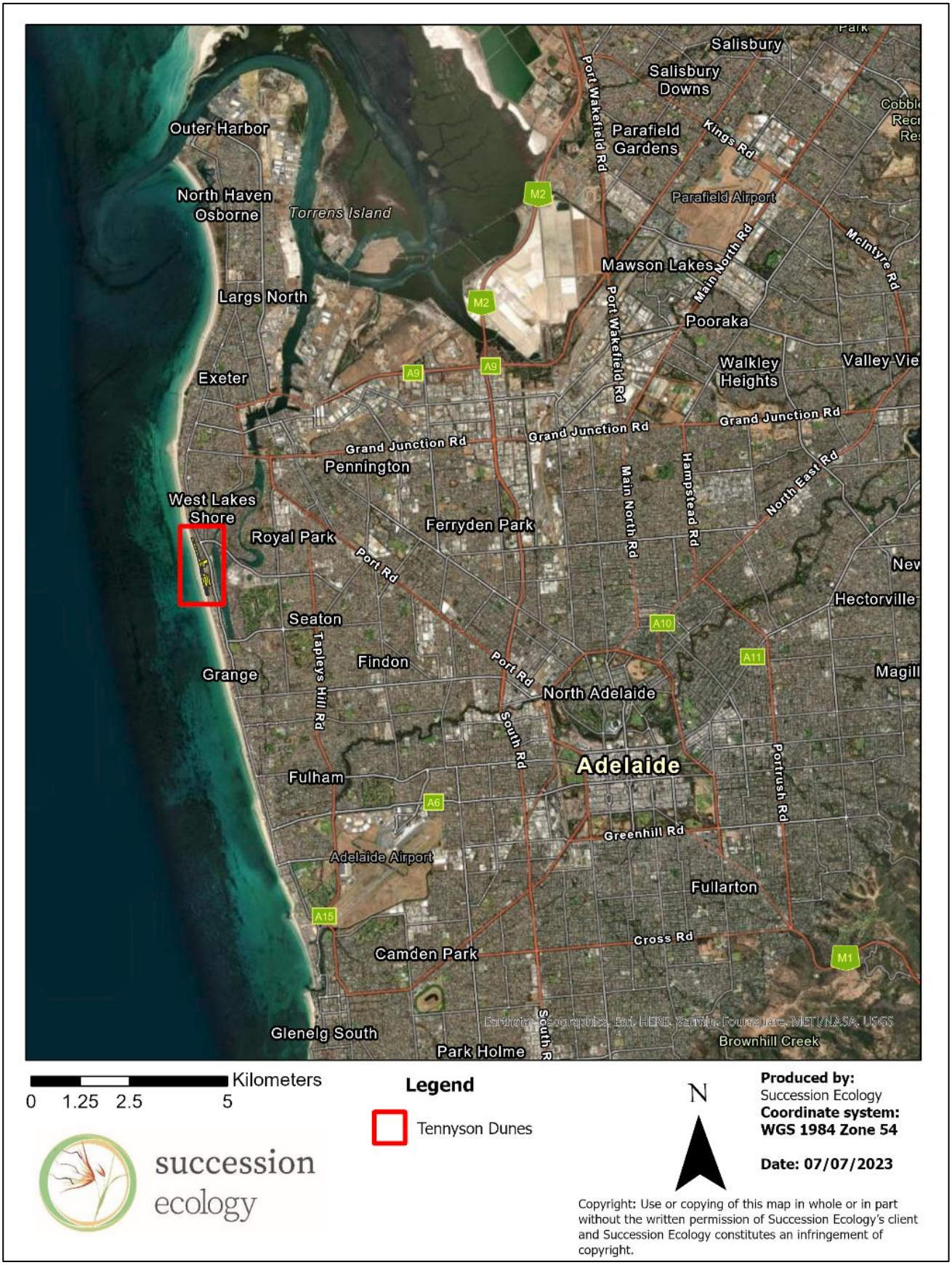

Figure 1: Location of the Tennyson Dune Reserve Project area in Adelaide, South Australia.

2.1.2 Management Background

Prior to the dedication of the dune system as a crown conservation land reserve in September 2015, conservation action within the dune system was managed by the Adelaide and Mt Lofty Ranges Natural Resources Management Board (NRM Board), in collaboration with the city of Charles Sturt and local community groups. Since 2015, the reserve has been under the management of the Department for Environment and Water (DEW), and the National Parks and Wildlife Service SA, with the Landscape Board providing support for on-ground conservation activities. Adjoining parcels of crown land are managed by the City of Charles Sturt local council.

The Green Adelaide Board superseded the NRM Board in 2020, which supports conservation action within the reserve through board levy investments and resources. However, conservation works within the reserve post 2020 have largely been funded by Green Adelaide Grants which support the work of the Tennyson Dunes Group.

A Vegetation Management Plan was developed for the Tennyson Dune Reserve as part of the SA Urban Forest Biodiversity Program for the City of Charles Sturt (Cordingley and Petherick 2006). The plan was created as a coordinated management approach for reducing degradation and enhancing the biodiversity value of this area. Seven management zones were identified based on vegetation communities, their relative position within the dune system, and any environmental modifications observed as a result of human use or activity (Table 2). These are Zone 1: Foredune, Zone 2: Interdune Swale, Zone 3a: Hind Dune North, Zone 3b: Hind Dune South, Zone 4a: Hind Dune Ridge North, Zone 4b: Hind Dune Ridge South, and Zone 5: Rehabilitation. In 2015, EAC Ecological Evaluations prepared a Biodiversity Action Plan for Tennyson Dunes (EAC Ecological Evaluations 2015), which has helped guide restoration and management activities by the Tennyson Dunes Group, Natural Resources Adelaide and Mount Lofty Ranges, and the City of Charles Sturt. Based on the condition of dune vegetation at the time of development, this Biodiversity Action Plan, split the Tennyson Dunes Reserve into eight management zones, which included the merging of Zones 3a and 3b (into Zone 3) and Zone 4a and 4b (into Zone 4) and the splitting of Zone 5 into 5a South and 5b North. Two additional management zones were also established, Zone 6: Interdune Swale with Patches of Remnant Hind Dune Vegetation and Zone 7: Areas of Garden Encroachment and Weedy Edges. The partitioning of the reserve into these management zones were to assist in implementing different management activities and priorities within different parts of the dune (e.g., the type and intensity of weed control necessary for different zones).

The management zones presented in the 2020 vegetation condition assessment report (T&M Ecologists 2020) was similar to those reported in the 2015 Biodiversity Action Plan, but some were split into additional zones (twelve total) to provide finer-scale differentiation between areas with different vegetation quality and management requirements (Table 2). The 2023 vegetation monitoring survey conducted by Succession Ecology retained many of the management zones presented in the 2020 vegetation assessment report, but included two additional amendments to the management zones to reflect vegetation condition and quality at the time of assessment (Figure 2 and Table 2). These include:

- The division of Zone 2 into Zone 2a North and Zone 2b South, based on differences in native species richness, the diversity of plant life forms diversity and native regeneration. These two subsections were assessed independently in 2020 but reported as a single zone in the 2020 vegetation condition report.
- The division of Zone 5b into Zone 5b and Zone 7d, to reflect the encroachment of garden species into reserve from neighbouring houses

Table 2: Vegetation management zones within the Tennyson Dune system, as reported within the 2006 Vegetation Management Plan and the 2020 Vegetation Condition Assessment Report prepared by T&M Ecologists. The vegetation association descriptions used for each zone in these reports are shown. The vegetation association description recorded in the 2020 Vegetation Condition Assessment originated from the 2015 Tennyson Dunes Biodiversity Action Plan.

2006 Vegetation Management Plan			**2020 Vegetation Assessments**		**2023 Vegetation Assessments**	
Zone	**Description**	**Vegetation**	**Zone**	**Vegetation**	**Zone**	**Vegetation**
1	Foredune	*Spinifex hirsutus* with emergent *Olearia axillaris* and *Atriplex cinerea* open grassland	**1**	*Thinopyrum junceiforme, Spinifex hirsutus* Tussock Grassland	**1**	*Thinopyrum junceiforme* and *Spinifex hirsutus* tussock grassland
2	Interdune Swale	*Olearia axillaris/Rhagodia candolleana ssp. candolleana* low open shrubland	**2a North**	*Olearia axillaris*, *Rhagodia candolleana ssp. candolleana* open shrubland	**2a North**	*Olearia axillaris* and *Rhagodia candolleana spp. candolleana* open shrubland
			2b South		**2b South**	*Olearia axillaris* and *Rhagodia candolleana spp. candolleana* open shrubland, with Spinifex understorey
3a	Hind Dune	*Olearia axillaris/Leucopogon parviflorus+/-Nitraria billardierei* low shrubland	**3a North**	*Olearia axillaris* Open shrubland	**3a North**	*Olearia axillaris* open shrubland
3b			**3b South**		**3b South**	*Olearia axillaris* and *Alyxia buxifolia* shrubland
			7c	Areas of garden encroachments and weedy edges	**7c**	Garden encroachment/weedy edge

2006 Vegetation Management Plan			2020 Vegetation Assessments		2023 Vegetation Assessments	
4a	Hind Dune Ridge	*Leucopogon parviflorus/Melaleuca lanceolata+/-Olearia axillaris* open shrubland	**4**	*Leucopogon parviflorus, Olearia axillaris, Acacia longifolia var. sophorae +/- Myoporum insulare* shrubland	**4**	*Leucopogon parviflorus, Olearia axillaris, Acacia longifolia var. sophorae, Myoporum insulare* shrubland
4b			**5b North**	*Olearia axillaris* Open shrubland with emergent *Allocasuarina verticillata*	**5b North**	*Olearia axillaris* shrubland with emergent *Allocasuarina verticillata*
					7d	Garden encroachment/weedy edge. *Olearia axillaris* shrubland with emergent *Allocasuarina verticillata*.
5	Rehabilitation	*Melaleuca lanceolata/Tetragonia implexicoma* tall shrubland	**5a South**	*Allocasuarina verticillata, Callitris gracilis* very low woodland	**5a South**	*Allocasuarina verticillata, Callitris gracilis* very low woodland
This area was not a part of the reserve in 2006			**6**	Interdune swale and remnant patches of hind-dune vegetation north of Coronado Court. *Olearia axillaris* shrubland	**6**	*Olearia axillaris* shrubland
			7a	Areas of garden encroachments and weedy edges. *Olearia axillaris* very open shrubland	**7a**	*Olearia axillaris* very open shrubland.
A very small area that was not originally included in the plan			**7b**		**7b**	Weedy Meadow

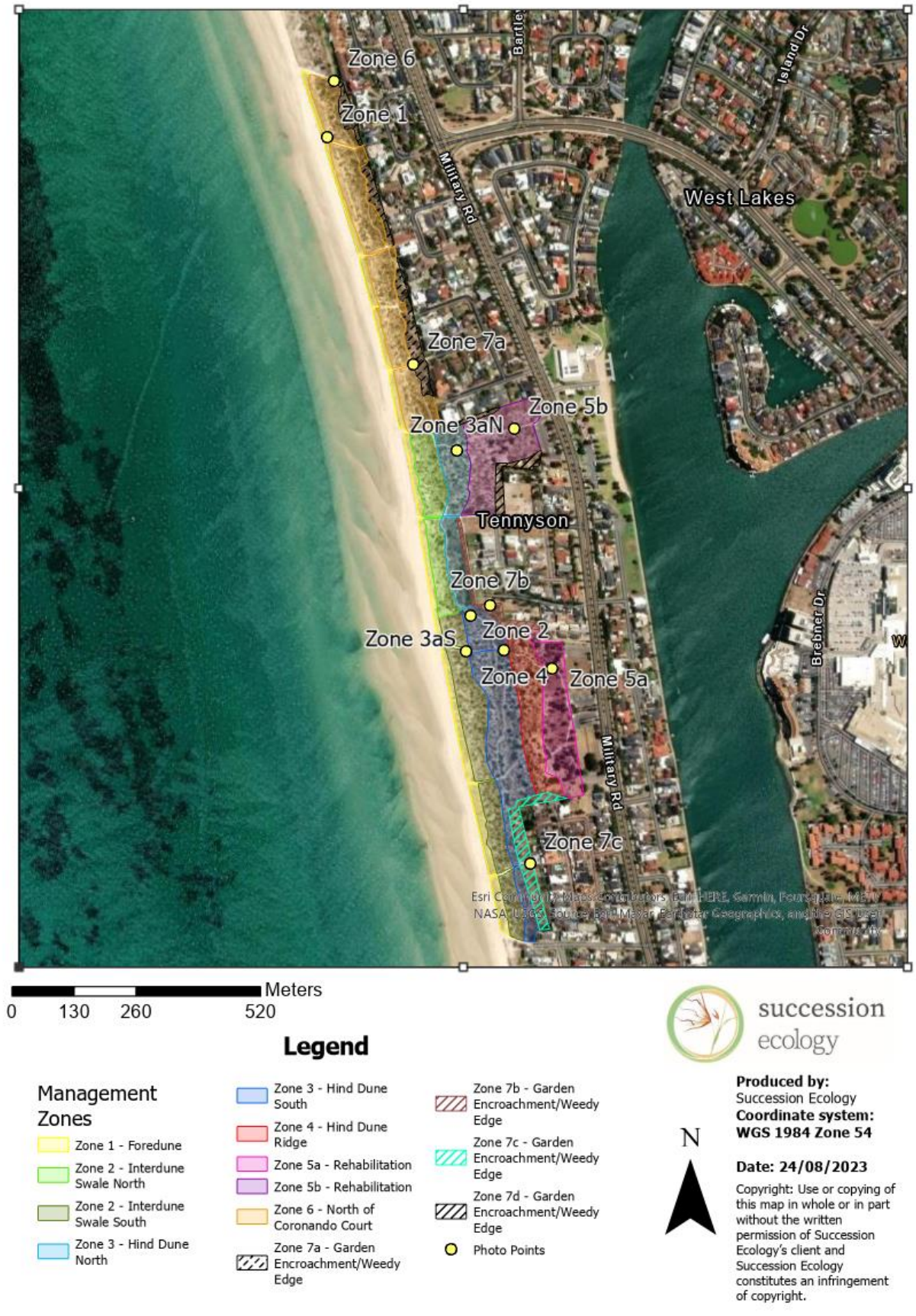

Figure 2: Vegetation Management Zones within the Tennyson Dune system and the associated location of reference photopoints.

2.1.3 Weed infestation

Weeds are a significant threat to biodiversity as they can out-compete native plants and degrade habitat. Some species, such as Perennial Veldt Grass (*Ehrharta calycina*) and Sea Wheat-grass (*Thinopyrum junceiforme*) were deliberately introduced into dune system to assist with sand stabilisation. Others such as *Gazania* sp., Marguerite Daisy (*Argyranthemum frutescens*) and a range of other succulent species like *Aeonium* sp. have escaped or encroached from adjacent residential gardens or been dumped as waste. The Tennyson Dunes Biodiversity Action Plan (EAC Ecological Evaluations 2015) outlines a list of priority weeds to be managed within the reserve (Table 3), which encompasses a number of declared and environmental weeds. Species such as the Western Coastal Wattle (*Acacia cyclops*), Bridal Creeper (*Asparagus asparagoides*), Perennial veldt Grass (*Ehrharta calycina*), Gazania (*Gazania sp.*), Coast Tea-tree (*Leptospermum laevigatum*), African Boxthorn (*Lycium ferocissimum*) and Dune Onion Weed (*Trachyandra divaricata*) have been rated as 'red alert' priority weeds in the Metropolitan Adelaide and Northern Coastal Action Plan (Caton et al. 2009).

Table 3: Important weed species and associated risk ratings (Vegetation Management Plan; (Cordingley and Petherick 2006)).

Priority	Scientific Name	Common Name	Importance Score	Weed Risk
1	*Lycium ferocissimum*	African Boxthorn	486.3	Very High
2	*Trachyandra divaricata*	Dune Onion Weed	463.2	Very High
3	*Asparagus asparagoides*	Bridal Creeper	416.8	Very High
4	*Ehrharta calycina*	Perennial Veldt Grass	302.6	Very High
5	*Gazania* sp.	Gazania	263.2	Very High
6	*Acacia cyclops*	Western Coastal Wattle	237.2	Very High
7	*Euphorbia paralias*	Sea Spurge	229.6	Very High
8	*Succulent* spp./ *Cacti* spp.	Succulent & Cacti	202.1	High
9	*Leptospermum laevigatum*	Coast Tea-tree	164.2	High
10	*Argyranthemum frutescens*	Marguerite Daisy	154.4	High
11	*Mesembryanthemum crystallinum*	Common Ice Plant	135.1	High
12	*Euphorbia terracina*	False Caper	126.3	High
13	*Arctotis stoechadifolia*	White Arctotis	110.5	High
14	*Carpobrotus edulis*	Hottentot Fig	95.8	High
15	*Galenia pubescens*	Coastal Galenia	94.7	High
16	*Chondrilla juncea*	Skeleton Weed	89.8	High
17	*Osteospermum fruticosum*	Seascape Daisy	73.7	Medium
18	*Oenothera stricta*	Evening Primrose	55.3	Medium
19	*Olea europaea*	European Olive	50.5	Medium
20	*Cynodon* spp.	Couch	44.2	Medium
21	*Rhamnus alaternus*	Buckthorn	37.9	Medium
22	*Pennisetum clandestinum*	Kikuyu	15.8	Low
23	*Stenotaphrum secundatum*	Buffalo Grass	15.8	Low
24	*Acacia saligna*	Golden Wreath Wattle	11.2	Low
25	*Lupinus consentii*	Blue Lupin	3.5	Low

Tennyson Dunes Reserve has been identified to have become an important non-breeding flocking and feeding site for the threatened Eastern Hooded Plover (*Thinornis cucullatus cucullatus*; (Emma Stephens et al. 2022)). They have been observed between Estcourt Rd Fort St and West Lakes Beach, as well as Estcourt Rd to Mirani Ct (Matt Endacott, pers comm. 2023, Figure 3). The Conservation Advice for Hooded Plover (DEH 2022) identifies a key threat from invasive weeds such as Sea Spurge (*Euphorbia paralias*), Marram grass (*Ammophila spp*.), Sea Wheat-grass (*Thinopyrum junceiforme*), Pyp Grass (*Ehrharta villosa*) and Beach Daisy (*Arctotheca populifolia*). These weeds reduce the availability of nesting, roosting and foraging habitat by covering large areas of the beach and altering dune morphology. In recent years the Green Adelaide, and

Hills and Fleurieu Landscape Boards have been scaling up dune grassy weed control and spinifex dune restoration near Hooded Plover nesting territories.

Figure 3: BDBSA observations of the Eastern Hooded Plover sightings along the Adelaide coastline close to the Tennyson Dunes Reserve (Stephens et al. .

3 METHODOLOGY

3.1 Desktop Assessment

Database searches were used to determine the range of threatened flora and fauna species, and ecological communities, protected under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) and *National Parks and Wildlife Act 1972 (NPW Act)*, that are likely to occur within a 5 km buffer around the Tennyson Dune Reserve. The search tools used include:

- A Protected Matters Search to identify matters of national significance under the *EPBC Act,* including threatened species and ecological communities.
- A NatureMaps and Atlas of Living Australia (ALA) search to determine flora and fauna species recorded within a 5 km radius of the site and species listed under the *NPW Act.*

3.2 Vegetation Assessment

Succession Ecology conducted a site assessment at the Tennyson Dunes on June 28th, 2023. The vegetation condition was assessed according to the BAM assessment metrics outlined in Table 4. Previous vegetation assessments of the site were conducted using the Native Vegetation Management Unit's BushRAT method (Appendix 1: BushRAT datasheet). This assessment system was updated in early 2019 with modifications to the scoring sheet and re-named as the BAM method. To allow for comparisons between vegetation condition data from 2014, 2020 and 2023, the BushRAT scores of previous years were updated to match BAM scoring guidelines. Grazing evidence, percentage bare ground and tree health were metrics used under the BushRAT but are not part of the BAM. These BushRAT metrics were retained as part of the vegetation assessment criteria for consistency in reporting. Raw BAM values were compared to benchmark values typical for the specific vegetation communities present (e.g., coastal environments typical to the Southern Mount Lofty Region) to generate their overall score.

Table 4: BAM vegetation Condition assessment metrics applied by Succession Ecology in June 2023.

Vegetation Assessment Component	Scoring Method
Native Plant Species Diversity	A count of the number of species present is compared to a "benchmark" value for that vegetation community type. This is then allocated a score from 0-15.
Weed Score	The cover and abundance of all weed species present is recorded. The 5 weeds with the highest product of threat rating and cover are summed to provide a score. This is then compared to a "benchmark" value for that vegetation type, and allocated a score from 0-15.
Native Plant Life Forms	The cover of different native plant life forms is compared to a "benchmark" value for that vegetation type. This is then allocated a score from 0-10.
Regeneration	The total number of woody native species in juvenile or seedling form is recorded and compared to a "benchmark" value for that vegetation type. This is then allocated a score from 0-8.
Native : Exotic Understorey Biomass	The percentage of the total vegetative biomass of shrubs and groundcover plants < 2m high that is native is noted. This is then allocated a score 0-5.

Vegetation Assessment Component	Scoring Method
Bare Ground	The percentage of the grounds surface that is truly bare is noted and allocated a score from 0-3. This is not part of the BAM, but was included as part of BushRAT method and therefore used in the 2023 assessment.
Tree Health	Average overall overstorey canopy health is allocated to a category, and then a score from 0-5. Scored only where trees are an expected component of the vegetation community. This assessment metric is not part of the BAM, but was included as part of BushRAT method and therefore used in the 2023 assessment.
Mature Tree Score	Calculated based on the mature tree density observed within the vegetation community and the percentage of canopy die back observed. Score ranges from 0-6, with a higher number indicating a higher density and healthier canopy.
Fallen timber	This score relates to the amount of branch and trunk sized logs present, with a rating of 0-5. Scored only where trees are an expected component of the vegetation community.
Grazing Evidence	This score relates to evidence of grazing pressure, including soil pugging and compacting, chewing and evidence of herbivore presence (e.g., rabbit warrens). A score of 0-4 is assigned. This assessment metric is not part of the BAM but was included as part of BushRAT method and therefore used in the 2023 assessment.

3.3 Photopoint Monitoring

Photopoint monitoring was conducted as part of the BushRAT Assessment and was continued for the purposes of this monitoring assessment. Images were taken at previously established photopoints within individual management zones and were recreated in the field as effectively as possible by Succession Ecology in June 2023. Photographs were then loaded onto large monitors and analysed to detect changes (note that representative photographs provided in this report will not have the same high definition or detail as used in analysis). Photographs were analysed using the indicators of change shown in the Table 5 below for differences, adapting from Milne (2015). Only the key indicators relevant for each management zone is presented within the corresponding results section of this report (Site Assessments, Section 4.5).

Table 5: Indicators of change used to assess photopoint pictures (adapted from (Milne 2015) and presented in T&M Ecologists (2020)).

Indicator of Change	Description
Presence/density of trees	The presence and density of trees – in most cases would be native species. Useful in revegetation, remnant protection and grazing management projects.
Diversity of trees	The number of different species of trees that can be detected – in most cases would be native species. Useful in revegetation, remnant protection and grazing management projects.

Indicator of Change	Description
Presence/density of shrubs	The presence and density of shrubs – in most cases would be native species. Useful in revegetation, remnant protection and grazing management projects.
Diversity of shrubs	The number of different species of shrubs that can be detected – in most cases would be native species. Useful in revegetation, remnant protection and grazing management projects.
Presence/density of grasses and/or herbaceous species	The presence and density of grasses and/or herbs. May be difficult to identify in many instances.
Diversity of grasses and/or herbaceous species	The number of different species of grasses and/or herbaceous species. May be difficult to detect different species in many instances.
Survival of plants (survivorship)	Number of plants that can be detected as surviving from examination of previous photographs. Particularly useful in revegetation projects but may be difficult to detect in some instances.
Plant growth	Degree of growth of plants over time. May be useful to consider a scale (e.g., range pole) in photopoint if this is an important indicator of success of a project.
Age structure	Different sized/age trees and/or shrubs. May indicate successful recruitment as a result of management intervention.
Fallen timber	Fallen trees or logs that can be seen in the photograph. These are an important habitat component for many fauna species.
Leaf litter/debris	Fallen sticks, twigs, and leaves on the ground. These may form habitat for fauna and can also suppress weeds.
Flowering and fruiting plants	Whether any species can be identified that are flowering or fruiting. May be difficult to detect in many cases, but an indicator of success, for example, in revegetation projects where planted stock become reproductive.
Recruitment	New native plants entering the population that have grown from a natural seed source.
Native plant biomass	Total amount of native plant material present. May be useful as an indicator of success for erosion treatment or grazing management.
Total biomass	Total amount of plant material present. May be useful as an indicator of success for erosion treatment or grazing management.
Presence/density/diversity of woody weeds/vine weeds	The presence, density and/or diversity of different woody weed species that are present.
Presence/density/diversity of perennial grass and herbaceous weeds	The presence, density and/or diversity of different perennial grass/herbaceous weed species that are present.
Presence/density/diversity of annual grass and herbaceous weeds	The presence, density and/or diversity of different annual grass and herbaceous weed species that are present.
Extent of bare soil	The amount of visible ground that has no vegetation, or moss or lichen cover. Particularly useful indicator for projects treating erosion.
Extent of exposed rock	Similar to exposed ground, but where rock can clearly be seen in the image.

Indicator of Change	Description
Tree/shrub shape	Plants that are being heavily grazed often have distinctive form – such as an umbrella shape (where the underside of the "umbrella" represents the maximum height that grazers can impact). May be useful for grazing management, particularly in arid zone woodlands and shrublands.
Presence/density of palatable plants	The presence or density of palatable plants that would be suppressed by grazing pressure. May require some expertise to identify the species as well as its palatability. Most useful in pastoral / arid land.
General signs of erosion	The extent of erosion visible in a photopoint.
Gully shape/extent	The shape and extent of gullying (as a result of erosion) visible in a photopoint.
Exposed roots	The extent of exposed roots (as a result of erosion) visible in a photopoint.
Slumping	The extent of slumping (gully side wall falling off).
Tree canopy health	The amount and/or health of visible leaf matter on trees in the photopoint.
Shrub canopy health	The amount and/or health of visible leaf matter on shrubs in the photopoint.

3.4 Report Limitations

An extensive field survey of vegetation diversity and condition was conducted on the 28th of June 2023. However, some species present within the Tennyson Dunes Reserve and recorded in previous surveys may not have been detected during the 2023 survey, due to the season in which the survey was conducted. The 2014 survey was conducted in August-September (spring) and the 2020 survey was conducted in January (summer), while the 2023 survey was conducted in June (winter). Consequently, it is expected that some of the summer growing annual species may not have been detected and may explain why the prevalence of some winter-growing species (e.g., Soursob, *Oxalis pes-caprae*) may be much higher during the 2023 survey. It is recommended that future surveys be conducted at a standardised time to account for seasonal variability.

The use of different vegetation assessors at each of the assessment periods (2014, 2020 and 2023) and the subjective nature of BAM cover estimates is another source of variability in the data collected at these times.

4 RESULTS & DISCUSSION

4.1 Desktop Assessment

The results of the desktop assessment are presented in Table 6 and Table 7, along with an assessment of the likelihood of occurrence (in reference to Table 8). Three flora and ten fauna species, listed under either the *EPBC Act* or the *NPW Act* have been recorded within 5 km of the project area. One plant species, the Rare Hawkweed Picris (*Picris squarrosa*) was observed within the project area during the field survey. Non-breeding Hooded Plovers (*Thinornis cucullatus cucullatus*) pairs have been observed around the Tennyson Dunes Reserve. Hooded Plovers sightings were recorded in 2019, 2020 and 2021 (Atlas of Living Australia database search), in the areas between Estcourt Rd and Fort St and between Estcourt Rd and Mirani Ct.

Table 6: A summary of the threatened flora species observed on-site or recorded within 5 km of the project area since 1995. Criteria for the likelihood of species occurrence within the project area has been provided in Table 8.

Species (Common Name)	NPW Act	EPBC Act	Data source	Date of last record	Species known habitat preferences	Likelihood of use for habitat - comments
Acacia dodonaeifolia (Hop-bush Wattle)	R		1, 2	2005	Mainly in woodland and open forest vegetation formation (Electronic Flora of SA 2021a).	Unlikely – no recent records.
Picris squarrosa (Hawkweed Picris)	R		1,2, 3, 4	2023	Coastal dunes, river alluvium and disturbed ground (Electronic Flora of SA 2021b).	Highly Likely – Suitable habitat present; was observed at site in 2014, 2020 and 2023.
Pterostylis Arenicola (Sandhill Greenhood)	V	VUL	1, 2, 3	2016	Found in sandy soil in mallee and *Callitris* woodland, with an understory of shrub, heath sedge and grass (Atlas of Living Australia 2021).	Unlikely – unsuitable habitat; habitat degraded due to introduction of exotic grasses.
Source: 1 – AoLA, 2 – NatureMaps, 3 – Protected matters search tool, 4 – Observed/recorded in the field, 5 – others. *NPW Act*; E= Endangered, V = Vulnerable, R= Rare *EPBC Act*; Ex = Extinct, CR = Critically endangered, EN = Endangered; VU = Vulnerable						

Table 7: A summary of the threatened fauna species observed on-site or recorded within 5 km of the project area since 1995. Criteria for the likelihood of species occurrence within the project area has been provided in Table 8.

Species (Common Name)	NPW Act	EPBC Act	Data source	Date of last record	Species known habitat preferences	Likelihood of use for habitat - comments
AVES						
Ardea intermedia plumifera (Plumed Egret)	R		1, 2, 3	2018	Frequent a wide variety of wetlands including manmade wetlands such as rice fields and sewage ponds (ALA 2022).	Possible – suitable habitat at the beachfront, however, lack of water channels.
Cereopsis novaehollandiae	R		1, 2	2014	Mostly seen as pairs or loose flocks scattered around coastal wetlands, salt marshes, and grassy	Unlikely – prefers open landscapes such as

novaehollandiae (Cape Barren Goose)					pasture areas (Australian Museum 2022).	green pasture areas for foraging.
Egretta garzetta nigripes (Little Egret)	R		1, 2	2022	Habitat varies widely, and includes the shores of lakes, rivers, canals, ponds, lagoons, marshes, and flooded land (Hancock and Kushland 1984).	Possible - suitable habitat at the beachfront, however, lack of water channels with sheltered vegetation.
Entomyzon cyanotis cyanotis (Blue-faced Honeyeater)	R		1, 2	2014	Found in open forests and woodlands close to water, such as monsoon forests, mangroves, and coastal heathlands (Australian Museum 2020a).	Unlikely – no suitable habitat present on-site.
Falco peregrinus macropus (Peregrine Falcon)	R		1, 2, 3	2023	Use a broad range of habitats from rainforest to arid. Need abundant prey and secure nest sites (DEH 2009).	Unlikely – species will not rely on site as there are not many large trees. Mainly overfly.
Thinornis cucullatus cucullatus (Hooded Plover)	V	VU	1, 2, 3	2023	Mainly occurs on wide beaches backed by dunes with large amounts of seaweed and inlet entrances (DEH 2022).	Highly likely - suitable habitat at the beachfront with non-breeding pairs recorded within the area.
Zanda funerea whiteae (Yellow-tailed Black Cockatoo)	V		1, 2, 3	2021	Inhabits a variety of habitats, favours eucalypt woodland and pine plantations (Birdlife Australia 2021).	Unlikely - species will not rely on site as there are not many large trees. Mainly overfly.
MAMMALS						
Pteropus poliocephalus (Grey-headed Flying-fox)	R	VU	1, 2, 3	2023	Typically roost in tall dense trees next to a water source (DEWNR 2020).	Unlikely - No large trees on-site. Mainly overfly.
Pteropus scapulatus (Little Red Flying-fox)	R		2	2013	Broad range of habitats such as tropical and temperate eucalypt forests (Australian Museum 2020b).	Unlikely - species will not rely on site as there are not many large trees. Mainly overfly.
REPTILES						
Chelonia mydas (Green Sea Turtle)	V	VU	2, 3	2003	Marine species, occurs in coral reefs and coastal seagrass pastures (Queensland Government 2020).	Unlikely – species is mainly marine.

Source; 1 – BDBSA, 2 – AoLA, 3 – NatureMaps 4 – Observed/3recorded in the field, 5 – Protected matters search tool, 6 – others.
NPW Act; E= Endangered, V = Vulnerable, R= Rare
EPBC Act; Ex = Extinct, CR = Critically endangered, EN = Endangered; VU = Vulnerable

Table 8: Criteria for the likelihood of occurrence of species within the project area.

Likelihood	Criteria
Highly Likely/Known	Recorded in the last 10 years, the species does not have highly specific niche requirements, the habitat is present and falls within the known range of the species distribution or; the species was recorded as part of field surveys.
Likely	Recorded within the previous 20 years, the area falls within the known distribution of the species and the area provides habitat or feeding resources for the species.
Possible	Recorded within the previous 20 years, the area falls inside the known distribution of the species, but the area provides limited habitat or feeding resources for the species. Recorded within 20 -40 years, survey effort is considered adequate, habitat and feeding resources present, and species of similar habitat needs have been recorded in the area.
Unlikely	Recorded within the previous 20 years, but the area provides no habitat or feeding resources for the species, including perching, roosting, or nesting opportunities, corridor for movement or shelter. Recorded within 20 -40 years; however, suitable habitat does not occur, and species of similar habitat requirements have not been recorded in the area. No records despite adequate survey effort.

4.2 Native Species Richness

Table 9 provides an overview of the 60 native species observed across the different management zones during the 2023 vegetation assessment. Zone 1 (foredune) and Zone 7d (weedy garden edge) had the lowest number of species (8 and 5, respectively), while Zone 3b had the highest diversity (36 species). Species richness was similar between the management zones that extend across the interdunal swales, with 18 species recorded in Zone 2a, 21 species in Zone 2b and 16 species in Zone 6. In the hind dunes, 23 species were observed in Zone 3a and 36 in Zone 3b, with 33 species recorded in the hind dune ridge (Zone 4). A high species diversity (30 species) was recorded within both of the restoration zones (5a and 5b). Species richness was variable between the weedy areas of garden encroachment, with 21 species recorded in Zone 7a, 20 species in Zone 7b, 34 species in Zone 7c, and 5 species in Zone 7d.

Native species richness increased between 2020 and 2023 in half of the management zones (Zone 1, Zone 3b, Zone 5a, Zone 5b, Zone 7a, and Zone 7c) and decreased in the other half (Zone 2a, Zone 2b, Zone 3a, Zone 6, and Zone 7b). Native species richness remained the same in Zone 4 (33 species). Native Pigface (*Carpobrotus rossii*) was the most common species (was observed in all of the management zones assessed), followed closely by the Coast Daisy-bush (*Olearia axillaris*; observed in 12 of the management zones). Coastal Wattle (*Acacia longifolia ssp. sophorae*), Knobby Club-rush (*Ficinia nodosa*) and Variable Groundsel (*Senecio pinnatifolius*) were also common and observed in 11 of the management zones.

The state rare Hawkweed Picris (*Picris squarrosa*) was observed in six of the management zones (2a, 3b, 4, 5a, 7a, and 7c). This species was previously thought to be present within zones 2a, 3a, 3b and 6, but were not observed during the 2020 vegetation assessment. Given its rare status, the species has been planted into some of these zones, such as Zone 7a and 7c.

Table 9: Native species observed during 2023 vegetation survey. Ticks (✓) indicate species that were recorded during 2023 survey but not recorded in previous surveys. Green double ticks (✓✓) show species that were present in a previous survey. An 'X' is used to indicate a species that was present in a previous survey (2014 or 2020) but was not recorded as present within that management zone during the 2023 survey. A double red X (XX) is used for species that have not been observed since 2014 and a single orange X is used for species which were observed in 2020 but not in 2023. 'Total' summarises the number of management zones in which the species was observed. An asterisk (*) is used to identify zones where a missing species may be the result of a change in management zone boundaries or subsections, rather than being indicative of a loss of that species from the vegetation community.

Scientific Name	Common Name	Management Zone													
		1	2a	2b	3a	3b	4	5a	5b	6	7a	7b	7c	7d	Total
Acacia cupularis	Cup Wattle						✓✓		✓	X			✓		3
Acacia ligulata	Umbrella Bush		✓	X	✓	✓	X	X			✓	✓✓	✓✓		6
Acacia longifolia ssp. sophorae	Coastal Wattle		✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓		11
Acacia pycnantha	Golden Wattle				X				✓✓					✓	2
Acacia sp.	Wattle											✓			1
Adriana quadripartita	Coast Bitterbush		XX	XX	✓✓	✓✓	X					✓	✓✓		4
Allocasuarina sp.	Sheoak												✓		1
Allocasuarina verticillata	Drooping Sheoak				✓✓	X	✓✓	✓✓	✓✓	✓			✓		6
Alyxia buxifolia	Sea Box		X*	✓✓	✓✓	✓✓	✓✓						✓✓		5
Apium prostratum	Sea Celery		✓												1
Atriplex cinerea	Coast Saltbush	✓✓	X*	✓✓	X			✓✓		✓✓	✓✓	✓✓	✓✓		7
Atriplex semibaccata	Creeping Saltbush											✓			1
Atriplex sp.	Saltbush					✓	✓						✓		3

Scientific Name	Common Name	Management Zone													
		1	2a	2b	3a	3b	4	5a	5b	6	7a	7b	7c	7d	Total
Atriplex suberecta	Sprawling Saltbush								✓		✓				2
Austrostipa flavescens	Coast Spear-grass				X	✓	✓✓		✓✓						3
Austrostipa scabra ssp. Falcata[1]	Slender Spear-grass						✓								1
Austrostipa sp.	Spear-grass								X	X					0
Baumea juncea	Bare Twig Rush					✓	✓✓	✓✓			X	✓			4
Billardiera cymosa ssp. cymosa	Sweet Apple-berry							✓	X				✓		2
Callitris gracilis	Southern Cypress Pine					✓	✓✓	✓✓	X X			✓	✓		5
Carpobrotus rossii	Native Pigface	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	13
Cassytha pubescens	Downy Dodder-laurel					X	✓✓								1
Chrysocephalum apiculatum	Common Everlasting							✓✓	X						1
Clematis microphylla	Old Man's Beard				✓	✓		✓							3
Crassula colligata ssp. lamprosperma	Australian Stonecrop		✓	✓							✓				3
Crassula closiana	Stalked Crassula		X X	X X	X	X X				X X					0
Daucus glochidiatus	Native Carrot		X X	X X	X X	X X				X X					0
Dianella brevicaulis	Short-stem Flax-lily		X	X	X	✓	✓	✓	X	X	X	X	✓		4

Scientific Name	Common Name	Management Zone													
		1	2a	2b	3a	3b	4	5a	5b	6	7a	7b	7c	7d	Total
Dianella revoluta	Black-anther Flax-lily						✓	✓							2
Dianella sp.	Flax-lily		✓	✓	✓				✓			✓			5
Dodonaea viscosa	Sticky Hop Bush		X	X		✓✓					X	✓✓			2
Enchylaena tomentosa	Ruby Saltbush		X	X	X	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	✓✓		7
Eucalyptus leucoxylon ssp. leucoxylon	Blue Gum							✓					✓		2
Eucalyptus sp.	Eucalypt											✓			1
Ficinia nodosa	Knobby Club-rush	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓		11
Geranium potentilloides var. potentilloides	Downy Geranium					✓									1
Helichrysum leucopsideum	Satin Everlasting					✓	X	✓	✓✓		✓				4
Kennedia prostrata	Running Postman				✓✓			✓							2
Kunzea pomifera	Muntries		X	X	✓✓	✓✓	✓✓	X	✓✓	X			✓✓		5
Lepidosperma gladiatum	Coast Sword-sedge		X*	✓✓	✓✓	✓✓	✓✓		✓✓	✓✓	✓✓	X	✓✓		8
Leucophyta brownii	Coast Cushion Bush		✓		✓✓	✓✓	✓✓	✓✓	✓✓	✓			✓✓		8
Leucopogon parviflorus	Coast Beard-heath		X	X	X X	✓✓	✓✓		X		X X	X X	✓✓		3
Lomandra leucocephala ssp. robusta	Woolly Mat-rush				X	✓	✓✓	✓✓	✓✓						4

Scientific Name	Common Name	Management Zone													
		1	2a	2b	3a	3b	4	5a	5b	6	7a	7b	7c	7d	Total
Lotus australis	Australian Trefoil		✓✓	✓✓		✓	X X	✓✓		✓	✓	X	✓		7
Lysiana exocarpi	Harlequin Mistletoe							✓							1
Melaleuca lanceolata	Dryland Tea-tree						✓✓	✓✓	✓				✓		4
Melaleuca sp.	Paperbark										✓		✓		2
Muehlenbeckia gunnii	Coastal Climbing Lignum		✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓		✓	✓✓	✓✓		10
Myoporum insulare	Common Boobialla		✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓		10
Nitraria billardierei	Nitre Bush			✓	✓✓	X X			✓✓	✓✓		X			4
Olearia axillaris	Coast Daisy-bush		✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	12
Pelargonium australe	Australian Pelargonium		X*	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	X	✓		8
Picris squarrosa	Hawkweed Picris		✓			✓	✓	✓			✓		✓		6
Pimelea serpyllifolia ssp. serpyllifolia	Thyme Riceflower		X*	✓✓	X	✓✓	X			✓✓	✓				4
Poa poiformis	Coast Tussock-grass				X	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	✓		7
Podolepis rugata var. littoralis	Coast Copper-wire Daisy					X						X			0
Rhagodia candolleana ssp. candolleana	Sea-berry Saltbush		✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	X	✓✓		9
Rhagodia sp.	Saltbush					✓									1

Scientific Name	Common Name	Management Zone												
		1	2a	2b	3a	3b	4	5a	5b	6	7a	7b	7c	7d	Total
Salsola kali[1]	Buckbush								✓						1
Scaevola crassifolia	Cushion Fanflower			✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	✓✓	✓✓	10
Senecio pinnatifolius	Variable Groundsel	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	✓✓	✓✓		11
Spinifex hirsutus	Hairy Spinifex	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	X	✓✓		✓✓	✓	10
Tetragonia implexicoma	Bower Spinach		✓✓	✓✓	X	✓✓	✓✓	**X X**	✓	✓✓	**X X**	✓✓	✓✓		8
Threlkeldia diffusa	Coast Bonefruit	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	X	✓✓	✓	X		10
2014 Total Native Species Richness		2	26		26	26	29	23	15	17	17	13	13	NA	
2020 Total Native Species Richness		2	23		31	26	33	25	27	22	18	21	21		
2023 Total Native Species Richness		6	18	21	23	36	33	30	30	16	21	20	34	5	

4.3 Introduced Species Richness and Cover

Table 10 summarises the weed species and their area coverage recorded during the 2023 vegetation assessment. In total 59 weed species were recorded across the Tennyson Dunes Reserve. Zone 1 had the lowest weed diversity (5 species) and Zone 7a had the highest (27 species). The other management zones had between 11 and 19 weed species.

A total of 23 out of the 25 priority weed species listed in the 2006 Vegetation Management Plan were observed during the 2023 vegetation assessment, with only Dune Onion Weed (*Trachyandra divaricata)* and Hottentot Fig (*Carpobrotus edulis*) not observed during the survey. Neither of these species were observed during the 2014 and 2020 vegetation surveys.

Nine declared weed species were identified during the survey, with Bridal Creeper (*Asparagus asparagoides*) being the most common and observed in 8 out of the 13 management zones. African Boxthorn (*Lycium ferocissimum*) was observed in four of the management zones, *Gazania sp*. were observed in three zones, Italian Buckthorn (*Rhamnus alaternus*) in two zones, and Skeleton Weed (*Chondrilla juncea*) in two zones. Aleppo Pine (*Pinus halepensis*), Athel Pine (*Tamarix aphylla*), Caltrop (*Tribulus terrestris*), and European Olive (*Olea europaea ssp.*) were only observed in a one management zone each.

The most commonly observed weed species were Soursob (*Oxalis pes-caprae*) and Sow-thistle (*Sonchus sp.),* which were both recorded in 11 of the 13 management zones. Two-horned Sea Rocket (*Cakile maritima ssp. maritima*), Perennial Veldt Grass (*Ehrharta calycina*), Hare's Tail Grass (*Lagurus ovatus*), and False Caper (*Euphorbia terracina*) were the next most common species, observed in 9 of the 13 management zones. Most species constituted a small percentage of the total management zone area (<1% cover), as shown in Table 10, although three zones had a high Soursob cover (26-50% in Zone 5a and >75% in Zone 7b and 7c). Zone 1 had a high Sea Wheat-grass (*Thinopyrum junceiforme*) cover of 26-50%.

The prevalence of weeds expressed as percentage area cover within management zones increased between 2020 and 2023 for many species (Table 10), including:

- Aleppo Pine (*Pinus halepensis*) - increased in Zone 7a,
- Black Nightshade (*Solanum nigrum*) - increased in Zone 7a,
- Blue Chalksticks (*Curio repens*) - increased in 7a,
- Caltrop (*Tribulus terrestris*) - increased in Zone 5b,
- Candelabra Aloe (*Aloe arborescens*) - increased in Zone 7a,
- Coastal Tea-tree (*Leptospermum laevigatum*) - increased in Zone 5b and 7a,
- European Olive (*Olea europaea ssp.*) - increased in Zone 7a,
- Flaxleaf Fleabane (*Conyza bonariensis*) - increased in Zone 3a, 3b, 4, 5a, 5b, 7a, and 7b,
- Golden Wreath Wattle (*Acacia saligna*) - increased in Zone 5a,
- Haworth's Aeonium (*Aeonium haworthii*) - increased in Zone 7a,
- Italian Buckthorn (*Rhamnus alaternus*) - increased in Zone 3b and 7c,
- Marguerite Daisy (*Argyranthemum frutescens*) - increased in Zone 7a,
- Milk Thistle (*Sonchus oleraceus*) - increased in Zone 5a and 7b,
- Nettle-leaf Goosefoot (*Chenopodium murale*) increased in Zone 7b and 7c,

- Nettle (*Urtica sp.*) - increased in Zone 5b and 7c,
- Showy Honey-myrtle (*Melaleuca nesophila*) - increased in Zone 5a and 7a,
- Shrubby Baeckea (*Baeckea frutescens*) increased in Zone 5b,
- Small-flower Marshmallow (*Malva parviflora*) - increased in Zone 7b,
- Sow Thistle (*Sonchus sp.*) - increased in all zones except Zone 6,
- Soursob (*Oxalis pes-caprae*) - increased in all zones except Zone 1,
- Tree Tobacco (*Nicotiana glauca*) - increased in Zone 7b,
- Tree Wormwood (*Artemisia arborescens*) - increased in Zone 7a,
- Vetch (*Vicia sp.*) - increased in Zone 3a and 5a,
- Western Coastal Wattle (*Acacia cyclops*) - increased in Zone 3b, 5a, 5b, 7a and 7c,
- Wild Mustard (*Sisymbrium orientale*) - increased in Zone 2a, 3b, 5a, 5b, 7b, and 7c, and
- Willow Myrtle (*Agonis flexuosa*) - increased in Zone 4 and 7c.

In most cases, these species were not previously documented as present within those management zones in 2020, suggesting that they are colonising new areas. Most of these species occupied a small area within the management zones (<1% coverage) in 2023 and therefore the observed change in cover since 2020 is relatively small (up to 1% change in area covered). Some species exhibited a greater change between 2020 and 2023, for example the increase in Marguerite Daisy (*Argyranthemum frutescens*) in Zone 7a from 0% to 1-5% cover and Bridal Creeper (*Asparagus asparagoides*) in Zone 5b increasing from <1% cover to 1-5% cover. For annual weed species (e.g., *Sonchus sp.*) the increase in cover may be due to the season in which the survey was conducted (the 2023 survey corresponds to their peak growing season).

For some of the weed species, their area cover increased in some management zones, while decreasing in others. For example, Two-horned Sea Rocket (*Cakile maritima ssp. maritima)* cover increased in four zones (3b, 5a, 5b, and 7a), decreased in four zones (2b, 3a, 7b, and 7c) and remained the same in four zones (1, 2a, 4, and 6). Similar mixed patterns of change across the landscape were observed for Couch *(Cynodon dactylon var. dactylon),* Medic (*Medicago sp.*), and Hare's Tail Grass (*Lagurus ovatus*).

Some weed species showed an overall decrease in cover across the Tennyson Dunes reserve. For example, *Bromus sp*. decreased significantly in cover in nine of the management zones and remained unchanged in Zone 3b, and White Arctotis (*Arctotis stoechadifolia*) cover decreased in three management zones and increased in one zone. Some species, such as False Caper (*Euphorbia terracina*) and Evening Primrose (*Oenothera stricta*) had almost no change in cover between 2020 and 2023.

Overall, Zone 3b had the greatest increase in weed cover, with 16 species increasing and no species decreasing in cover. Zone 7a also showed a high increase in weed cover, with 22 species increasing in cover, but partly compensated for with 10 species decreasing in cover.

Table 10: Weed cover scores visually estimated during the 2020 and 2023 vegetation surveys. A score of 0 indicates 0% weed cover, 1 indicates < 1% cover, 2 indicated 1-5% cover, 3 indicated 6-25% cover, and 4 indicates 26-50% cover, 5 indicates 51-75% cover and 6 indicates > 75% cover. Red coloured cells indicate species where an increase in cover was observed between the two sampling times. Orange cells indicate a site where species were present, and the cover remained the same (no change). Green cells indicate sites where weed cover decreased between the two sampling times. Priority weeds are those identified as management priorities as part of the 2006 Tennyson Dunes Vegetation Management Plan. No data for Zone 7d is available from 2020, as this zone was previously considered as part of zone 5b but mapped as an independent zone in 2023 following field observations of weed prevalence.

Scientific Name	Common Name	Priority/ Declared	% Weed Cover Scores in Management Zones																							
			1		2a		2b		3a		3b		4		5a		5b		6		7a		7b		7c		7d	
			20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23
Acacia cyclops	Western Coastal Wattle	Priority	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	1		0
Acacia saligna	Golden Wreath Wattle	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		0
Aeonium arboreum	Aeonium	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0		0
Aeonium haworthii	Haworth's aeonium	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0
Agave americana	Agave	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0		0
Agonis flexuosa	Willow Myrtle	None	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1		0
Aloe arborescens	Candelabra Aloe	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0
Arctotis stoechadifolia	White Arctotis	Priority	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	3	1	0	0	0	0		0

Scientific Name	Common Name	Priority/ Declared	% Weed Cover Scores in Management Zones																							
			1		2a		2b		3a		3b		4		5a		5b		6		7a		7b		7c		7d	
			20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23
Argyranthemum frutescens	Marguerite Daisy	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0		0
Artemisia arborescens	Tree Wormwood	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		1
Asparagus asparagoides	Bridal Creeper	Both	0	0	1	1	1	1	0	0	0	1	0	1	0	1	1	2	0	1	0	0	0	0	0	2		0
Asphodelus fistulosus	Onion Weed	None	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0		1
Avena sp.	Wild Oats	None	0	0	1	0	1	0	1	0	0	1	0	0	1	0	1	1	1	1	2	0	1	0	0	1		0
Baeckea frutescens	Shrubby Baeckea	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		0
Bromus sp.	Brome	None	0	0	1	0	1	0	1	0	1	1	1	0	0	0	1	0	2	0	4	0	2	0	3	1		0
Cakile maritima ssp. maritima	Two-horned Sea Rocket	None	1	1	1	1	1	0	1	0	0	1	1	1	0	1	1	2	1	1	0	1	2	0	2	1		0
Cenchrus clandestinus	Kikuyu	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1		0
Chenopodium murale	Nettle-leaf Goosefoot	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1		0
Chondrilla juncea	Skeleton Weed	Both	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0		0

Scientific Name	Common Name	Priority/ Declared	% Weed Cover Scores in Management Zones																							
			1		2a		2b		3a		3b		4		5a		5b		6		7a		7b		7c		7d	
			20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23
Conyza bonariensis	Flaxleaf Fleabane	None	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	0	0	1	0	1	0	0		0
Cotyledon orbiculata	Cotyledon	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0		1
Curio repens	Blue Chalksticks	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0
Cynodon dactylon var. dactylon	Couch	Priority	0	0	1	0	1	0	0	1	0	1	0	1	3	1	1	1	0	0	2	1	1	0	1	0		0
Dimorphotheca pluvialis	Cape Marigold	None	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	3	1	0	1	0	0	0	2		1
Ehrharta calycina	Perennial Veldt Grass	Priority	0	0	1	1	1	1	1	2	2	2	2	2	3	2	1	2	1	0	0	0	1	1	1	2		0
Eucalyptus sp.	WA Eucalyptus Species	None	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0		1
Euphorbia paralias	Sea Spurge	Priority	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		0
Euphorbia terracina	False Caper	Priority	0	0	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	2	1		0
Galenia pubescens var. pubescens	Coastal Galenia	Priority	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	1	1	0	0	1	1	0	0		0
Gazania sp.	Gazania	Both	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0		0

Scientific Name	Common Name	Priority/ Declared	% Weed Cover Scores in Management Zones																							
			1		2a		2b		3a		3b		4		5a		5b		6		7a		7b		7c		7d	
			20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23
Lagurus ovatus	Hare's Tail Grass	None	0	0	1	2	1	2	1	1	0	1	1	2	1	2	2	1	1	1	2	1	2	0	2	0		0
Leptospermum laevigatum	Coast Tea-tree	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0		0
Lupinus cosentinii	Blue Lupin	Priority	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0		0
Lycium ferocissimum	African Boxthorn	Both	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	2	0	0	1	0	1	0		1
Malva parviflora	Small-flower Marshmallow	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0		0
Medicago sp.	Medic	None	0	0	2	2	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	0	0	1	0	0		0
Melaleuca nesophila	Showy Honey-myrtle	None	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0		1
Mesembryanthemum cordifolium	Heartleaf Iceplant	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
Mesembryanthemum crystallinum	Common Iceplant	Priority	0	0	0	0	0	0	1	0	0	0	1	0	1	2	0	0	0	0	1	0	1	2	0	0		0
Nicotiana glauca	Tree Tobacco	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0		0

Scientific Name	Common Name	Priority/ Declared	% Weed Cover Scores in Management Zones																							
			1		2a		2b		3a		3b		4		5a		5b		6		7a		7b		7c		7d	
			20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23
Oenothera stricta	Evening Primrose	Priority	0	0	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0		1
Olea europaea ssp.	European Olive	Priority	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0
Osteospermum fruticosum	Seascape Daisy	Priority	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0		0
Oxalis pes-caprae	Soursob	None	0	0	0	1	0	2	0	2	0	2	0	2	0	4	0	1	0	1	0	1	0	6	0	6		0
Pelargonium zonale	Horseshoe Geranium	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
Phoenix canariensis	Canary Date Palm	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0		0
Pinus halepensis	Aleppo Pine	Declared	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0		0
Rhamnus alaternus	Italian Buckthorn	Both	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1		0
Senecio angulatus	Cape Ivy	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
Sisymbrium orientale	Wild Mustard	None	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	1		
Solanum nigrum	Black Nightshade	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0

Scientific Name	Common Name	Priority/ Declared	% Weed Cover Scores in Management Zones																							
			1		2a		2b		3a		3b		4		5a		5b		6		7a		7b		7c		7d	
			20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23	20	23
Sonchus oleraceus	Milk Thistle	None	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0		0
Sonchus sp.	Sow-thistle	None	0	1	0	2	0	2	0	1	0	2	0	2	0	2	0	2	0	0	0	2	0	2	0	1		0
Tamarix aphylla	Athel Pine	Declared	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		0
Thinopyrum junceiforme	Sea Wheat-grass	None	4	4	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		1
Tribulus terrestris	Caltrop	Declared	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		0
Urtica sp.	Nettle	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1		
Vicia sp.	Vetch	None	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		0
Yucca sp.	Yucca	None	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0		0

4.4 Additional Observations

Although not present in the vegetation assessments, the following additional observations were made by Succession Ecology and Matt Endacott (pers comm. 2023) with regards to native species:

- The state rare Hawkweed Picris (*Picris squarrosa*) has increased in abundance and extent, now occurring within six management zones within Tennyson Dunes Reserve.
- The regionally threatened Satin Everlasting (*Helichrysum leucopsideum*) is still present in the patches detected during the 2020 Vegetation Assessment, with some recruitment being observed.
- The regionally threatened Woolly Mat-rush (*Lomandra leucocephala*) has increased in cover in the areas close to the southern carpark.
- The plantings conducted around the southern carpark, including a patch within the carpark (planted by the Council), have survived and are showing healthy progressive growth.

Dieback was noted on eight native species during the 2023 survey, Cup Wattle (*Acacia cupularis;* Zone 5b), Coastal Wattle (Acacia *longifolia ssp. sophorae;* Zone 2b and 4), Rare Bitterbush (*Adriana quadripartita*; Zone 3b), Sea Box (*Alyxia buxifolia*; Zone 3b), Sticky Hop Bush (*Dodonaea viscosa*; Zone 3b and 7b), Coast Daisy-bush (*Olearia axillaris*; Zone 2a, 2b, 3a, 5a, 6, and 7b), Sea-berry Saltbush (*Rhagodia candolleana ssp. candolleana*; Zone 3b), and Variable Groundsel (*Senecio pinnatifolius*; Zone 4).

Extensive foot traffic was observed within the hind-dunes, where visitors had climbed over the fencing and walked through the dunes. The trampling of dune vegetation by visitors has the potential to increase the amount of bare ground and degrade the vegetation quality within this part of the dune system.

4.5 Site Assessments

4.5.1 Management Zone 1

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

***Thinopyrum junceiforme, Spinifex hirsutus* Tussock Grassland**

As a foredune community, this management zone naturally has a low species diversity and low diversity of plant life forms, with a relatively higher proportion of grasses and herbs, a lack of tall shrubs and relatively high percentage of bare ground (26-50%), as shown in Table 11.

The foredune at Tennyson is dominated by two grass species: the introduced Sea Wheat-grass (*Thinopyrum junceiforme;* occupying approximately 30-40% ground cover) and the native *Spinifex hirsutus* (scattered across the zone, ~1-5% foliage cover of total zone), as shown in Figure 4 and Table 12. Previously, the removal of Sea Wheat-grass was considered unfeasible and not a high priority for the Tennyson Dunes Reserve as it has become naturalised and aids with dune restoration (T&M Ecologists 2020). However, grassy dune control and *Spinifex* restoration has been conducted over the last few years as part of the "Our Plover Coast" project on metropolitan and Fleurieu beaches. This has shown success in trialling treatments for Sea Wheat-grass and other dune weeds (Landscape South Australia Hills and Fleurieu 2023). Weed control initially involves hand pulling, and leaves the deeper dead rhizome and root mass, which combined with *Spinifex* plantings, can minimise the risk of dune destabilisation. Invasive weeds reduce the availability of nesting, roosting and foraging habitat for the threatened Hooded Plover by altering dune morphology, creating steeper and higher dunes than those dominated with local native *Spinifex* plants due to their growth habits (Bell 1988; Hilton et al. 2006; Cousens et al. 2013; DEH 2022). Two priority weed species were recorded during the 2023 survey, Sea Spurge (*Euphorbia paralias*) and Gazania (*Gazania sp.*; declared weed), which pose serious threats to the foredune. Gazania in particular poses an issue given the increase in extent of its spread further away from residential gardens.

A total of six native species were recorded within this management zone in 2023. The native species richness was much lower in previous survey years (two in 2014 and one in 2020), with *Atriplex cinerea* and *Carpobrotus rossii* observed to be establishing in parts of the zone in 2023. The amount of *Spinifex hirsutus* has been greatly increased through successful propagation techniques for restoration trials at Coastal Community Nurseries supported by Green Adelaide and local councils.

The overall vegetation condition score for this management zone increased between the 2020 survey (13) and the 2023 survey (28), pointing at a positive effect from Sea Wheat-grass management.

Table 11: Comparison of Zone 1 vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	2	4/15	1	2/15	6	11/15
Weeds	24	1/15	24	1/15	5	6/15
Native Plant Life Forms	3	3/10	2	2/10	10	7/10
Regeneration	0	0/8	0	0/8	0	SNB*
Native : Exotic Understorey Biomass	5-10% Native	1/5	10-20% Native	2/5	5-10% Native	1/5
Bare Ground	5-25%	2/3	5-25%	2/3	26-50%	1/3
Grazing Evidence		4/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**15/60**		**13/60**		**28/52**	

*SNB – No standard rating for this benchmark community available.

Figure 4: Photopoint Management Zone 1 Tennyson Dunes Reserve facing South at (GPS: 269663; 6138308).

Table 12: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 1.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Appears to be less bare ground in photopoint in 2023 than 2020.	Positive	Low	Low	The location of the photopoint is at the end of a beach access track. Current signage might have resulted in less disturbance allowing grasses to gradually spread.
General signs of erosion	Dune morphology appears to have reduced in steepness and height.	Positive	Moderate	High	Increase in the extent of *Spinifex hirsutus* and subsequent alternations of dune stabilisation.
Presence / density / diversity of annual grasses and herbaceous species	Rolling Spinifex (*Spinifex hirsutus*) more abundant in 2023 than previous years (2014 and 2020).	Positive	Moderate	Moderate	Natural grass growth and spread, supplemented by spinifex plantings provided by Coastal Community Nurseries supported by Green Adelaide and local councils post-2020.
	Diversity of weed species detected has increased from previous years.	Negative	High	Moderate	Species such as *Gazania* sp. have spread into the foredune, potentially wind pollinated from nearby gardens.
	Reduction in extent of Sea Wheat-grass (*Thinopyrum junceiforme*) across the foredune	Positive	Moderate	Moderate	Weed control conducted as part of the "Our Plover Coast" project as well as implementation of *Spinifex* plantings might have caused a reduction in extent of Sea Wheat-grass.

4.5.2 Management Zone 2a North and 2a South

2a North – *Olearia axillaris* and *Rhagodia candolleana* spp. *candolleana* open shrubland and 2a South – *Olearia axillaris* and *Rhagodia candolleana* spp. *candolleana* open shrubland with Spinifex understorey

Zone 2 refers to the northern stretch of the interdune swale at Tennyson Dunes. This management zone supports plants that are now considered rare on the Adelaide coastline, such as *Kunzea pomifera* and *Lotus australis*. The zone was split into Zone 2a North and 2b South in the 2020 vegetation condition report (T&M Ecologists 2020) based on a difference in their weed load at the time of assessment (2020). This difference was due to the successful management of targeted weeds such as Perennial Veldt Grass, Bridal Creeper, Coastal Galenia and False Caper towards the southern end of the zone. Although these subsections were assessed separately, a single photopoint was used for monitoring vegetation change for this entire site (Figure 5).

The number of weed species have decreased between 2020 and 2023 (from 18 species to 11-12 species; Table 13 and Table 14), with a similar weed load observed between the two subsections within the zone (northern and southern) in the 2023 survey. Three declared weeds were observed within Zone 2. African Boxthorn (*Lycium ferocissimum*) was only observed in the northern section (Zone 2a), while *Gazania sp.* (declared weed) was only observed in Zone 2b, and Bridal Creeper (*Asparagus asparagoides*) was observed in both subsections. Four priority weed species were identified within Zone 2. Perennial Veldt Grass (*Ehrharta calycina*) was observed in both subsections, while False Caper (*Euphorbia terracina*) and Coastal Galenia (*Galenia pubescens var. pubescens*) were only observed in the southern subsection (Zone 2b).

Sea Spurge (*Euphorbia paralias*) was also observed in Zone 2a. A fungal bio-control agent, *Venturia paralias*, was approved for release in Australia in November 2020 to prevent the spread of Sea Spurge (CSIRO 2023). Known to be highly host-specific to *E. paralias*, the fungus has received a risk estimate of Negligible, under Australia's appropriate level of protection (ALOP) guidelines. The release of *Venturia paralias* could potentially be used to reduce the extent of Sea Spurge cover within the Tennyson Dunes Reserve.

Overall, the southern section (Zone 2b) had a slightly higher native species richness and plant life form diversity (21 species) than the northern section (18 species in Zone 2a) and showed evidence of native species regeneration which was not observed in the northern section. The state rare Hawkweed Picris (*Picris squarrosa*) was observed within Zone 2a. This species was previously thought to be present within this area but was not detected during the 2020 vegetation assessment. The overall vegetation condition score for the subsections decreased between the 2020 survey (47) and the 2023 survey (38).

Table 13: Comparison of Zone 2 vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023			
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value (2a)	BAM Score (2a)	Raw Value (2b)	BAM Score (2b)
Native Plant Species Diversity	26	14/15	23	12/15	18	11/15	21	12/15
Weeds	22	5/15	18	7/15	12	5/15	11	5/15
Native Plant Life Forms	17	9/10	18	10/10	22	10/10	28	10/10
Regeneration	5	7/8	4	6/8	1	2/8	0	0/8
Native : Exotic Understorey Biomass	> 80% Native	5/5	> 80% Native	5/5	40-80% Native	4/5	> 80% Native	5/5
Bare Ground	< 5%	3/3	< 5%	3/3	5-25%	2/3	5-25%	2/3
Grazing Evidence		2/4		4/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**45/60**		**47/60**		**38/60**		**38/60**	

Figure 5: Photopoint Management Zone 2 Tennyson Dunes Reserve facing South, (GPS: 269919, 6137435). There is only one photopoint for Zone 2 as a whole (does not have a separate one for the northern and southern sections of the zone).

Table 14: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 2.

Relevant change indicators	Specific detail	Positive or negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
General signs of erosion	Sand has been pushed up against the cleared access track. There is further accumulation from 2020, following on from 2014 where 60cm of sand accumulated close to the photopoint.	Negative	High	Low	Likely due to the location of the photo-point close to a walkway.
Presence/density/diversity of annual grass, sedge, and herbaceous weeds	Soursob (*Oxalis pes-caprae*) cover increased from 2020; however, extent lesser than what was observed in 2014.	Neutral	High	Low	Likely due to the seasonal timing of the assessment.
Total biomass	Overall native shrub cover seems to have increased from 2020.	Positive	Moderate	Moderate	Natural progression of shrub cover spreading across the management zone.
Shrub canopy health	There appears to be dieback of emerging shrubs present in 2020, but not visible in 2023.	Negative	High	Low	Possibly due to destabilisation of sand close to the track.
Presence/density of grasses and/or herbaceous species	Grass cover (particularly Sea Wheat-grass and *Spinifex hirsutus*) has increased.	Neutral	Low	Low	Dieback of shrubs might have allowed for larger extent of occupancy for gasses.

4.5.3 Management Zone 3a North

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

***Olearia axillaris* Open shrubland**

This management zone was split into two sub-zones 3a North and 3b South in the 2006 Management Plan. Management Zone 3a has undergone some negative changes since the 2020 condition assessment, including an increased weed rating and a decrease in native plant diversity (from 31 species in 2020 to 23 species in 2023; Table 15). Priority weeds identified within this section include Couch (*Cynodon dactylon var. dactylon*), Perennial Veldt Grass (*Ehrharta calycina*), False Caper (*Euphorbia terracina*), Evening Primrose (*Oenothera stricta*) and the African Boxthorn (*Lycium ferocissimum*; declared weed).

Photopoint assessments indicate a higher density of mid-storey species such as *Olearia axillaris* present in 2023 compared to previous survey years (Figure 6 and Table 16).

The overall vegetation condition score for this management zone decreased between the 2020 survey (50) and the 2023 survey (36).

Table 15: Comparison of Zone 3a vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	26	14/15	31	15/15	23	12/15
Weeds	34	2/15	15	8/15	13	4/15
Native Plant Life Forms	18	10/10	18	10/10	23	10/10
Regeneration	4	6/8	4	6/8	2	3/8
Native : Exotic Understorey Biomass	40-80% Native	4/5	40-80% Native	4/5	40-80% Native	4/5
Bare Ground	< 5%	3/3	< 5%	3/3	< 5%	3/3
Grazing Evidence		4/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**43/60**		**50/60**		**36/60**	

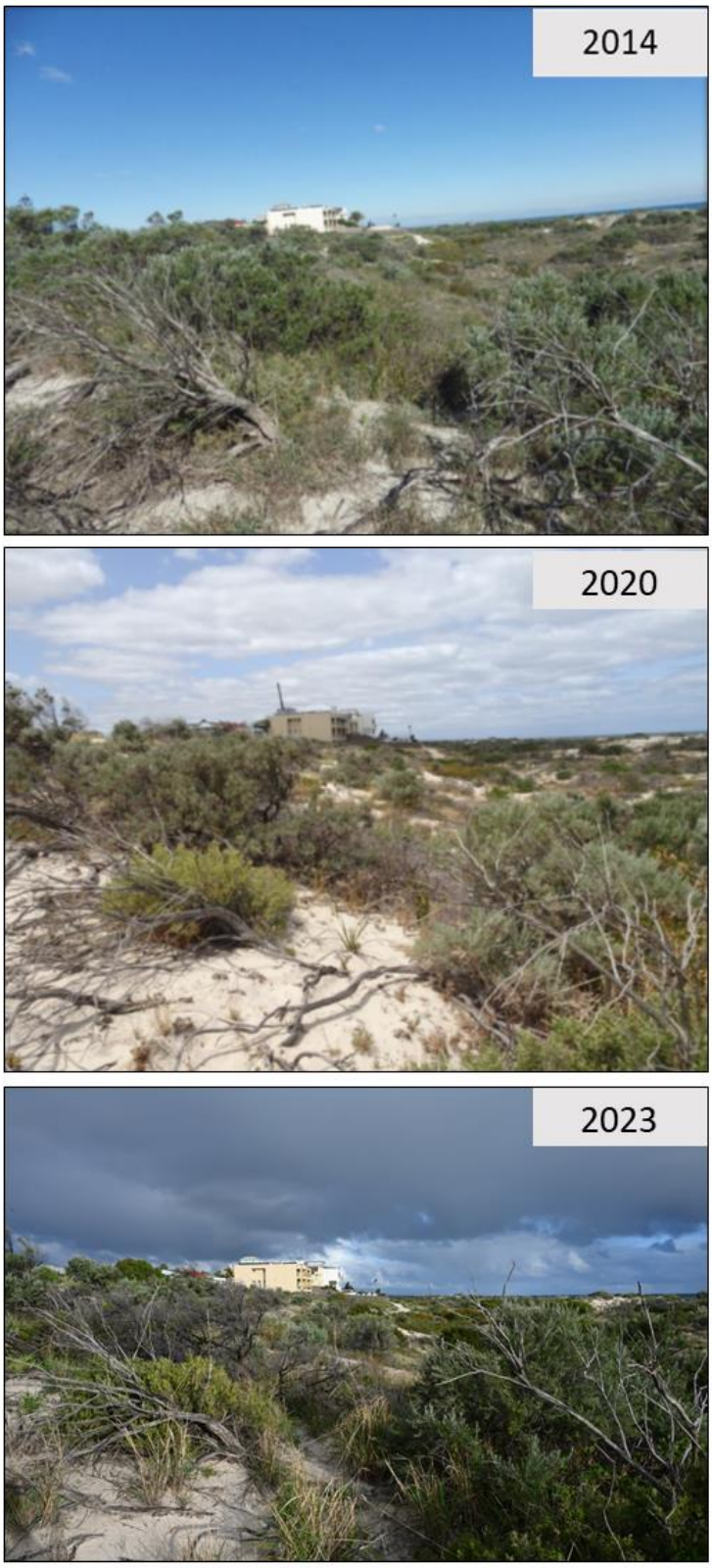

Figure 6: Photopoint Management Zone 3a North Tennyson Dunes Reserve facing South (GPS: 269899, 6137775).

Table 16: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 3a North.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Plant growth	Greater extent of cover of native mid-storey species such as *Olearia axillaris*.	Positive	High	High	Weed control potentially reducing competition for resources, therefore allowing for greater canopy cover in native mid-storey species. The previous years showing good rainfalls will have contributed to plant growth.
Bare ground	Less bare ground in photopoint in 2023 than 2020.	Neutral	High	Moderate	Greater native species foliage cover reducing bare ground proportion.
Presence/density/diversity of grasses and herbaceous weeds	Weed cover of species such as Perennial Veldt Grass and Hare's Tail Grass has increased compared to previous years.	Negative	High	Moderate	Increased weed cover facilitated by disturbance (human activity and foot traffic through dunes) and favourable seasonal growth conditions.
Shrub canopy health	Canopy health has improved from 2020.	Positive	Moderate	Moderate	Natural growth seen in species such as *Olearia axillaris*.

4.5.4 Management Zone 3b South

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

***Olearia axillaris and Alyxia buxifolia* Open shrubland**

This management zone was split into two sub-zones 3a North and 3b South in the 2006 Management Plan. The 2020 vegetation condition report (T&M Ecologists 2020) further modified section 3a by creating a clear distinction between the more intact sub-zone (3b), and the garden-encroached, degraded zone (7c). This distinction aims to assist with the management of weeds originating from neighbouring property gardens.

The number of native species recorded within this management zone significantly increased between 2020 (26 species) and 2023 (36 species), as shown in Table 17. Similar to Zone 3a, photopoint assessments indicate a higher density of mid-storey species such as *Olearia axillaris* present in 2023 compared to previous survey years (Figure 7 and Table 18). The state rare Hawkweed Picris (*Picris squarrosa*) was observed in this subsection. A few individuals of Downy Geranium (*Geranium potentilloides var. potentilloides*) were planted within this section of the dune by volunteers and were observed as present during the 2023 survey.

The number of weed species within Zone 3b did not change between the two monitoring surveys, however, the weed cover and weed biomass increased, decreasing the weed score. This subsection contained a larger number of priority and declared weed species than the northern subsection, including Perennial Veldt Grass (*Ehrharta calycina),* Coastal Galenia (*Galenia pubescens*), Couch (*Cynodon dactylon var. dactylon*), White Arctotis (*Arctotis stoechadifolia*), Western Coastal Wattle (*Acacia cyclops*), and False Caper (*Euphorbia terracina*). Two declared species, Italian Buckthorn (*Rhamnus alaternus*) and Bridal Creeper (*Asparagus asparagoides*) were also recorded in this subsection.

The overall vegetation condition score for this management zone decreased between the 2020 survey (50) and the 2023 survey (45).

Table 17: Comparison of Zone 3b vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Score	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	26	13/15	26	13/15	36	15/15
Weeds	16	8/15	19	7/15	19	4/15
Native Plant Life Forms	18	10/10	18	10/10	35	10/10
Regeneration	4	6/8	6	8/8	6	8/8
Native : Exotic Understorey Biomass	> 80% Native	5/5	> 80% Native	5/5	20-40% Native	3/5
Bare Ground	< 5%	3/3	< 5%	3/3	5-25%	2/3
Grazing Evidence		3/4		4/4		3/4
TOTAL VEGETATION CONDITION SCORE	**48/60**		**50/60**		**45/60**	

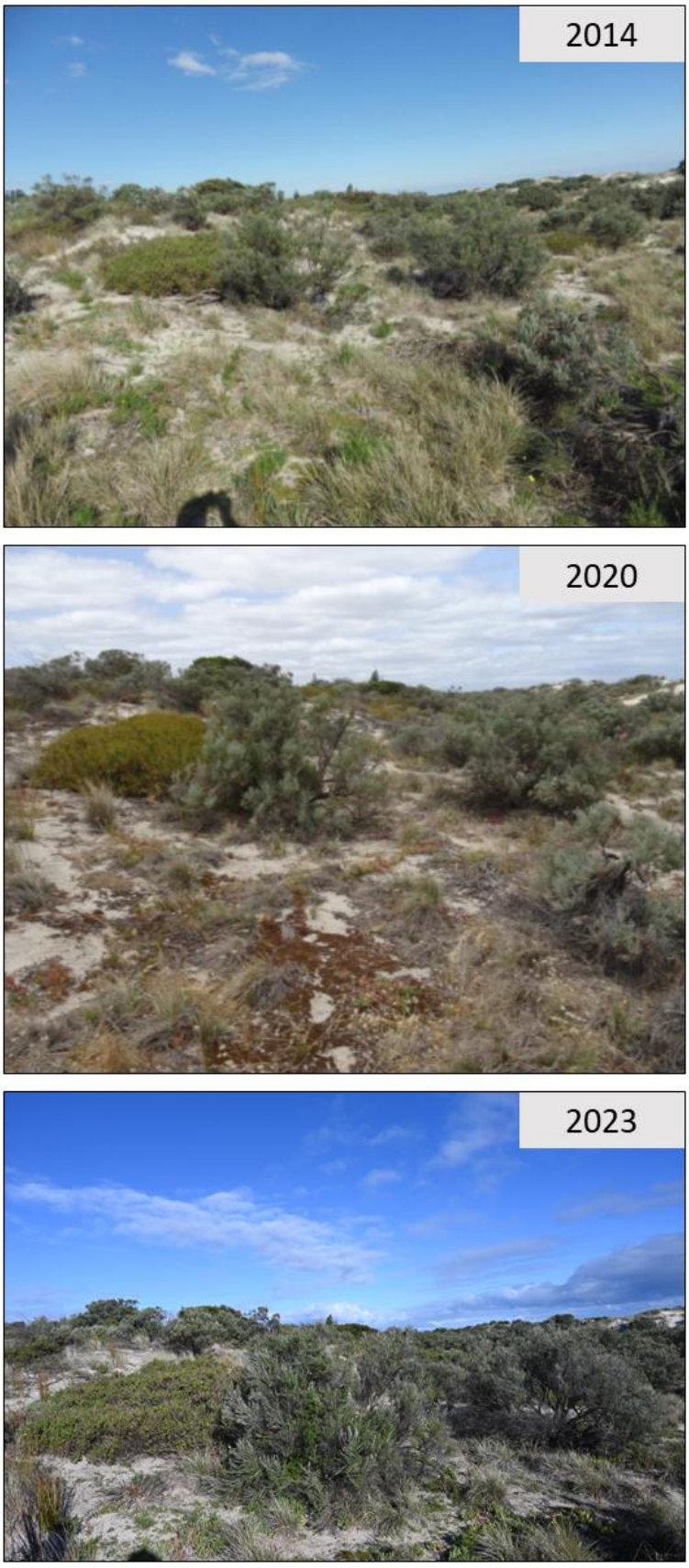

Figure 7: Photopoint Management Zone 3b South Tennyson Dunes Reserve facing South (GPS: 269931, 6137494).

Table 18: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 3b South.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Plant growth	Greater extent of cover of native mid-storey species such as *Olearia axillaris*.	Positive	High	High	Weed control potentially reducing competition for resources, therefore allowing for greater canopy cover in native mid-storey species. The previous years showing good rainfalls will have contributed to plant growth.
Bare ground	Greater bare ground in photopoint in 2023 than 2020.	Negative	Moderate	Low	Moss dieback might have caused this. Observation could also be seasonal.
Presence/density/diversity of grasses and herbaceous weeds	Weed cover of species such as Hare's Tail Grass has increased compared to previous years.	Negative	High	Moderate	Increased weed cover facilitated by disturbance (human activity and foot traffic through dunes) and good growth conditions.
Density of low shrubs / mat plants	Cover of Native Pigface (*Carpobrotus rossii*) appears to have progressively increased from 2014 to 2020 to 2023.	Positive	Moderate	Low	Might represent real change in cover but may also simply be increased detectability due to higher proportion of bare ground.

4.5.5 Management Zone 4

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

***Leucopogon parviflorus, Olearia axillaris, Acacia longifolia* var. *sophorae* +/- *Myoporum insulare* Shrubland**

This zone used to be sub-dived into 4a (more intact) and 4b (rehabilitation) in the 2006 Management Plan. Due to revegetation and weed control efforts, particularly in the vicinity of the southern carpark, the sub-zone 4b is no longer deemed to be as degraded or in need of large-scale rehabilitation. The previously mapped Zone 4b has now been incorporated into Zone 5b, with a large-scale revegetation program recommended in the 2020 vegetation assessment report (T&M Ecologists 2020).

The number of native species within this zone was similar between the 2020 and 2023 vegetation surveys, however, the diversity of native plant life forms has increased (Table 19). The overstorey of this hind dune ridge habitat, is dominated by Coast Beard-heath (*Leucopogon parviflorus)* and Coast Daisy-bush (*Olearia axillaris)*, with the occasional Dryland Tea-tree (*Melaleuca lanceolata)*. The state rare Hawkweed Picris (*Picris squarrosa*) was observed within this zone. Less bare ground was visible at the photopoint in 2023 compared to previous surveys (Figure 8 and Table 20), however, the overall amount of bare ground has increased between the 2020 and 2023 surveys (from <5% to 26-50%).Figure 8: Photopoint Management Zone 4 Tennyson Dunes Reserve facing South (GPS: 269990, 6137346).

The number of weed species decreased between the 2020 survey (19 species) and 2023 survey (15 species). Seven priority weed species were recorded within this zone, Bridal Creeper (*Asparagus asparagoides; declared weed*), Skeleton Weed (*Chondrilla juncea; declared weed*), Couch (*Cynodon dactylon var. dactylon*), Perennial Veldt Grass (*Ehrharta calycina*), False Caper (*Euphorbia terracina*), Evening Primrose (*Oenothera stricta*), and Seascape Daisy (*Osteospermum fruticosum*).

The overall vegetation condition score for this management zone decreased between the 2020 survey (44) and the 2023 survey (42).

Table 19: Comparison of Zone 4 vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	29	14/15	33	15/15	33	15/15
Weeds	13	9/15	19	7/15	15	4/15
Native Plant Life Forms	18	10/10	14	8/10	22	10/10
Regeneration	4	6/8	3	4/8	3	4/8
Native : Exotic Understorey Biomass	> 80% Native	5/5	40-80% Native	4/5	40-80% Native	4/5
Bare Ground	< 5%	3/3	< 5%	3/3	26-50%	1/3
Grazing Evidence		2/4		3/4		4/4
TOTAL VEGETATION CONDITION SCORE	**49/60**		**44/60**		**42/60**	

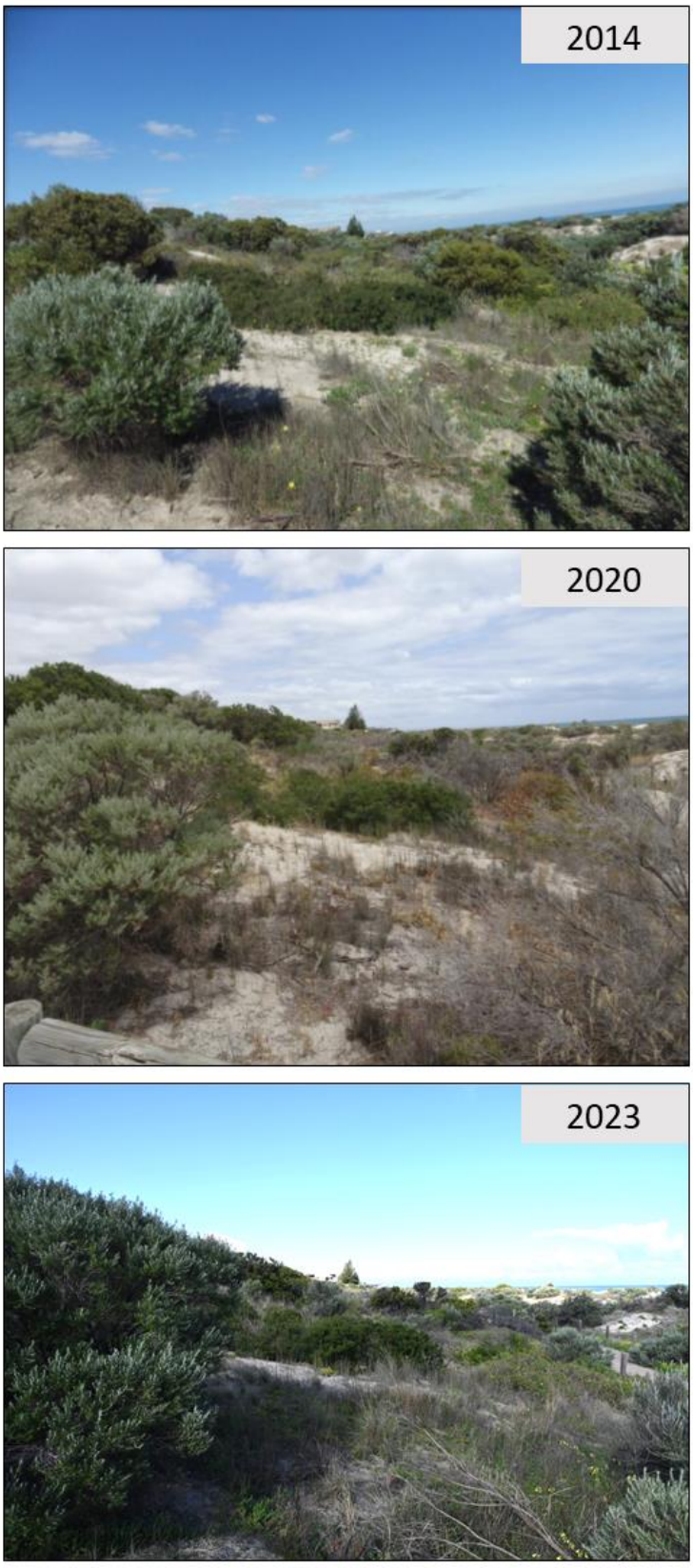

Figure 8: Photopoint Management Zone 4 Tennyson Dunes Reserve facing South (GPS: 269990, 6137346).

Table 20: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 4.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Less bare ground in 2023 compared to 2020.	Neutral	Moderate	Low	Higher grass cover from weed species.
Presence/density/diversity of grasses and herbaceous weeds	Weed cover of species such as Hare's Tail Grass and Perennial Veldt Grass has increased compared to previous years.	Negative	High	Moderate	Cover of weed species has increased, potentially because this Management Zone is not a priority area for weed control.
	Soursob (*Oxalis pes-caprae*) prevalent in 2014, not in 2020 but prevalent again in 2023.	Negative	Moderate	Low	Likely due to seasonal timing of assessment. Soursob is a winter-growing weed species.

4.5.6 Management Zone 5a South

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

***Allocasuarina verticillata, Callitris gracilis* Very low Woodland (back dune adjacent southern carpark)**

The structural and species diversity of vegetation around the southern carpark has changed notably since the implementation of the 2006 Vegetation Management Plan, with several broad-scale revegetation projects implemented within this management zone. This site now supports an open cover of Sheoak (*Allocasuarina verticillata*), Southern Cypress Pine (*Callitris gracilis*) and Dryland Tea-tree (*Melaleuca lanceolata*) over a range of small shrubs including Variable Groundsel (*Senecio pinnatifolius)*, Cushion Fanflower (*Scaevola crassifolia)*, Coast Bonefruit (*Threlkeldia diffusa,)* and Sea-berry Saltbush (*Rhagodia candolleana)*. Muntries (*Kunzea pomifera)*, Australian Trefoil (*Lotus australis)*, and Woolly Mat-rush (*Lomandra leucocephala ssp. robusta)* were all planted within Zone 5a as part of revegetation efforts. The state rare Hawkweed Picris (*Picris squarrosa*) was observed within this zone. Overall, species richness within this zone has increased since the last vegetation condition assessment (25 species in 2020 compared to 30 species in 2023; Table 21).

The understorey is weedy and dominated by Soursobs (*Oxalis pes-caprae)*. The number of weed species within this management zone has decreased since 2020 (from 30 to 19 species), however, the weed cover and biomass has increased (Figure 9 and Table 22). Eight priority weed species were observed within this zone, Western Coastal Wattle (*Acacia cyclops*), Golden Wreath Wattle (*Acacia saligna*), Couch (*Cynodon dactylon var. dactylon*), Perennial Veldt Grass (*Ehrharta calycina*), Blue Lupin (*Lupinus cosentinii*), Common Iceplant (*Mesembryanthemum crystallinum*), and Evening Primrose (*Oenothera stricta*). Two declared weed species (Athel Pine, *Tamarix aphylla,* and Bridal Creeper, *Asparagus asparagoides*) were observed in 2023.

Overall, the amount of bare ground did not change between 2020 and 2023. However, the ground cover in one section of the zone was heavily modified due to works conducted by a local volunteer group, where leaf litter and coarse woody debris was collected and placed into piles. There are plans to spread these out across the area to provide habitat for local reptile species (e.g., for Painted Dragons, *Ctenophorus pictus*).

The overall vegetation condition score for this management zone increased slightly between the 2020 survey (34) and the 2023 survey (35).

Table 21: Comparison of Zone 5a vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	23	11/15	25	12/15	30	13/15
Weeds	24	5/15	30	3/15	19	1/15
Native Plant Life Forms	17	8/10	16	8/10	24	10/10
Regeneration	1	2/8	3	4/8	4	5/8
Native : Exotic Understorey Biomass	40-80% Native	4/5	20-40% Native	3/5	10-20% Native	2/5
Bare Ground	< 5%	3/3	26-50%	1/3	26-50%	1/3
Grazing Evidence		2/4		3/4		3/4
TOTAL VEGETATION CONDITION SCORE	**35/60**		**34/60**		**35/60**	

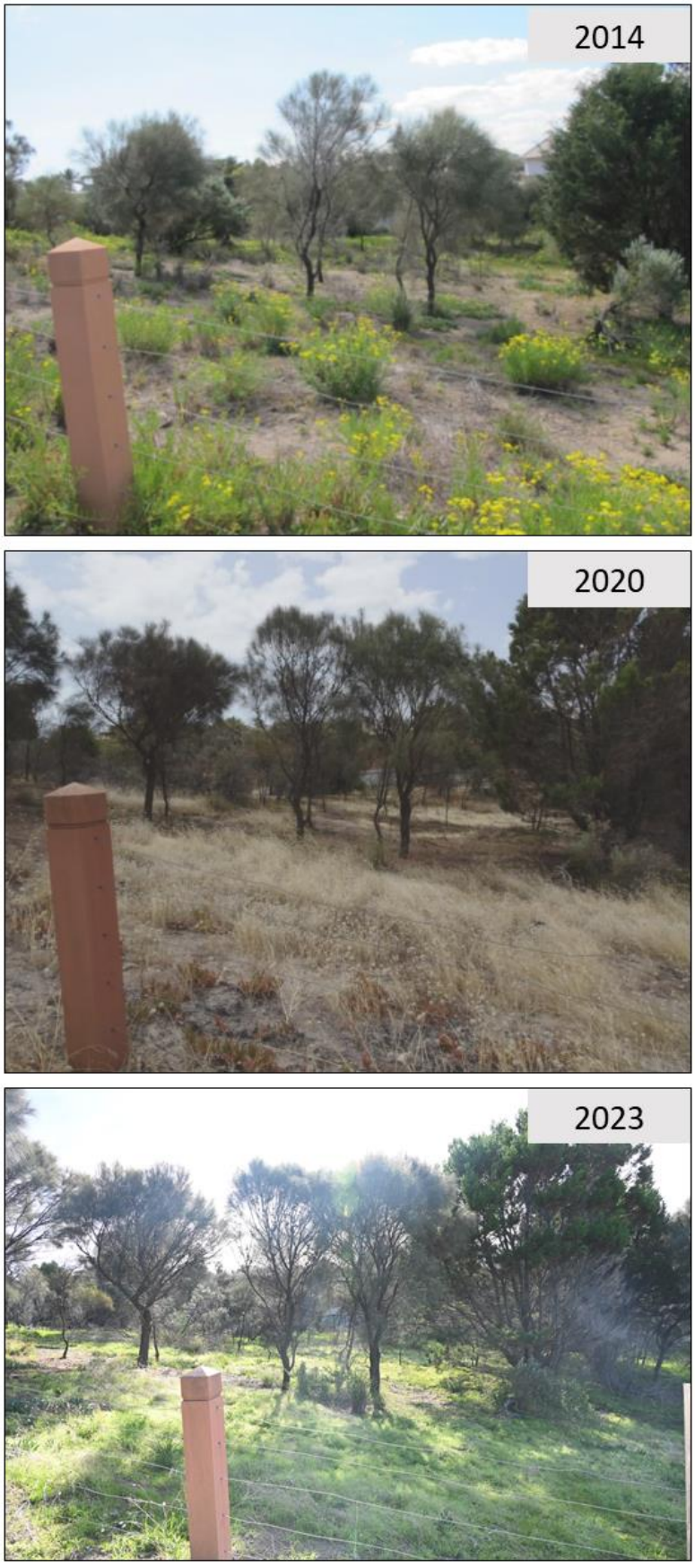

Figure 9: Photopoint Management Zone 5a Tennyson Dunes Reserve facing North (GPS: 270074, 6137407).

Table 22: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 5a South.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Plant growth	Drooping Sheoaks (*Allocasuarina verticillata*) and Native Pine (*Callitris gracilis*) have continued to grow and survive from 2014 to 2023.	Positive	High	High	Ongoing survival and growth of revegetation.
Presence/density/diversity of grasses and herbaceous weeds	Weed cover of species has increased compared to previous years.	Negative	High	Moderate	Cover of weed species has increased, especially Soursob, potentially due to seasonal timing of assessment.
Density of low shrubs / mat plants	Cover of Native Pigface (*Carpobrotus rossii*) appears to have decreased from 2020 to 2023.	Negative	Moderate	Low	Might represent real change in cover but may also simply be decreased detectability due to higher proportion of weed cover.

4.5.7 Management Zone 5b North

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

***Olearia axillaris* Open shrubland with emergent *Allocasuarina verticilllata* (back dune adjacent northern carpark)**

Management Zone 5b is adjacent to the northern carpark, which is comprised of scattered remnant vegetation and revegetation plantings. The native species richness for this zone increased between 2020 (27 species) and 2023 (30 species), as did the diversity of native plant life forms (Table 23). The number of regenerating species increased between these two survey times, from 1 to four (Figure 10 and Table 24).

The number of weed species did not change between 2020 and 2023, but the cover and biomass increased, decreasing the weed score for this zone. Two declared weed species, Bridal Creeper (*Asparagus asparagoides*) and Caltrop (*Tribulus terrestris*) were observed during the 2023 survey. Six additional priority weed species were observed within this zone, Western Coastal Wattle (*Acacia cyclops*), Couch (*Cynodon dactylon var. dactylon*), Perennial Veldt Grass (*Ehrharta calycina*), False Caper (*Euphorbia terracina*), Coastal Galenia (*Galenia pubescens var. pubescens*), and Coast Tea-tree (*Leptospermum laevigatum*).

A large number of weeds were present along the southern boundary of this zone. The vegetation assessment conducted by Succession Ecology in 2023 has classified this southern region of Zone 5b as a new management zone (Zone 7d) to account for the high prevalence of weed species extending into the reserve from the neighbouring housing development/properties.

The overall vegetation condition score for this management zone decreased between the 2020 survey (43) and the 2023 survey (41).

Table 23: Comparison of Zone 5b vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	15	9/15	27	14/15	30	14/15
Weeds	30	3/15	18	7/15	18	3/15
Native Plant Life Forms	11	6/10	17	9/10	23	10/10
Regeneration	1	2/8	1	2/8	4	6/8
Native : Exotic Understorey Biomass	10-20% Native	2/5	40-80% Native	4/5	20-40% Native	3/5
Bare Ground	< 5%	3/3	< 5%	3/3	26-50%	1/3
Grazing Evidence		1/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**26/60**		**43/60**		**41/60**	

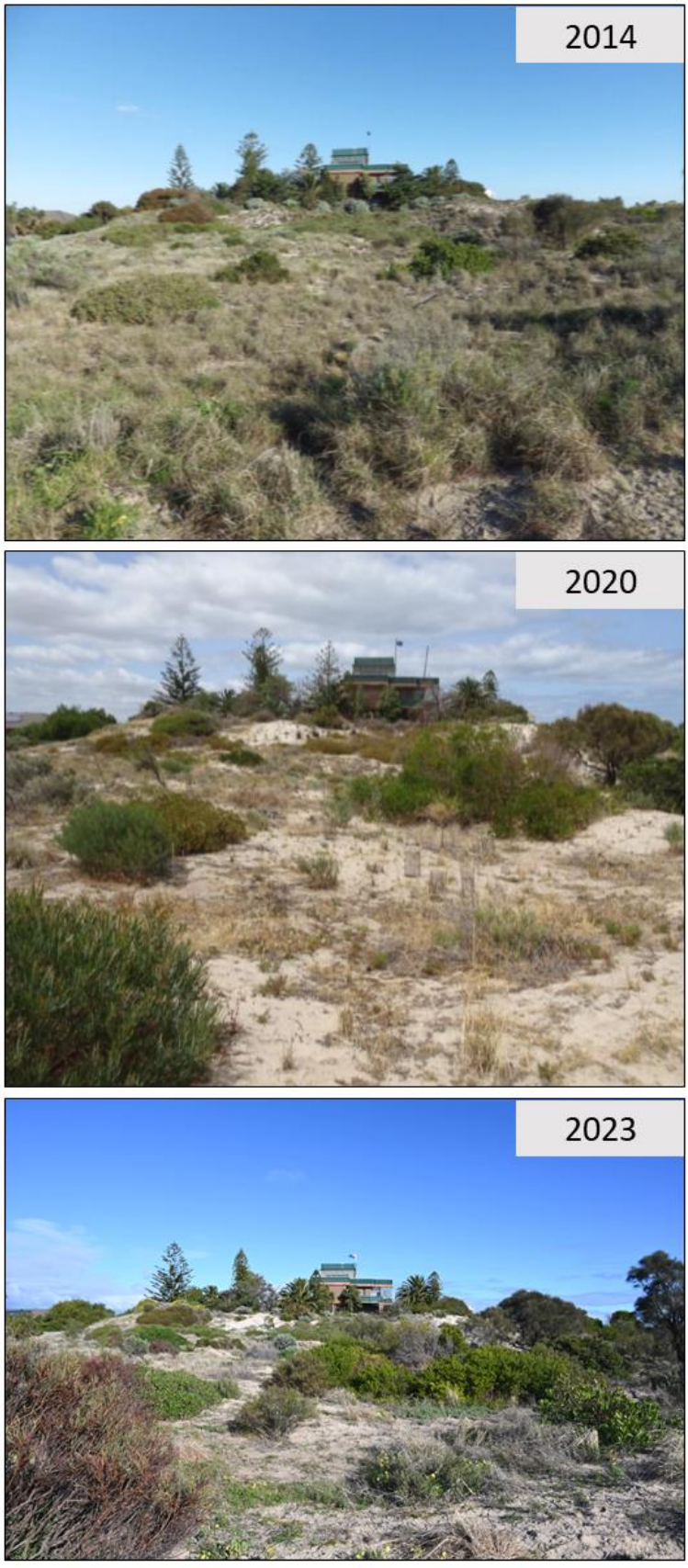

Figure 10: Photopoint Management Zone 5b Tennyson Dunes Reserve facing South (GPS: 269999, 6137814).

Table 24: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 5b North.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Lesser bare ground in photopoint in 2023 than 2020.	Positive	Moderate	Low	Higher grass cover, mostly weed species have occupies a greater foliage extent.
Native Plant Species Diversity	Not detectable in photopoint but native species has increased since 2014 and 2020.	Positive	High	High	Recent revegetation has increased species richness in this Management Zone.
Recruitment	Regeneration of native shrubs such as *Senecio pinnatifolius.*	Positive	High	High	Native shrub generation, potentially due to Perennial Veldt Grass control. Veldt grass cover has reduced significantly since 2014.
Presence/density/diversity of grasses and herbaceous weeds	Soursob (*Oxalis pes-caprae*) prevalent in 2014, not in 2020 but prevalent again in 2023.	Negative	Moderate	Low	Likely due to seasonal timing of assessment.

4.5.8 Management Zone 6

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

Interdune swale and remnant patches of hind-dune vegetation north of Coronado Court

This zone occurs between the foredune and the narrow north-south walking track north of Coronado Court and includes small patches of moderately intact hind-dune vegetation that persist between areas of garden encroachment. Native species richness has decreased since 2020 (from 22 species to 16), as has the number of regenerating species (from four to zero), as shown in Table 25. There was less bare ground visible at the photopoint in 2023 than 2020 (Figure 11 and Table 26) and was really low (<5% bare) across most of Zone 6.

Weed diversity has decreased since 2020, from 17 species to 13. Three declared weed species were observed within this zone, Bridal Creeper (*Asparagus asparagoides*), Skeleton Weed (*Chondrilla juncea*) and African Boxthorn (*Lycium ferocissimum*). Four additional priority weeds were observed, *Aeonium arboreum*, Sea Spurge (*Euphorbia paralias*), False Caper (*Euphorbia terracina*), and Coastal Galenia (*Galenia pubescens var. pubescens*). The release of *Venturia paralias* could potentially be used to reduce the extent of Sea Spurge cover within the Tennyson Dunes Reserve.

The overall vegetation condition score for this management zone decreased between the 2020 survey (46) and the 2023 survey (35).

Table 25: Comparison of Zone 6 vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	17	10/15	22	12/15	16	10/15
Weeds	18	7/15	17	7/15	13	4/15
Native Plant Life Forms	20	10/10	19	10/10	23	10/10
Regeneration	4	6/8	4	6/8	0	0/8
Native : Exotic Understorey Biomass	> 80% Native	5/5	40-80% Native	4/5	40-80% Native	4/5
Bare Ground	< 5%	3/3	< 5%	3/3	< 5%	3/3
Grazing Evidence		4/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**45/60**		**46/60**		**35/60**	

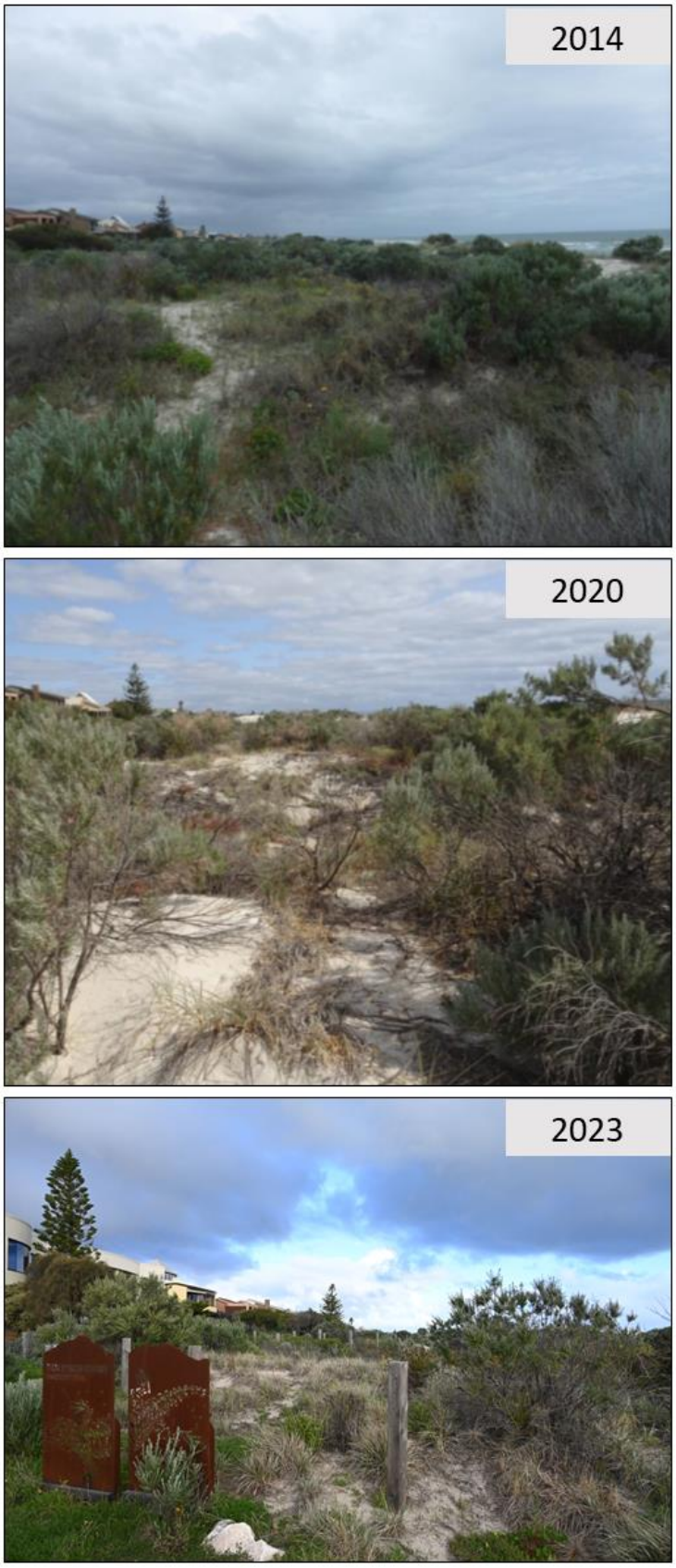

Figure 11: Photopoint Management Zone 6 Tennyson Dunes Reserve facing South (GPS: 269658, 6138407).

Table 26: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 6.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Lesser bare ground in photopoint in 2023 than 2020.	Positive	High	Moderate	Higher grass cover, especially *Spinifex hirsutus*.
Native Plant Species Diversity	Not detectable in photopoint but native species has increased since 2014 and 2020.	Positive	High	High	Recent revegetation has increased species richness in this Management Zone.
Density / Diversity of annual grasses and herbaceous weeds	Increase in diversity of weeds from 2020.	Negative	High	Moderate	Succulent species have established in this zone potentially due to further garden encroachment in nearby housing developments.
	Soursob (*Oxalis pes-caprae*) not prevalent in 2020 but prevalent again in 2023.	Negative	Moderate	Low	Likely due to seasonal timing of assessment.

4.5.9 Management Zone 7a

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

Areas of garden encroachments and weedy edges

Zone 7a encompasses the back section of the dunes which run along the boundary between the reserve and neighbouring housing. Native species diversity increased slightly between 2020 (18 species) and 2023 (21 species), although the ratio of native to exotic species biomass decreased (from 40-80% to 5-20%) as shown in (Table 27). This is due to an increase in the number of weed species (from 20 to 27), their overall cover and biomass. Two declared weed species, the European Olive (*Olea europaea ssp*.) and *Gazania sp.* were observed within this section of the reserve. An additional 13 priority weeds were recorded within this management zone; Western Coastal Wattle (*Acacia cyclops*), *Aeonium arboreum,* Haworth's aeonium *(Aeonium haworthii)*, Agave (*Agave americana*), Candelabra Aloe (*Aloe arborescens*), White Arctotis (*Arctotis stoechadifolia*), Marguerite Daisy (*Argyranthemum frutescens*), *Cotyledon orbiculata*, Blue Chalksticks (*Curio repens*), Couch (*Cynodon dactylon var. dactylon*), False Caper (*Euphorbia terracina*), Coast Tea-tree (*Leptospermum laevigatum*), and Seascape Daisy (*Osteospermum fruticosum*).

The amount of bare ground visible from the photopoint has decreased since 2020 (Figure 12 and Table 28) and is fairly low (<5% bare) across most of this management zone. The state rare Hawkweed Picris (*Picris squarrosa*) was observed within this zone during the 2023 survey.

The overall vegetation condition score for this management zone decreased between the 2020 survey (39) and the 2023 survey (33).

Table 27: Comparison of Zone 7a vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	RAW Value	BAM Score
Native Plant Species Diversity	17	10/15	18	11/15	21	12/15
Weeds	32	3/15	20	6/15	27	4/15
Native Plant Life Forms	13	8/10	12	7/10	16	9/10
Regeneration	1	2/8	3	4/8	0	0/8
Native : Exotic Understorey Biomass	20-40% Native	3/5	40-80% Native	4/5	5-20% Native	1/5
Bare Ground	< 5%	3/3	< 5%	3/3	< 5%	3/3
Grazing Evidence		4/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**33/60**		**39/60**		**33/60**	

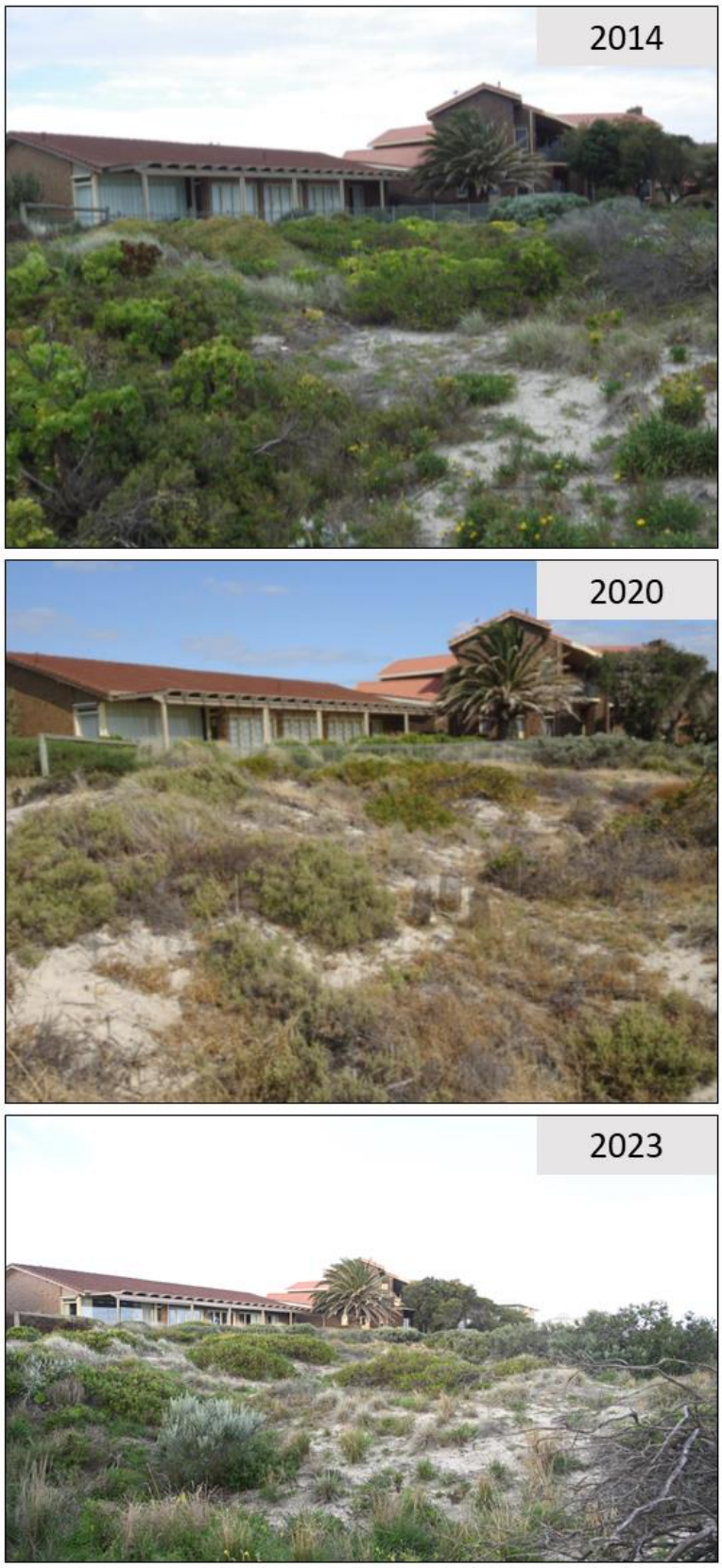

Figure 12: Photopoint Management Zone 7a Tennyson Dunes Reserve facing South-East (GPS: 269828,6137922).

Table 28: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 7a.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Lesser bare ground in photopoint in 2023 than 2020.	Positive	High	Moderate	Higher grass cover, especially *Spinifex hirsutus*.
Native Plant Species Diversity	Not detectable in photopoint but native species has increased since 2014 and 2020.	Positive	High	High	Recent revegetation has increased species richness in this Management Zone.
Density / Diversity of annual grasses and herbaceous weeds	Soursob (*Oxalis pes-caprae*) not prevalent in 2020 but prevalent again in 2023.	Negative	Moderate	Low	Likely due to seasonal timing of assessment.
Native Plant Biomass	Progressive increase of native understorey from 2014 to 2023.	Positive	High	High	Lower cover of introduced species, particularly succulents such as *Aeonium* sp. and *Gazania* sp. which are no longer visible in the photopoint.

4.5.10 Management Zone 7b

Description of this Management Zone from 2020 Vegetation Assessment Report:

Areas of garden encroachments and weedy edges.

This management zone corresponds to an area that was previously cleared and prepared for housing development and encompasses the remnant coastal vegetation in the surrounding area. Native species richness within this zone has decreased slightly (from 21 species to 20) since 2020 (Table 29). Although the number of weed species has decreased since 2020 (from 20 species to 14), the overall weed cover and biomass has significantly increased. Consequently, the amount of bare ground in this zone has significantly decreased since 2020, from 26-50% to <5% (Figure 13 and Table 30). Four priority weed species were observed within this zone, Perennial Veldt Grass (*Ehrharta calycina*), False Caper (*Euphorbia terracina*), Coastal Galenia (*Galenia pubescens var. pubescens*), Common Iceplant (*Mesembryanthemum crystallinum*).

The overall vegetation condition score for this management zone decreased between the 2020 survey (32) and the 2023 survey (27).

Table 29: Comparison of Zone 7b vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020		2023	
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	13	8/15	21	12/15	20	12/15
Weeds	20	6/15	20	6/15	14	1/15
Native Plant Life Forms	6	3/10	8	4/10	9	5/10
Regeneration	1	2/8	2	3/8	1	2/8
Native : Exotic Understorey Biomass	10-20% Native	2/5	10-20% Native	2/5	< 5% Native	0/5
Bare Ground	26-50%	1/3	26-50%	1/3	< 5%	3/3
Grazing Evidence		3/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**25/60**		**32/60**		**27/60**	

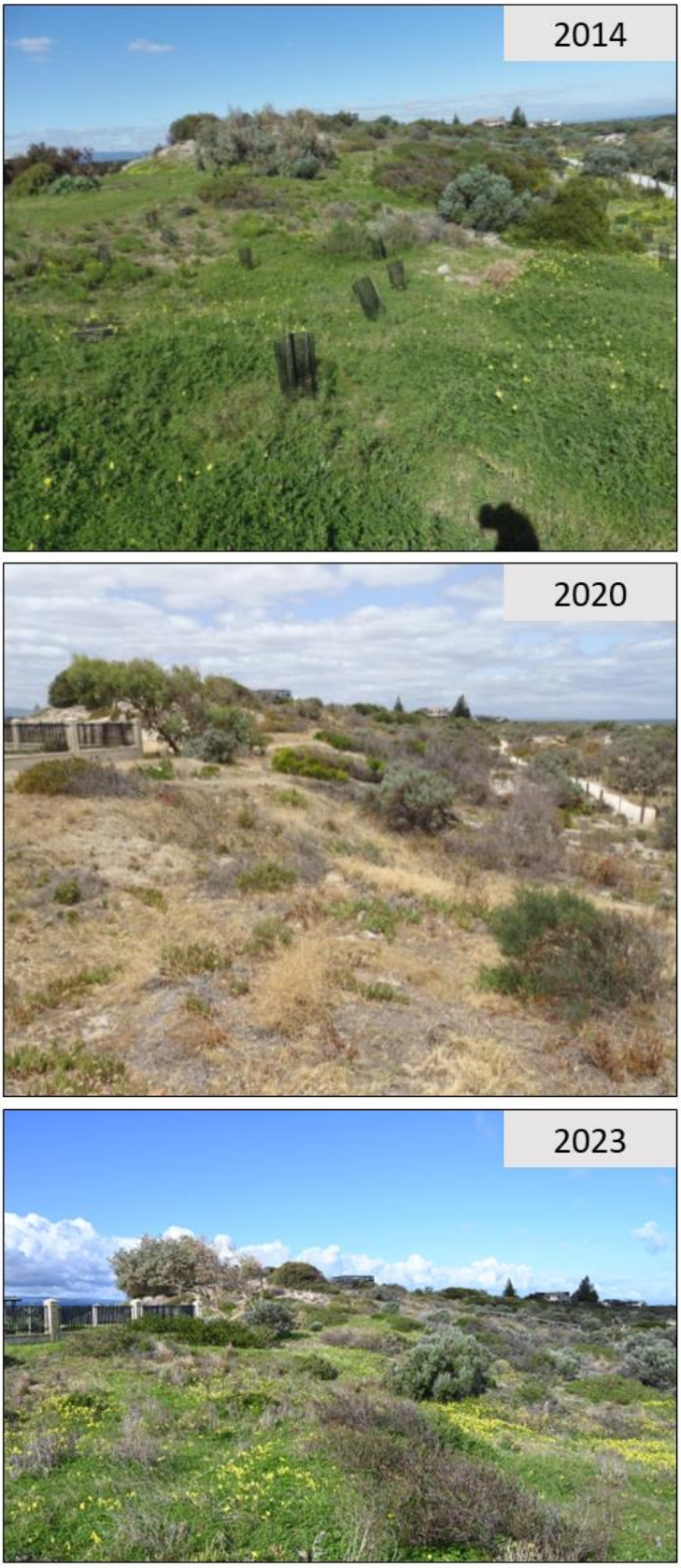

Figure 13: Photopoint Management Zone 7b Tennyson Dunes Reserve facing South-East (GPS: 269967,6137510).

Table 30: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 7b.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Less bare ground in photopoint in 2023 than 2020.	Negative	High	Moderate	Higher weed cover, especially Soursob (*Oxalis pes-caprae*).
Density / Diversity of annual grasses and herbaceous weeds	Soursob (*Oxalis pes-caprae*) not observed in 2020 but prevalent in 2023.	Negative	Moderate	Low	Likely due to seasonal timing of assessment.
Native : exotic Understorey Biomass	The proportion of the understorey that is native has been estimated to have progressively increased from 2014 to 2023.	Positive	High	High	Native shrub foliage cover has increased due to natural growth over time.

4.5.11 Management Zone 7c

Description of this Management Zone from 2015 Tennyson Dunes Biodiversity Action Plan:

Areas of garden encroachments and weedy edges.

Management Zone 7c was initially considered as part of Zone 3b in the original Biodiversity Action Plan (EAC Ecological Evaluations 2015), but was classed as a separate zone in the 2020 vegetation condition assessment report (T&M Ecologists 2020) to account for the heavy invasion by weed species from nearby gardens. This zone encompasses the area at the rear of the dunes which backs onto the neighbouring residential housing. Native species richness within this zone increased from 20 in 2020 to 34 in 2023, although the overall native biomass decreased from 20-40% native to 5-20% native (Table 31). This is largely due to the increase in weed species cover and biomass within the area (Figure 14 and Table 32). The number of weed species decreased after 2020 (from 22 to 16), but the area covered by these species increased significantly, resulting in a very low weed score (0 out of 15). Two declared weeds were observed during the 2023 survey, Bridal Creeper (*Asparagus asparagoides*) and Italian Buckthorn (*Rhamnus alaternus*). An additional four priority weed species were also observed during the 2023 survey, Western Coastal Wattle (*Acacia cyclops*), Kikuyu (*Cenchrus clandestinus*), Perennial Veldt Grass (*Ehrharta calycina*) and False Caper (*Euphorbia terracina*).

The state rare Hawkweed Picris (*Picris squarrosa*) was observed within Zone 7c in 2023.

The overall vegetation condition score for this management zone decreased between the 2020 survey (40) and the 2023 survey (35).

Table 31: Comparison of Zone 7c vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014		2020			2023
	Raw Value	BAM Score	Raw Value	BAM Score	Raw Value	BAM Score
Native Plant Species Diversity	17	10/15	20	12/15	34	15/15
Weeds	23	5/15	22	5/15	16	0/15
Native Plant Life Forms	10	6/10	12	7/10	21	10/10
Regeneration	1	2/8	4	6/8	1	2/8
Native : Exotic Understorey Biomass	20-40% Native	3/5	20-40% Native	3/5	5-20% Native	1/5
Bare Ground	26-50%	1/3	< 5%	3/3	< 5%	3/3
Grazing Evidence		3/4		4/4		4/4
TOTAL VEGETATION CONDITION SCORE	**30/60**		**40/60**			**35/60**

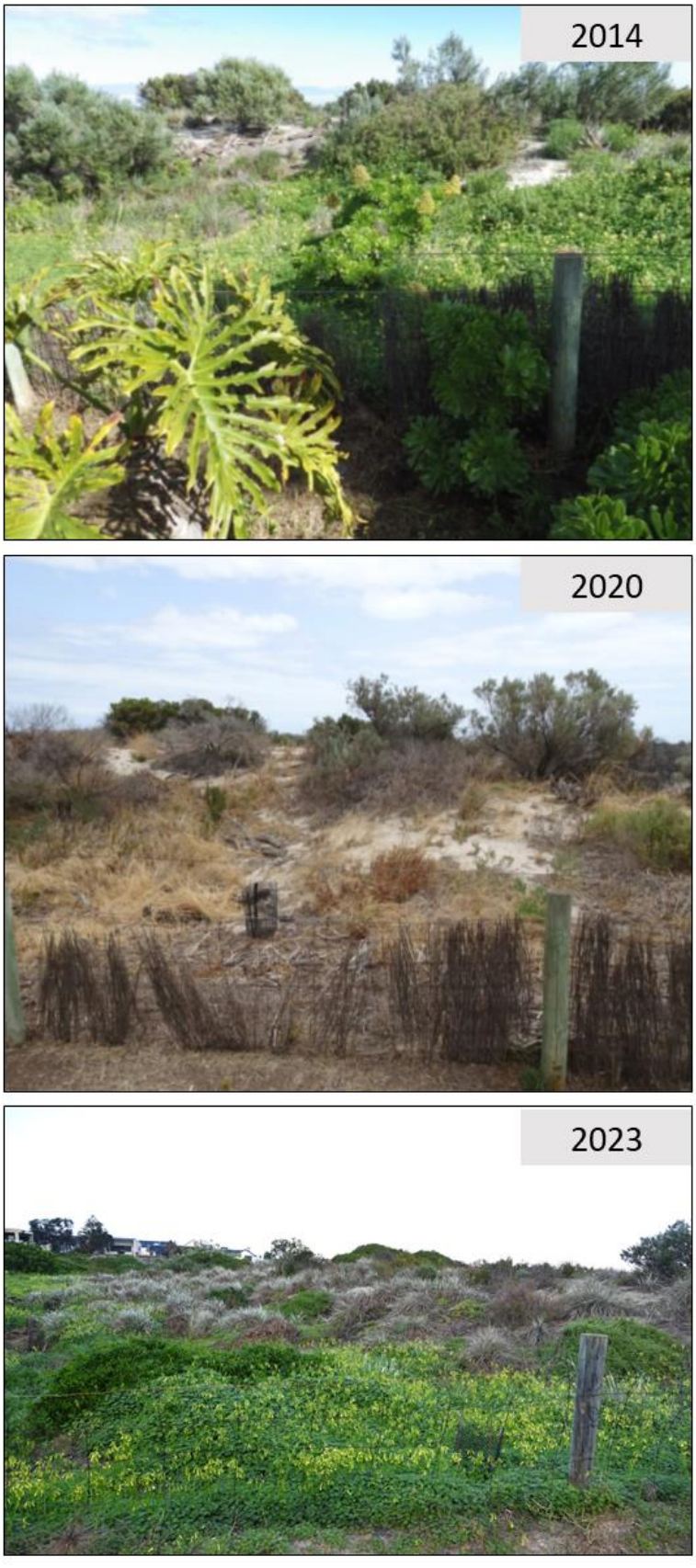

Figure 14: Photopoint Management Zone 7c Tennyson Dunes Reserve facing West (GPS: 270042, 6137117).

Table 32: Confidence and reasons for changes in photopoints and BAM scores in Management Zone 7a.

Relevant change indicators	Specific detail	Positive / Negative change	Confidence change is real	Confidence change represents long-term change at broad scale	Possible reasons
Bare ground	Lesser bare ground in photopoint in 2023 than 2020.	Positive	High	Moderate	Higher grass cover, especially *Spinifex hirsutus*.
Native Plant Species Diversity	Not detectable in photopoint but native species has increased since 2014 and 2020.	Positive	High	High	Recent revegetation has increased species richness in this Management Zone.
Density / Diversity of annual grasses and herbaceous weeds	Soursob (*Oxalis pes-caprae*) not observed in 2020 but prevalent in 2023.	Negative	Moderate	Low	Likely due to seasonal timing of assessment.

4.5.12 Management Zone 7d

Areas of garden encroachments and weedy edges.

A large number of weeds were present along the southern boundary of Zone 5b. The vegetation assessment conducted by Succession Ecology in 2023 has classified this southern region of Zone 5b as a new management zone (Zone 7d) to account for the high prevalence of weed species extending into the reserve from the neighbouring housing development/properties. This is a small area, with a different mix of exotic weed species than the rest of Zone 5b. Twelve weed species were observed within this area (Table 33), including one declared weed (African Boxthorn, *Lycium ferocissimum*) and two additional priority weed species (Evening Primrose, *Oenothera stricta*, and *Cotyledon orbiculata*).

Zone 7b had a very low native species diversity (5 species and 6 native plant life forms) and low native species biomass (<5%).

Table 33: Comparison of Zone 7d vegetation attributes between the three monitoring surveys. For the BAM scores, the first number indicates the score assigned and the second number (after the dash) indicates maximum possible points. The raw regeneration value number indicates the number of regenerating species.

Attribute	2014	2020	2023	
			Raw Value	BAM Score
Native Plant Species Diversity	NOT ASSESSED INDEPENDENTLY IN 2014 OR 2020; ASSESSED AS PART OF MANAGEMENT ZONE 5B		5	3/15
Weeds			12	11/15
Native Plant Life Forms			6	3/10
Regeneration			0	0/8
Native : Exotic Understorey Biomass			< 5% Native	1/5
Bare Ground			< 5%	1/3
Grazing Evidence				4/4
TOTAL VEGETATION CONDITION SCORE				**23/60**

Figure 15: Site images of Management Zone 7d on the southern boundary of Management Zone 5bc.

5 SUMMARY AND CONCLUSIONS

The vegetation condition assessment conducted within the Tennyson Dunes Reserve in June 2023 recorded a number of positive and negative changes within the landscape since the last assessment period (January 2020). The native species diversity increased in half of the management zones assessed (Zone 1, Zone 3b, Zone 5a, Zone 5b, Zone 7a and Zone 7c) and the number of weed species observed decreased in nine of the twelve management zones (Zone 1, Zone 2a, Zone 2b, Zone 3a, Zone 4, Zone 5a, Zone 6, Zone 7b, and Zone 7c). The state rare Hawkweed Picris (*Picris squarrosa*) increased in abundance within the reserve and was observed in six of the management zones. This increase in native plant richness and plant life form diversity is largely the result of targeted revegetation action and weed control within the dune system. However, despite the observed decline in weed diversity, the overall weed cover and understorey biomass increased in most management zones, resulting in an overall decrease in the weed score. Consequently, the overall vegetation condition score for the assessed areas decreased in 10 of the 12 management zones. The overall vegetation condition score improved for Zone 1 (foreshore) and Zone 5a (revegetation zones) only. Although the cover of most individual weed species is relatively low within the management zones, the cumulative cover by weeds is high (low native: exotic understorey biomass) and unless this is managed, it could become problematic in the future.

A total of 23 out of the 25 priority weed species listed in the 2006 Vegetation Management Plan were observed during the 2023 vegetation assessment, including nine declared weed species. Of the declared weeds, Bridal Creeper (*Asparagus asparagoides*) was the most common and observed in eight of the management zones. The Landscape South Australia Act 2019 requires land managers to implement weed management and control any declared weed species within their properties. This suggests that the extent of weed control within the Tennyson Dunes Reserve is not currently sufficient for maintaining vegetation condition and that the management regimes implemented should be reviewed and altered to address the weed problem experienced.

The primary focus of management within the Tennyson Dunes Conservation Reserve should be the control of declared weeds and priority weed species. This is particularly true for the zones on the edge of the reserve, where neighbouring properties and gardens act as a source of weeds. A collaborative management approach with neighbouring landholders is recommended where possible, to ensure that garden species do not spread into the reserve and that highly invasive species (e.g., *Gazania sp.*) are not planted near the reserve boundary. Supplementary revegetation of native species may be beneficial but is of lower priority relative to weed control. The native species richness for most of the zones was satisfactory when compared to benchmark community values.

Other broader reserve management issues include the prevalence of rabbits and foxes within the reserve and human activity within the dunes. Extensive evidence of people walking through the dunes (and not using designated walking trails) was observed during the 2023 vegetation assessment. This foot traffic has the potential to damage vegetation, reduce ground cover and degrade the vegetation quality. It is recommended that additional controls such as fencing and signage be put in place to minimise human activity within the dunes, as current fencing does not appear to be a sufficient deterrent.

6 REFERENCES

ALA. 2022. Ardea intermedia plumifera (Plumed Egret).

Atlas of Living Australia. 2021. Species Profile: Pterostylis arenicola, Sandhill Greenhood Orchid.

Australian Museum. 2020a. Species Profile: Blue-faced Honeyeater (Entomyzon cyanotis).

Australian Museum. 2020b. Species Profile: Little Red Flying-fox.

Australian Museum. 2022. Species Profile: Cereopsis novaehollandiae. Cape Barren Goose.

Birdlife Australia. 2021. Species profile: Zanda funerea whiteae, Yellow-tailed Black Cockatoo.

Cordingley, S., and C. Petherick. 2006. Vegetation Management Plan, Tennyson Dune Reserve (Yaitya Worra). SA Urban Forest Biodiversity Program.

CSIRO. 2023. Sea Spurge.

DEH. 2009. Threatened Species Profile: Falco peregrinus, Peregrine Falcon.

DEH. 2022. Species Profile: Thinornis cucullatus cucullatus, Eastern Hooded Plover.

Department of Agriculture, Water and the Environment. 2020. Australia's bioregion – maps. Australian Government. Available from: https://www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps.

DEWNR. 2020. Threatened Species Profile: Pteropus poliocephalus, Grey-headed Flying Fox.

EAC Ecological Evaluations. 2015. Tennyson Dunes On-Ground Works Biodiversity Action Plan.

Electronic Flora of SA. 2021a. Species Profile: Acacia dodonaeifolia, Hop-bush Wattle.

Electronic Flora of SA. 2021b. Species profile: Picris squarrosa, Squat Picris.

Emma Stephens, Renee Mead, and Dr. Grainne Maguire. 2022. Monitoring Hooded Plovers on the Adelaide Coast and Fleurieu Peninsula: A summary of breeding success for the 2021/2022 season.

Hancock, J., and J. A. Kushland. 1984. The Herons Handbook. Species Profile: Egretta garzetta nigripes, Little Egret.

Landscape South Australia Hills and Fleurieu. 2023. Our Plover Coast: Restoring habitats for Hooded Plovers and other beach nesting birds.

Milne, T. 2015. Review of photopoint monitoring in the SAMDB NRM region. A report prepared for the South Australian Murray Darling Basin Natural Resources Management Board, Mount Barker.

Queensland Government. 2020. Species profile—Chelonia mydas (green turtle).

Thackway, R., and I. D. Cresswell. 1995. An interim biogeographic regionalisation for Australia: a framework for setting priorities in the National Reserves System Cooperative Program. Version 4.0. Australian Nature Conservation Agency, Reserve Systems Unit, Canberra.

T&M Ecologists. 2020. Tennyson Dunes Vegetation Condition Change Evaluation 2014-2020.

7 APPENDIX 1: BUSHRAT DATASHEET

Native Plant Life Forms	Cover Rating		
include height of flowering head & dead branches, # – life form rep'd largely by annuals not in full foliage			
Trees >15 m			
Trees 5 – 15 m			
Trees < 5m			
Mallee > 5m			
Mallee ≤ 5m			
Shrubs > 2 m			
Shrubs 0.5–2m			
Shrubs < 0.5 m			
Herbs			
Mat Plants			
Grasses >0.2m			
Grasses ≤ 0.2m			
'Sedges' > 1m			
'Sedges' ≤ 1m			
Hummock grass			
Vines,scramblers			
Mistletoe			
Ferns			
Grass-trees			
Total			

Cover Rating	
not many, cover <1%	1
Plentiful, cover <1%	1a
Covering 1 - 5%	2
Covering 6 – 25%	3
Covering 26 – 50%	4
Covering 51 – 75%	5
Covering > 75%	6

Bare Ground	
exclude soil crust, litter, exposed rock	
> 51% of site bare ground	0
26-50% bare ground	1
5–25 % bare ground	2
< 5% bare ground	3

Grazing Evidence (score 4 minus 1 for each sign below)	
heavy/severe chewing	
widespread pugging/compaction	
grazing animals observed /widespread dung &/or fur;	
active warren/stock camp	

Fallen Timber/debris (log size – that of canopy species (+ emergent species if present)				
Log diameter	None	<1 per 10 canopy trees	≥1 per 10 canopy trees	Score
Trunk sized	0	1	1	
Branch-sized	0	0.5	1	
Litter	Little or none	Sparse and/or patchy litter layer	Dense and more or less continuous litter layer	Score
Litter	0	0.5	1	

Application No: ....

Recorder/s: ....

Hollow-bearing Trees (sm hollows – <5cm, large hollows – >5cm)	
None	0
Sm hollows only	1
Large +/- sm hollows in </=5 trees/ha	2
Large +/- sm hollows in 6-10 trees/ha	3
Large +/- sm hollows in 11-20 trees/ha	4
Large +/- sm hollows in >20 trees/ha	5

Tree Health (excl. long-dead trees)	
<10% dieback	5
10-25% dieback, few branches dead	4
26-50% dieback, many branches dead	3
51-75% dieback, most branches dead +/- epicormic growth	2
76-99% dieback, most epicormic growth dead	1
100% dieback	0

Native:exotic Understorey Biomass	
include dead material if attached & recognisable as native	
% native	
91%+	10
81-90	9
71-80	8
61-70	7
51-60	6
41-50	5
31-40	4
21-30	3
11-20	2
0-10	1

Soil Type: .... Aspect: .... O/S Ave. Ht: ....

Vegetation Association Description: ....

....

'Treeless' in its natural state (refer to manual)? Y/N

NVBMU BushRAT Assessment Site: .... Date: ...... Zone: ... Datum: ...... E: .... N: .... Ph dir'n: ...

d=dominant, v=voucher, e=edge, p=planted, R=regen (perennials). For weeds, mark annuals that are not with full foliage with #

Native spp. (cover categories not required, but optional for dominants)				C	C			Weed spp. (cover category required for all)	C	C		
			Data collected using simplified/ derived method? Y/N									
			Substantial rock outcrop or cover Y/N									
			Substantial moss and/or lichen Y/N									
			Are long-dead trees present? Y/N									
			Optional tree health information: Dieback estimates species by species:									

The tables below are for data pertaining to the **site in general** (i.e. can be **external** to the surveyed quadrat, such as species only encountered when moving between quadrats. Note, weed covers are not required.

Native spp								Weed spp			

Photographs		
No.	**Description**	**Waypoint**
1	Photo representative of surveyed quadrat	

Notes (fencing/exclusions/other issues)