Sorrento Foreshore Reserve Flora Survey and Vegetation Condition Assessment

City of Joondalup

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DOCUMENT TRACKING

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Template 2.8.1

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Abbreviations

Abbreviation	Description
BAM Act	State *Biosecurity and Agriculture Management Act 2007*
BC Act	State *Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
the City	City of Joondalup
CLUSTER	Hierarchical Clustering
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy and the Environment and Water
DEC	Department of Environment and Conservation
DotEE	Department of Environment and Energy
DPIRD	Department of Primary Industries and Regional Development
DRF	Declared Rare Flora
DWER	Department of Water and Environmental Regulation
ELA	Eco Logical Australia
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Act 1999*
ESA	Environmentally Sensitive Area
FCT	Floristic Community Type
ha	hectares
IBRA	Interim Biogeographical Regionalisation for Australia
km	kilometre
KPI	Key Performance Indicator
MDS	Multi-Dimensional Scaling
mm	millimetre
m	metre
P	Priority
PEC	Priority Ecological Community
PRIMER	Plymouth Routines in Multivariate Ecological Research v6
SIMPER	Similarity Percentages
TEC	Threatened Ecological Community
TSSC	Threatened Species Scientific Committee
WA	Western Australia
WAH	Western Australian Herbarium

Abbreviation	Description
WAOL	Western Australian Organism List
WoNS	Weed of National Significance

Executive Summary

Eco Logical Australia was engaged by the City of Joondalup to undertake a Detailed and Targeted flora survey and vegetation condition assessment of Sorrento Foreshore Reserve, an area of bushland 9.88 hectares in size, located in the suburb of Sorrento, Western Australia. The information provided from the current assessment will be used to report on the change in vegetation condition in accordance with the City's endorsed Natural Area Key Performance Indicators (KPIs), and to inform an update of the existing Sorrento Foreshore Reserve Management Plan.

A previous study was completed within the survey area, totalling 8.09 hectares, by Emerge Associates in 2019, including an additional 1.65 hectares of Open Beach/Rock area. Results of the current survey were assessed against Emerge Associates findings.

The field survey was conducted in Spring from 21 to 22 September 2023, in accordance with the Environmental Protection Authority *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016).

Vegetation communities were described through the reassessment of twelve 10 x 10 metre quadrats, all of which were previously established by Emerge Associates in 2019. A Targeted flora survey was conducted to record occurrences of any conservation significant flora species and/or communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the State *Biodiversity Conservation Act 2016* or by the Department of Biodiversity, Conservation and Attractions, including Bush Forever significant flora and/or vegetation. Opportunistic flora species were also recorded across the survey area.

A Targeted weed survey was conducted to record weed species within the survey area, including mapping of City of Joondalup pest plant (Caltrop), City of Joondalup priority weed species and species listed as a Weed of National Significance or as a Declared Pest under the State *Biosecurity and Agriculture Management Act 2007*.

A total of 61 flora taxa (31 native and 30 introduced) were recorded within the survey area from quadrats and opportunistic collections, representing a 15% increase in species recorded by Emerge Associates in 2019 (53 species total; 27 native and 26 introduced; Emerge Associates 2020). No Threatened (Declared Rare) or Priority listed flora species by the Department of Biodiversity, Conservation and Attractions were recorded within the survey area. One Bush Forever significant flora species, namely *Melaleuca lanceolata* (Rottnest Teatree), was recorded from one location (one individual) within the survey area. *Melaleuca lanceolata* is listed as a Bush Forever species significant to the Perth Metropolitan Region (Government of Western Australia 2000).

A total of 30 introduced (weed) species were recorded within the survey area, representing 49.2% of the total species recorded. No introduced species recorded are listed as a WoNS or as a Declared Pest under the BAM Act. Of the 30 weed species recorded, ten are listed on the City of Joondalup priority weed list for Sorrento Foreshore Reserve. The City's declared pest plant, *Tribulus terrestris* (Caltrop), was not recorded during the current survey.

A total of four vegetation communities were delineated and mapped within the survey area, all of which are consistent with those originally described and mapped by Emerge Associates in 2019 (Emerge Associates 2020):

- Ar: Shrubland to closed shrubland of *Acacia rostellifera* with scattered shrubs *Olearia axillaris* and/or *Rhagodia baccata*;
- Sc: Heathland to low open heathland *Scaevola crassifolia* with scattered shrubs *Olearia axillaris* over scattered grassland *Spinifex longifolius* over scattered herbs *Acanthocarpus preissii*;
- ScOaAp: Heathland to open heathland *Scaevola crassifolia*, *Olearia axillaris*, *Acacia rostellifera*, *Rhagodia baccata*, *Pimelea ferruginea* and *Leucophyta brownii* over sedgeland to open sedgeland *Lepidosperma gladiatum* (or absent) over open herbland *Acanthocarpus preissii*; and
- Sl: Grassland to open grassland of *Spinifex longifolius* with scattered shrubs *Olearia axillaris* and *Scaevola crassifolia*.

Intact vegetation within the survey area comprised 4.65 hectares (47.1% of the survey area). The remaining 5.22 hectares (52.9% of the survey area) comprised Open Beach/Rocks (5.20 ha; 52.7%) and Planted (non-native) vegetation (0.02 ha; 0.2%). Vegetation Community Sl was the most widespread vegetation community recorded, covering 16.2% (1.60 hectares) of the survey area. Extent of vegetation communities recorded within the survey area remained relatively consistent since the 2019 assessment (Emerge Associates 2020), with differences accounted for in the increased survey area size (9.88 ha compared with 8.09 ha), with an additional area of 1.65 ha recorded of Open beach/Rocks.

Results of the multivariate analysis showed that quadrats within vegetation communities Sc, Ar and ScOaAp had a strong affiliation with Floristic Community Type 29a. Floristic Community Type 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community. A total of 3.05 hectares (30.9% of the survey area) was considered as representing this Priority 3 ecological community.

Quadrats within vegetation community Sl were unable to be assessed against FCTs defined by Gibson *et al*. (1994) due to poor condition and low species diversity. Quadrats within vegetation community Sl are qualitatively likely to represent Supergroup 4: S14: *Spinifex longifolius* grassland and low shrublands, based on the dominance of *Spinifex longifolius*, location (Quindalup South System) and landform (foredunes; Keighery *et al*. 2012; Government of Western Australia 2000).

Vegetated areas within the survey area accounted for 4.65 hectares (47.1% of the survey area) and ranged from Good to Very Good condition, based on the Keighery (1994) vegetation scale provided in the Environmental Protection Authority *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). Majority of the survey area was observed to be in Very Good condition (4.02 hectares; 40.7% of the survey area). Vegetation condition within the survey area has remained relatively consistent since the 2019 assessment (Emerge Associates 2020), with majority of the survey area recorded in Very Good (3.98 ha; 49.45%) and Good (0.51 ha; 6.3%) condition by Emerge Associates (Emerge Associates 2020).

No fungi species were recorded within the survey area. A total of 11 fauna species (10 native; one pest species) were recorded opportunistically within the survey area, comprising nine birds, one

mammal and one reptile. No conservation significant fauna species were recorded within the survey area during the field survey. One introduced fauna species were recorded during the field survey, namely European Rabbit (*Oryctolagus cuniculus*), recorded from secondary signs (scats).

Based on results of the current survey, the following recommendations have been made to assist in the conservation of native flora, vegetation and environmental values present within Sorrento Foreshore Reserve:

- Continue long-term monitoring of weed populations within the survey area. Implement weed control, particularly for City of Joondalup priority weeds. Concentrate weed control activities along track edges and boundaries between remnant bushland and cleared areas.
- Prioritise maintenance of the vegetation at Sorrento Foreshore Reserve due to the presence of the Floristic Community Type 29a Priority 3 Ecological Community.
- It is recommended to continue monitoring for evidence of pathogens, and to maintain correct hygiene practices within the survey area.
- It is recommended to monitor the dumping of rubbish and remove where necessary.
- It is recommended to limit uncontrolled access to the dunes (establish/repair fencing where necessary), and to clearly mark authorised tracks to reduce the risk of dune disturbance.
- Continue dune stabilisation works (e.g., planting, matting) to reduce erosion, where required.
- Undertake feral animal control for rabbits within the survey area to reduce grazing pressure and risks to revegetation works.

1. Introduction

1.1. Project background

Eco Logical Australia (ELA) was engaged by the City of Joondalup (the City) to undertake a Detailed and Targeted flora survey and vegetation condition assessment of Sorrento Foreshore Reserve, an area of 9.88 hectares (ha; the survey area) in size located in Sorrento, approximately 20 kilometres (km) north of Perth, Western Australia (WA; **Figure 1**). Sorrento Foreshore Reserve is a conservation area within the City of Joondalup with high biodiversity values, vested with and managed by the City.

Information provided from the current assessment will be used to report on the change in vegetation condition in accordance with the City's endorsed Natural Area Key Performance Indicators (KPIs), and to inform an update of the existing Sorrento Foreshore Reserve Management Plan (City of Joondalup 2015). The most recent ecological surveys were undertaken by Emerge Associates in 2019 (Emerge Associates 2020).

More specifically, the objectives of this survey include:

- An assessment of flora and vegetation communities in accordance with the Environmental Protection Authority (EPA) *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016);
- Undertake a vegetation condition assessment using the Keighery vegetation condition scale (1994; EPA 2016);
- A Targeted survey for State, Federal and/or Department of Biodiversity, Conservation and Attractions (DBCA) conservation significant flora, including Bush Forever significant flora and/or vegetation;
- An assessment to verify if the vegetation meets the requirements specified in the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) 'Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community', using the four-stage assessment process itemised in the Approved Conservation Advice (Threatened Species Scientific Committee [TSSC] 2016);
- An assessment to verify if the vegetation meets the requirement specified in the Department of Environment and Energy (DotEE; recently updated to be the Department of Climate Change, Energy and the Environment and Water [DCCEEW]) 'Approved Conservation Advice (incorporating listing advice) for the Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community' using the assessment process outlines in the Conservation Advice (DotEE 2019a);
- [1]An assessment to verify if the vegetation meets the requirements specified in the Commonwealth EPBC Act '*Approved Conservation Advice for Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion*' using the assessment process outlines in the Conservation Advice (Department of Climate Change, Energy, the Environment and Water [DCCEEW] 2023);

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[1] It is noted that the Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion was listed as a TEC in effect under the EPBC Act 1999 from 15 November 2023, and as such has been included in the assessment retrospectively.

- Record and map all weed species encountered including State, Federal (Weed of National Significance [WoNS], Declared Pests listed under the State *Biosecurity and Agriculture Management Act 2007* [BAM Act]), City of Joondalup pest plant and/or priority weeds in the City of Joondalup (priority species list provided by the City);
- Record opportunistic sightings of fauna (including invertebrates) and fungi during the flora survey, in particular fauna species of State or Federal conservation significance; and
- Make recommendations to conserve biodiversity values.

Figure 1: Survey area location

☐ Survey Area

N

0	100	200		400

Metres
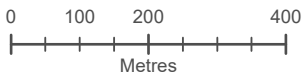
Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 5/12/2023

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2. Environmental setting

2.1. Regional context

Broad environmental values for the region relevant to the survey area are presented in **Table 1**.

Table 1: Environmental values of the region

Existing environmental attributes	Survey area
Interim Biogeographical Regionalisation for Australia (IBRA) Bioregion (Department of Agriculture, Water and the Environment [DAWE] 2023)	Swan Coastal Plain (SWA)
IBRA Subregion (DAWE 2023)	Perth (SWA02)
Geology, landform and soils (Department of Primary Industries and Regional Development [DPIRD] 2023a)	**Quindalup South System**: Coastal dunes, of the Swan Coastal Plain, with calcareous deep sands and yellow sands. Coastal scrub.
Beard's (1975) vegetation mapping	**Spearwood 998**: Medium woodland; tuart (36.35% remaining in the Perth sub-region; Government of Western Australia 2019). **Guilderton 1007**: Mosaic: Shrublands; _Acacia lasiocarpa_ & _Melaleuca acerosa_ heath / Shrublands; _Acacia rostellifera_ & _Acacia cyclops_ thicket (68.68% remaining in the Perth sub-region; Government of Western Australia 2019).

3. Methodology

3.1. Desktop review

3.1.1. Database searches and literature review

The following State databases were searched for information relating to conservation listed flora and ecological communities in order to compile and summarise existing data to inform the field survey. Database searches undertaken around the central coordinate 381195 metres (m) E; 6477878 N are presented in **Table 2**. Applied buffers below are considered suitable based on flora and fauna assemblages expected to occur within the survey area.

Table 2: Database searches undertaken for the survey area

Database	Reference	Buffer (km)
DBCA Threatened and Priority flora database searches for Declared Rare Flora (DRF) listed under the latest WA Wildlife Conservation (Rare Flora) Notice and Priority Flora.	DBCA 2023a	10
DBCA Threatened and Priority Ecological Communities' database search.	DBCA 2023b	10
DPIRD Western Australian Organism List (WAOL)	DPIRD 2023b	-
Department of Water and Environmental Regulation (DWER) Environmentally Sensitive Area (ESA) Database	DWER 2023	-

In addition, the following documents were also reviewed:

- *Flora and Vegetation Condition Assessment Sorrento Foreshore Reserve* (Emerge Associates 2020); and
- *Sorrento Coastal Foreshore Reserve Management Plan* (City of Joondalup 2015).

3.2. Field survey

3.2.1. Survey team and timing

A Detailed and Targeted flora and vegetation survey was conducted by Jeff Cargill (Principal Botanist), Jeni Morris (Ecologist) and Maitland Ely (Graduate Ecologist) from 21 to 22 September 2023. The survey team's relevant qualifications, experience and licences are provided in **Table 3** below.

A total of 36.8 millimetres (mm) of rainfall was recorded from the nearby Bureau of Meteorology (BoM) Wanneroo weather station (station number 9105; rainfall data 1905-present; located approximately 12 km north-northeast of the survey area) during the field survey (BoM 2023). In the three months prior to the field survey (June to August), a total of 364.1 mm of rainfall was recorded, which is less than the long-term average for the same period (445 mm; BoM 2023). Survey conditions during the field survey were considered suitable, with the majority of species in various stages of reproduction (e.g., flowering, seeding, fruiting), allowing for positive identification of both common and cryptic species.

Table 3: Survey team

Name	Qualification	Relevant experience	Licenses
Dr. Jeffry Cargill	BSc. Hons. PhD Environmental Sciences	Jeff has extensive experience in botanical and ecological studies throughout Western Australia including baseline vegetation studies (Reconnaissance and Detailed surveys), Targeted threatened and priority flora surveys, fauna and black cockatoo surveys, MNES surveys and rehabilitation and vegetation monitoring programs.	Flora Taking (Biological Assessment) Licence number: FB62000138-2 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 2223-0115
Jeni Morris	BSc. Conservation and Wildlife Biology	Jeni has completed several flora and vegetation surveys on the Swan Coastal Plain and within the City of Joondalup including at Shepherd's Bush Reserve, Iluka-Burns Beach Coastal Reserve, Warwick Open Space, Craigie Bushland Reserve and Yellagonga Regional Park.	Flora Taking (Biological Assessment) Licence number: FB62000070-2 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 178-2122
Maitland Ely	BSc. Conservation Biology and Botany	Maitland joined ELA as a Graduate Environmental Scientist in 2020. He has experience undertaking Baseline and Targeted flora and vegetation survey and Basic and Detailed fauna survey in Western Australia.	Flora Taking (Biological Assessment) Licence number: FB62000455

3.3. Flora and vegetation survey

A Detailed and Targeted flora and vegetation survey was conducted in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). A total of twelve 10 m x 10 m existing quadrats, established by Emerge Associates in 2019 (Emerge Associates 2020), were re-sampled during the current survey (**Figure 2**).

Stainless steel fence droppers were used to permanently mark the north-west corner of each quadrat, where not already present. Dominant vegetation communities were described, with respect to dominant species, structure and overall condition. The survey involved the use of 10 x 10 m quadrats as recommended for the Swan Coastal Plain bioregion (EPA 2016). Opportunistic sampling of species not recorded within the quadrats was undertaken to supplement the existing list of species recorded from within the survey area.

Photos were taken from the same position as those undertaken by Emerge Associates (Emerge Associates 2020). The following data was recorded within each quadrat:

- Site details (site name, site number, observers, date and location);
- Environmental information including landform, soil type and colour, bare ground and leaf litter cover, rock outcropping and time since last fire event; and
- Biological information including vegetation structure, vegetation condition in accordance with Keighery (1994), degree of disturbance, species present and species percentage cover.

A Targeted survey was completed within the survey area to identify any conservation significant flora or communities potentially occurring, including:

- Threatened flora or Threatened Ecological Communities (TECs) listed under the EPBC Act;
- Threatened (Declared Rare) Flora listed under the latest WA Wildlife Conservation (Rare Flora) Notice under the State *Biodiversity Conservation Act 2016* (BC Act);
- Priority Ecological Communities (PECs) endorsed by the Western Australian Minister for the Environment;
- Priority (P) flora recognised by DBCA; and
- Bush Forever significant flora and/or vegetation (Government of Western Australia 2000).

The survey methodology involved personnel conducting traverses across the survey area, with lined spaced (on average) 5-30 m apart depending on factors such as habitat type, disturbance (e.g., tracks) and landform. Locations of survey transects are shown in **Figure 2** below. Flora species able to be identified in the field were recorded, and voucher specimens of unfamiliar species were collected for later identification. All collections were assigned a unique collecting number. For conservation significant flora species identified in the field, the following was recorded:

- A colour photograph;
- GPS location;
- Population size estimate;
- Location of population boundaries;
- Associated habitat/landscape element;
- Time and date observed;
- Observer details; and
- A voucher specimen suitable for use as a reference specimen (if appropriate to do so for conservation significant flora).

3.4. Weed survey and mapping

The survey area was surveyed and mapped for State, Federal and/or Priority weeds as specified by the City of Joondalup, including all WoNS, Declared Pests listed under the BAM Act and City of Joondalup declared pest plants. The City of Joondalup *Priority Weed List for Sorrento Foreshore Reserve* is provided in **Table 4**.

For each priority weed species, including WoNS and/or Declared Pest species encountered, a GPS location coordinate was recorded using points for individual plants or polygons for populations. Weed data was collected in accordance with the DBCA (previously Department of Environment and Conservation [DEC]) Standard Operating Procedure 22.1 *Techniques for mapping weed distribution and cover in bushland and wetlands* (DEC 2011).

Table 4: City of Joondalup Priority weed species list for Sorrento Foreshore Reserve

Species (Common Name)	Ranking^
Avena barbata (Wild Oats)	Permitted – s11
Cakile maritima (Sea Rocket)	Permitted – s11
Conyza sp. (Fleabane)	Permitted – s11
Ehrharta calycina (Perennial Veldt Grass)	Permitted – s11
Ehrharta longiflora (Annual Veldt Grass)	Permitted – s11
Euphorbia paralias (Sea Spurge)	Permitted – s11
Euphorbia terracina (Geraldton Carnation Weed)	Permitted – s11
Fumaria capreolata (Fumitory)	Permitted – s11
Oxalis pes-caprae (Soursob)	Permitted – s11
Pelargonium capitatum (Rose Pelargonium)	Permitted – s11
Tetragonia decumbens (Sea Spinach)	Permitted – s11
Thinopyrum distichum (Sea Wheat)	Permitted – s11
Trachyandra divaricata (Onion weed)	Permitted – s11

Note: * refers to an introduced species.
^ DPIRD Western Australian Organism List (DPIRD 2023b)

3.5. Data analysis

3.5.1. Flora species accumulation curve

A flora species accumulation curve was undertaken to indicate adequacy of the survey effort (Clarke and Gorley 2006). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence-based coverage estimator of species richness. When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered adequate.

3.5.2. Vegetation communities

Plymouth Routines in Multivariate Ecological Research v6 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites based on their species composition (Clarke and Gorley 2006). A presence/absence transformation was applied to the dataset to align with Gibson *et al.* (1994). Introduced species (weeds), specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component) were excluded from the data set prior to analysis. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Data were analysed using a series of multivariate analysis routines including Hierarchical Clustering (CLUSTER) and Similarity Percentages (SIMPER). Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities.

Previously assigned vegetation mapping codes and descriptions (Emerge Associates 2020) were validated and retained during the current assessment to maintain consistency between survey periods.

A Threatened and Priority Ecological Community (TEC/PEC) Occurrence Report Form was completed and submitted for all TECs and PECs identified within the survey area.

3.5.2.1. FCT analysis

Species within the Gibson *et al*. (1994) data set were updated to align with current names as specified by FloraBase (DBCA and Western Australian Herbarium [WAH] 2023). Using current records, several species in the Gibson *et al*. (1994) data set were shown to be significant range extensions from the Swan Coastal Plain, where appropriate such cases were removed. Excluded and misapplied names were removed from the data set and infra-specific names were reduced. The merged dataset was analysed using a combination of pre-treatments such as the inclusion and/or removal of introduced species and singletons. The removal of singletons from the merged dataset, an accepted pre-treatment for such analysis, produced the best results (e.g., stronger correlations; Clarke and Gorley 2006). Inclusion of such data merely served to confound the dataset by introducing stochastic and 'site' artefact data. Transformed data were analysed using a combination of multivariate analysis routines including Bray-Curtis Similarity Matrices, single insertion Cluster Analysis (Flexible Beta) and Multi-Dimensional Scaling (MDS).

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to Floristic Community Types (FCTs) defined by Gibson *et al*. (1994). To identify the presence of FCT's appropriate multivariate analyses comparing current data to that of Gibson *et al*.

(1994) species by quadrat data, and inferences based on dominant species and geomorphology were used. Given the nature of the data (e.g., spatial and temporal differences), results and subsequent extrapolations, assigned FCT's within the survey area were inferred and not absolute, i.e., a vegetation code assigned to an FCT was inferred to comprise, to varying degrees, floristic aspects of that FCT as defined by Gibson *et al.* (1994). These FCTs were subsequently compared with vegetation communities delineated by ELA.

3.5.2.2. Assessment of diagnostics to assess presence of Threatened Ecological Communities

The 'Banksia Woodlands of the Swan Coastal Plain' TEC is listed as Endangered under the EPBC Act (TSSC 2016). For information to assist in referral, environmental assessment and compliance issues, it has been recommended to refer to the Listing Advice and/or Conservation Advice and Recovery Plan on the DotEE Species Profile and Threats Database (TSSC 2016). The Listing Advice and/or Conservation Advice defines the national ecological community and includes key diagnostic characteristics, condition thresholds and additional considerations (TSSC 2016).

In order to determine whether the 'Banksia Woodlands of the Swan Coastal Plain' TEC is present in the survey area key diagnostic characteristics must be met under Section 2 of the Conservation Advice (TSSC 2016). The four-stage assessment identified by DotEE to ascertain the presence of the Banksia Woodlands endangered ecological community within the site was undertaken by ELA following the field survey.

The 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' ecological community is listed as Critically Endangered under the EPBC Act (DotEE 2019). For information to assist in referral, environmental assessment and compliance issues, it has been recommended to refer to the Listing Advice and/or Conservation Advice on the DotEE Species Profile and Threats Database (DotEE 2019). The Listing Advice and/or Conservation Advice defines the national ecological community and includes key diagnostic characteristics, condition thresholds and additional considerations (DotEE 2019a).

In order to determine whether the 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC is present in the survey area key diagnostic characteristics must be met under Section 3.2 of the Conservation Advice (DotEE 2019). The assessment identified by DotEE to ascertain the presence of the Tuart (*Eucalyptus gomphocephala*) Woodlands endangered ecological community within the site was undertaken by ELA following the field survey.

3.6. Flora identification and nomenclature

Flora specimen identification was undertaken by ELA Principal Botanist Jeff Cargill. Species identification utilised taxonomic literature and keys and where required specimens were confirmed using the WAH collection. Where considered appropriate, specimens that meet WAH specimen lodgement requirements (e.g., Threatened and Priority Flora, range extensions), will be submitted along with Threatened and Priority Report forms to DBCA. Nomenclature used for the flora species within this report follows the WA Plant Census as available on FloraBase (DBCA and WAH 2022).

3.7. Limitations

The EPA *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) recommends including discussion of the constraints and limitations of the survey methods used.

Constraints and limitations for the Detailed and Targeted flora and vegetation for the survey area are summarised in **Table 5** below. No survey limitations were identified.
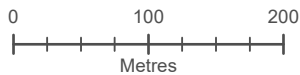
Table 5: Survey limitations

Constraint	Limitations
Sources of information	**Not a constraint**: The Swan Coastal Plain has been well surveyed, with increasing survey work occurring due to the ongoing urban development of the Perth metropolitan area. Several flora surveys have been undertaken in the region which have been utilised for the purposes of this survey. Gibson *et al.* 1994 was a primary source for determination of methods, analysis and results for assessing FCTs. Broad-scale vegetation mapping at a scale of 1:1,000,000 was available. Land system mapping at a scale of 1:2,000,000 and soil and landform mapping was also available. The information which was available was sufficient and as such sources of information were not considered a major limitation.
Scope of work	**Not a constraint:** The survey requirement for a Detailed and Targeted flora and vegetation survey in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) was adequately met.
Completeness of survey	**Not a constraint:** The area was surveyed to the satisfaction of the scope and a Detailed and Targeted flora and vegetation survey as per relevant guidelines.
Intensity of survey	**Not a constraint:** Survey effort was considered adequate to meet objectives of the scope. The area was surveyed for conservation significant flora species and vegetation communities by field staff undertaking transects across the survey area spaced 5-30 m apart on average. This method provided an accurate assessment of habitat characteristics and likelihood of conservation significant species. The number of quadrats established was sufficient to determine the vegetation communities present and to identify any vegetation of conservation significance. Adequacy of the current sampling effort was tested via a species accumulation curve; approximately 87% of the flora potentially present within the survey area were recorded, not including the additional 20 species collected opportunistically during the field survey.
Timing, weather, season, cycle	**Not a constraint:** The survey area is located in the Swan Coastal Plain bioregion of Western Australia. Recommended survey timing for this region is in spring (September – November; EPA 2016). The field survey was undertaken at the beginning of September, with only slightly less than average rainfall recorded in the three months preceding the field survey (BoM 2023). Many flora species were flowering at the time of the field survey or had sufficient material (fruit) available to identify the dominant and target species. All flora species of conservation significance identified from the desktop assessment flower during the field survey period (September -November) or are conspicuous shrubs/trees (e.g., *Eucalyptus foecunda* subsp. *foecunda*) and would likely have been seen within the survey area had they been present. The timing was appropriate for conducting this level of survey.
Disturbances	**Not a constraint:** Disturbances within the survey area included the presence of weeds, grazing and edge effects. These disturbances did not negatively impact the ability to meet objectives outlined in the scope of works.
Resources	**Not a constraint:** The personnel conducting this field survey were suitably qualified to identify specimens, having previously undertaken flora and vegetation assessments on the Swan Coastal Plain, including in several reserves for the City of Joondalup.
Accessibility	**Not a constraint:** All relevant areas of the survey area were easily accessed and able to be surveyed.

Figure 2: Survey effort

Survey Area
Quadrat
Traverse

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 18/12/2023

0   100   200
Metres

N

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4. Results

4.1. Desktop review

4.1.1. Conservation significant flora species and ecological communities

A DBCA Threatened and Priority Flora and Ecological Communities' database search was undertaken to identify conservation significant flora species and communities recorded within, or nearby to, the survey area (current and historic). Additional documents reviewed included:

- *Flora and Vegetation Condition Assessment Sorrento Foreshore Reserve* (Emerge Associates 2020); and
- *Sorrento Coastal Foreshore Reserve Management Plan* (City of Joondalup 2015).

A total of 11 flora species of conservation significance were identified from the desktop assessment occurring within a 10 km radius of the survey area, including one species listed as Endangered (EN) under the EPBC Act and BC Act, and 10 species listed as Priority flora by DBCA. Of these, none have been previously recorded within the survey area:

- *Marianthus paralius* (listed as EN under the EPBC Act and BC Act);
- *Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425; listed as P1 by DBCA);
- *Grevillea* sp. Ocean Reef (D. Pike Joon 4; listed as P1 by DBCA);
- *Leucopogon maritimus* (listed as P1 by DBCA);
- *Acacia benthamii* (listed as P2 by DBCA);
- *Austrostipa mundula* (listed as P3 by DBCA);
- *Conostylis bracteata* (listed as P3 by DBCA);
- *Pimelea calcicola* (listed as P3 by DBCA);
- *Stylidium paludicola* (listed as P3 by DBCA);
- *Eucalyptus foecunda* subsp. *foecunda* (listed as P4 by DBCA); and
- *Jacksonia sericea* (listed as P4 by DBCA).

Of the 11 flora species of conservation significance were identified from the desktop assessment,

A total of eight conservation significant ecological communities were identified as occurring within a 10 km radius of the survey area (DBCA 2023b), none of which intersect with the survey area (**Table 6**).

Conservation codes, categories and criteria for flora and fauna protected under the EPBC Act and the BC Act are provided in **Appendix A**.

Table 6: Conservation significant ecological communities occurring within, or in proximity to, the survey area (DBCA 2023b)

Community ID	Community description	Ranking (Federal)	Ranking (State)
Tuart woodlands	Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain	CR	P3
SCP20a	*Banksia attenuata* woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson *et al*. 1994)	EN	CR
Banksia WL SCP	Banksia Woodlands of the Swan Coastal Plain ecological community	EN	P3
SCP30a	*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands of the Swan Coastal Plain (floristic community type 30a as originally described in Gibson et al. 1994)	-	BR
SCP29b	Acacia shrublands on taller dunes	-	P3
SCP29a	Coastal shrublands on shallow sands	-	P3
SCP24	Northern Spearwood shrublands and woodlands	-	P3
SCP25	Southern *Eucalyptus gomphocephala-Agonis flexuosa* woodlands	-	P3
*Honeymyrtle shrubland	Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion	CR	CR

*It is noted that the Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion was listed as a TEC in effect under the EPBC Act 1999 from 15 November 2023, and as such has been included in the desktop assessment retrospectively.

4.1.2. Expected flora assemblages

A summary of the number of flora species (native and introduced) previously recorded from within Sorrento Foreshore Reserve is provided in **Table 7** below.

Table 7: Summary of flora species and conservation significant species recorded within Sorrento Foreshore Reserve from previous studies

Study	Number of species			Number of quadrats established	Conservation significant species/communities recorded
	Native	Introduced	Total		
City of Joondalup (NACMS) 2015	21	24	45	N/A	Nil
Emerge Associates (2020)	27	26	53	12	Bush Forever significant species: *Melaleuca lanceolata*

4.2. Flora and vegetation

4.2.1. Flora overview

A total of 61 taxa (31 native and 30 introduced taxa) from 51 genera and 27 families were recorded across twelve 10 m x 10 m quadrats established within the survey area (41 taxa), and from opportunistic collections (20 taxa). Average species richness per quadrat was 15.5 species, ranging from a low of 10 species at Q8 and Q9 to a high of 25 species at Q6. Families with the highest number of species included Poaceae (10 species) and Asteraceae (10 species). *Acacia* was the best represented genus throughout the survey area with three taxa recorded. No orchid species were recorded during the field survey. A flora species list is provided in **Appendix B** and a site by species matrix is provided in **Appendix C**. Quadrat site data is presented in **Appendix D**.

4.2.2. Accumulates species – site surveyed (species-area curve)

A species accumulation curve (**Figure 3**) was used to evaluate the adequacy of sampling (Clarke and Gorley 2006). Only species data recorded from defined quadrats were used; no opportunistic flora collections were included. The asymptotic value was determined using Michaelis Menten modelling. Using this analysis, the incidence-based coverage estimator of species richness was calculated to be 47.2. Based on this value, and the total of 41 species recorded within quadrats, approximately 86.9% of the flora species potentially present within the survey area were recorded. This result, in addition to a total of 20 opportunistic collections, indicates that the majority of flora potentially present within the survey area were recorded.
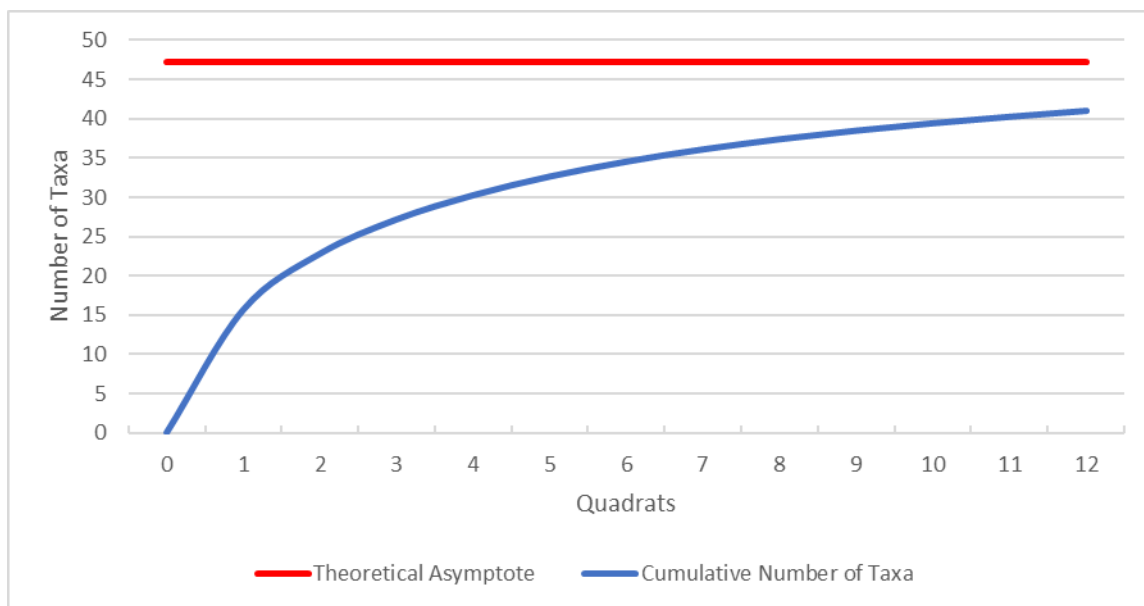
Figure 3: Average randomised species accumulation curve

4.2.3. Conservation and Bush Forever significant flora

No Threatened or Priority flora species listed under the EPBC Act, the BC Act or by DBCA were recorded within the survey area. One Bush Forever significant species was recorded within the survey area, namely *Melaleuca lanceolata* (Rottnest Island Teatree), recorded from one location (one individual; **Figure 4**).

4.2.4. Introduced flora

A total of 30 introduced (weed) species were recorded within the survey area, representing 49.2% of the total species recorded. No introduced species recorded are listed as a WoNS or as a Declared Pest under the BAM Act.

Of the 30 weed species recorded, ten are listed on the City of Joondalup priority weed list for Sorrento Foreshore Reserve (**Table 8**). The City's declared pest plant, *Tribulus terrestris* (Caltrop), was not recorded during the current survey. Locations of City of Joondalup priority weeds recorded within the survey area are presented in **Appendix E**. .

Table 8: CoJ Priority weed species recorded within Sorrento Foreshore Reserve

Species	Common Name	Ranking
Avena barbata	Wild oats	-
Cakile maritima	Sea rocket	-
Oxalis pes-caprae	Soursob	-
Ehrharta longiflora	Annual veldt grass	-
Euphorbia paralias	Sea spurge	-
Euphorbia terracina	Geraldton Carnation Weed	-
Fumaria capreolata	Whiteflower fumitory	-
Pelargonium capitatum	Rose pelargonium	-
Tetragonia decumbens	Sea spinach	-
Trachyandra divaricata	Dune onion weed	-

4.2.5. Vegetation communities

A total of four vegetation communities were delineated and mapped within the survey area (**Appendix F**). Where relevant, vegetation codes previously assigned by Emerge Associates (2020) were validated during the current analysis and subsequently retained for consistency purposes.

Vegetation communities are described in **Table 9** and presented in **Figure 5** below. Intact vegetation within the survey area comprised 4.65 hectares (47.1% of the survey area), with the remaining 5.22 hectares (52.9% of the survey area) comprising 'Open Beach/Rocks' (5.20 ha; 52.7%) and 'Planted' (non-native) vegetation (0.02 ha; 0.2%). A comparison of vegetation communities between the current survey and those recorded by Emerge Associates is presented in **Table 9**. Extent of vegetation communities recorded within the survey area has remained relatively consistent since the 2019 assessment (Emerge Associates 2020), with minor differences accounted for in the increased survey area size (9.88 ha compared with 8.09 ha). Vegetation community ScOaAp has decreased in size from 0.82 ha (Emerge Associates 2020) to 0.79 ha, following refinement of vegetation community boundaries during the current assessment.

Table 9: Vegetation communities recorded within the survey area

Image	Vegetation community	Vegetation description	Quadrats	Emerge Associates 2020		ELA 2023	
				Extent (ha)	Proportion (%)	Extent (ha)	Proportion (%)
	Ar	Shrubland to closed shrubland of *Acacia rostellifera* with scattered shrubs *Olearia axillaris* and/or *Rhagodia baccata*	Q2, Q3, Q4	0.83	10.26	0.90	9.1
	Sc	Heathland to low open heathland *Scaevola crassifolia* with scattered shrubs *Olearia axillaris* over scattered grassland *Spinifex longifolius* over scattered herbs *Acanthocarpus preissii*	Q1, Q10, Q11	1.34	16.56	1.36	13.8

Image	Vegetation	Vegetation description	Quadrats	Emerge Associates 2020		ELA 2023	
	ScOaAp	Heathland to open heathland *Scaevola crassifolia*, *Olearia axillaris*, *Acacia rostellifera*, *Rhagodia baccata*, *Pimelea ferruginea* and *Leucophyta brownii* over sedgeland to open sedgeland *Lepidosperma gladiatum* (or absent) over open herbland *Acanthocarpus preissii*	Q5, Q6, Q12	0.82	10.14	0.79	8.0
	Sl	Grassland to open grassland of *Spinifex longifolius* with scattered shrubs *Olearia axillaris* and *Scaevola crassifolia*	Q7, Q8, Q9	1.52	18.79	1.60	16.2
Open Beach/Rocks				3.55	43.88	5.20	52.7
Planted (non-native) vegetation				0.03	0.37	0.02	0.2
Total				**8.09**	**100**	**9.88**	**100.0**

4.2.6. Conservation significant ecological communities

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994). Results of this analysis are shown below in **Table 10**.

Results of the multivariate analysis showed that quadrats within vegetation community Sc had a moderate affiliation with FCT 29a. This community, covering a total area of 1.36 ha (13.8% of the survey area), was considered to represent floristic aspects of FCT 29a (**Figure 6**). FCT 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community (DBCA 2023b). These results are consistent with Emerge Associates (2020), who determined that vegetation community Sc represents FCT 29a (1.34 ha; 16.56% of the survey area; Emerge Associates 2020).

Quadrats within vegetation community Ar had a moderate to weak affiliation with FCT 29a. This community, covering a total area of 0.90 ha (9.1% of the survey area), is considered as representing floristic aspects of the FCT 29a (listed as P3 by DBCA; **Figure 6**). These results are consistent with Emerge Associates (2020), who determined that vegetation community Ar represents FCT 29a (0.83 ha; 10.26% of the survey area; Emerge Associates 2020).

Quadrats within vegetation community ScOaAp had a moderate affiliation with FCT 29a and, to a lesser extent, FCT 29b. FCT 29b, described as '*Acacia* shrublands on taller dunes, southern Swan Coastal Plain, dominated by *Acacia* shrublands or mixed heaths on the larger dunes' (DBCA 2023b). This community, covering a total area of 0.79 ha (8.0% of the survey area), is considered as representing floristic aspects of the FCT 29a (listed as P3 by DBCA; **Figure 6**). These results are consistent with Emerge Associates (2020), who determined that vegetation community ScOaAp represents FCT 29a (0.82 ha; 10.14% of the survey area; Emerge Associates 2020).

Quadrats within vegetation community Sl were unable to be assessed against FCTs defined by Gibson *et al*. (1994) due to poor condition and low species diversity. Qualitatively, quadrats within vegetation community Sl are likely to represent FCT S14: *Spinifex longifolius* grassland and low shrublands, based on species, location and landform (Keighery *et al*. 2012). These results are consistent with Emerge Associates (2020), who determined that vegetation community Sl represents FCT S14 (1.52 ha; 18.79% of the survey area; Emerge Associates 2020).

A graphical representation of relationships between ELA vegetation communities and Floristic Community Types (FCTs) defined by Gibson *et al*. (1994) is shown in **Appendix G**.

Table 10: Relationships between ELA vegetation communities and FCTs defined by Gibson et al. (1994)

ELA Vegetation Community	ELA Quadrat	Gibson site	FCT	%Bray-Curtis Similarity
Sc	Q1	BURN-2	29a	34.1
		PRES-1	29a	15.4
	Q10	BURN-2	29a	35
	Q11	BURN-2	29a	26.3
Ar	Q2	PRES-1	29a	26.3
		BURN-2	29a	21.8
		TRIG-1	29b	25
	Q3	PRES-1	29a	25.6
	Q4	PRES-1	29a	16.2
		NAVB-1	16	18.3
Sl	Q7	n/a	n/a	n/a
	Q8	n/a	n/a	n/a
	Q9	n/a	n/a	n/a
ScOaAp	Q5	TRIG-2	29a	34.8
	Q6	TRIG-1	29b	36.7
		PRES-1	29a	25.5
	Q9	PRES-1	29a	19.5
		TRIG-1	29b	32.6

4.2.6.1. Banksia Woodlands of the Swan Coastal Plain TEC diagnostic

Vegetation within the survey area does not represent the Banksia Woodlands of the Swan Coastal Plain TEC, due to there being no *Banksia* tree species recorded. As such, the full assessment for this TEC, as outlined in the approved conservation advice (TSSC 2016), was not completed.

4.2.6.2. Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain TEC diagnostic

Vegetation within the survey area does not represent the Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC, due to there being no *E. gomphocephala* recorded. As such, the full assessment for this TEC, as outlined in the approved conservation advice (DotEE 2019), was not completed.

4.2.6.3. Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion TEC diagnostic

It is noted that the Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion was listed as a TEC in effect under the EPBC Act 1999 from 15 November 2023 (post-field survey). As such, an assessment against diagnostic characteristics listed in the approved conservation advice (DCCEEW 2023), was not completed. In WA the nationally defined Honeymyrtle shrubland ecological community is typically identified and mapped as FCT 26a *Melaleuca huegelii – M. systena* shrublands of limestone ridges (Gibson 1994; DCCEEW 2023). Vegetation within the survey area is not considered as likely representing the TEC, due to there being no vegetation dominated by *Melaleuca huegelii* (chenille honeymyrtle), and/or *M. systena* (coastal honeymyrtle), and/or *Banksia sessilis* (parrot bush), and due to FCT analysis of the patch finding no affiliation with FCT 26a.

4.2.7. Vegetation condition

Vegetated areas within the survey area accounted for 4.65 hectares (47.1% of the survey area) and ranged from Good to Very Good condition, based on the Keighery (1994) vegetation scale provided in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). Majority of the survey area was observed to be in Very Good condition (4.02 hectares; 40.7%

of the survey area). Disturbances within the survey area included the presence of weeds, edge effects (lesser condition) adjacent to tracks/cleared areas and minor rubbish dumping.

A comparison of vegetation condition between the current survey and those recorded by Emerge Associates is presented in **Table 11**. Vegetation condition within the survey area has remained relatively consistent since the 2019 assessment (Emerge Associates 2020), with majority of the survey area recorded in Very Good (3.98 ha; 49.45%) and Good (0.51 ha; 6.3%) condition by Emerge Associates (Emerge Associates 2020). Vegetation condition within the survey area is presented in **Figure 7** below. Vegetation condition per vegetation community is presented **Table 12** and **Figure 8**.

Table 11: Vegetation condition within the survey area in 2023 compared to vegetation condition recorded by Emerge Associates (Emerge Associates 2020)

Vegetation condition	Emerge Associates 2020		Current assessment (2023)*	
	Total area (ha)	Proportion of the survey area (%)	Total area (ha)	Proportion of the survey area (%)
Pristine	0.00	0.00	0.00	0.00
Excellent	0.00	0.00	0.00	0.00
Very Good	3.98	49.45	4.02	40.7
Good	0.51	6.30	0.64	6.5
Degraded	0.00	0.00	0.00	0.00
Completely Degraded	0.03	0.37	0.00	0.00
Total vegetated areas	**4.52**	**56.12**	**4.65**	**47.1**
Other (tracks, open beach, cleared areas)	3.55	43.88	5.22	**52.90**
Total survey area	**8.07**	**100.00**	**9.88**	100.00

*Totals are subject to rounding errors of 0.01-0.1

Table 12: Vegetation condition per community within the survey area

Vegetation community	Vegetation Condition ha (% of total of vegetation community)						
	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded	Total ha (%)
Ar	0.00 (0)	0.00 (0)	0.90 (100)	0.00 (0)	0.00 (0)	0.00 (0)	0.90 (100)
Sc	0.00 (0)	0.00 (0)	1.34 (98.4)	0.02 (1.6)	0.00 (0)	0.00 (0)	1.36 (100)
ScOaAp	0.00 (0)	0.00 (0)	0.79 (100)	0.00 (0)	0.00 (0)	0.00 (0)	0.79 (100)
Sl	0.00 (0)	0.00 (0)	0.98 (61.5)	0.62 (38.5)	0.00 (0)	0.00 (0)	1.60 (100)

*Totals are subject to rounding errors of 0.01-0.1

4.3. Fungi

No fungi species were recorded within the survey area.

4.4. Fauna

A total of 11 fauna species (10 native; one pest species) were recorded opportunistically within the survey area, comprising nine birds, one mammal and one reptile (**Table 13**).   No conservation significant fauna species were recorded within the survey area during the field survey.

One introduced fauna species were recorded during the field survey, namely European Rabbit (*Oryctolagus cuniculus*), recorded from secondary signs (scats).

Table 13: Fauna species recorded opportunistically within the survey area

Type	Species	Common name	Observation type
Bird	*Anhinga novaehollandiae*	Australasian Darter	Directly observed
Bird	*Anthochaera carunculata*	Red Wattlebird	Directly observed
Bird	*Chroicocephalus novaehollandiae*	Silver Gull	Directly observed
Bird	*Corvus coronoides*	Australian Raven	Directly observed
Bird	*Eolophus roseicapilla*	Galah	Directly observed
Bird	*Geopelia placida*	Peaceful Dove	Directly observed
Bird	*Hirundo neoxena*	Welcome Swallow	Directly observed
Bird	*Lichenostomus virescens*	Singing Honeyeater	Directly observed
Bird	*Phalacrocorax carbo*	Great Cormorant	Directly observed
Mammal	*Oryctolagus cuniculus*	European Rabbit	Secondary signs (scats)
Reptile	*Ctenotus* sp.	Ctenotus sp.	Directly observed

Note: * refers to a pest species; ^ refers to a naturalised exotic species

Figure 4: Locations of conservation significant flora within the survey area

Survey Area
Open Beach/Rocks
Current revegetation works

Conservation significant flora
- *Melaleuca lanceolata* (Bush Forever Significant)

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 27/02/2024

N

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logical
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Figure 5: Vegetation communities recorded within the survey area

Legend:

- Survey Area
- Open Beach/Rocks
- Current revegetation works

Vegetation communities
- Ar
- Sl
- Sc
- ScOaAp

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 27/02/2024

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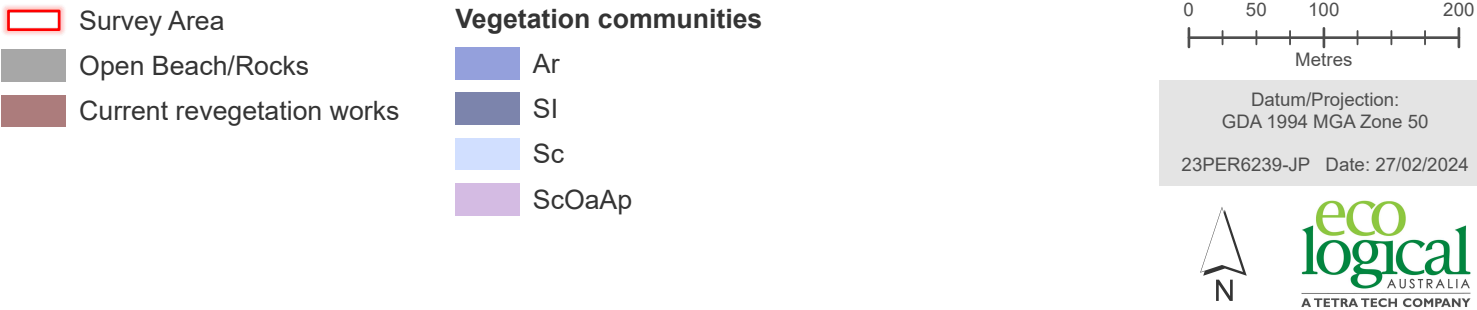
Figure 6: Conservation significant vegetation communities recorded within the survey area

Survey Area

Open Beach/Rocks

Current revegetation works

Conservation significant vegetation communities

FCT 29a: Coastal shrublands on shallow sands (P3)

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 27/02/2024

N

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logical
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Figure 7: Vegetation condition recorded within the survey area

Survey Area

Open Beach/Rocks

Current revegetation works

Vegetation condition

Very Good

Good

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 27/02/2024

Figure 8: Vegetation condition per community within the survey area

Legend:

- Survey Area
- Open Beach/Rocks
- Current revegetation works

Vegetation communities
- Ar
- Sl
- Sc
- ScOaAp

Vegetation condition
- Very Good
- Good

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-JP   Date: 27/02/2024

N

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5. Discussion and recommendations

5.1. Flora

A total of 61 flora taxa (31 native and 30 introduced) were recorded within the survey area from quadrats and opportunistic collections. This number represents a 15% increase from the number of species recorded by Emerge Associates in 2019 (53 species total; 27 native and 26 introduced; Emerge Associates 2020), likely due to the increased survey effort. A lower number of taxa was recorded from the current survey area than in nearby reserves (e.g., Burns Beach-Iluka Foreshore Reserve [121 species; 74 native and 47 introduced] and Hillarys-Kallaroo Coastal Foreshore Reserve [117 species; 68 native and 49 introduced]. The lower number of taxa recorded can be attributed to the smaller size of Sorrento Foreshore Reserve; 9.9 ha compared to 60.6 ha (Burns Beach-Iluka) and 94 ha (Hillarys-Kallaroo). It was also noted by the City (pers comms; 4/1/2024) that vegetation in the northern section of the survey area was artificially created by the City, with infill undertaken by the Friends of Sorrento Beach and Marmion Foreshore group. Planted vegetation within the survey area will likely contribute to the lower species diversity.

Average species richness per quadrat was 15.5 species, ranging from a low of 10 species at Q8 and Q9 to a high of 25 species at Q6. This is higher than Emerge Associates (2020), where an average species richness of 13.8 species (range 9-23 species) was recorded. A species accumulation curve determined that approximately 87% of the flora species potentially present within the survey area were recorded from quadrats (41 species). This result, in addition to flora species recorded opportunistically (20 species), indicates that the majority of flora potentially present within the survey area were recorded. This figure suggests that a comprehensive flora inventory of the survey area has been compiled.

No Threatened or Priority flora listed under the EPBC Act, the BC Act or by DBCA were recorded within the survey area. No conservation significant species were previously recorded within the survey area by Emerge Associates (2020). One Bush Forever significant species was recorded within the survey area, namely *Melaleuca lanceolata* (Rottnest Island Teatree), recorded from one location (one individual). This individual plant was also recorded by Emerge Associates (2020).

Weed species comprised 49.2% (30 species) of the total flora taxa recorded, representing an overall increase in the number of weed species recorded by Emerge Associates (2020), with 26 introduced taxa recorded. Given the time between surveys, a slight increase in the number of weed species recorded could be attributed to an increase in survey effort, natural fluctuations in occurrence or natural movement given the time between surveys conducted (2019 to 2023).

No introduced species recorded are listed as a WoNS or as a Declared Pest under the BAM Act. Of the 30 weed species recorded, ten are listed on the City of Joondalup priority weed list for Sorrento Foreshore Reserve. This includes:

Avena barbata (Wild oats), *Cakile maritima* (Sea rocket), *Oxalis pes-caprae* (Soursob), *Ehrharta longiflora* (Annual veldt grass), *Euphorbia paralias* (Sea spurge), *Euphorbia terracina* (Geraldton Carnation Weed), *Fumaria capreolata* (Whiteflower fumitory), *Pelargonium capitatum* (Rose pelargonium), *Tetragonia decumbens* (Sea spinach), and *Trachyandra divaricata* (Dune onion weed). Of these, *C. maritima*, *E. terracina*, *P. capitatum* and *T. decumbens* had the highest cover and distribution across the survey area, with *C. maritima* and *T. decumbens* occurring along the dunes along the western boundary of the survey area, and *E. terracina* and *P. capitatum* occurring more commonly within vegetation along the eastern boundary of the survey area adjacent to West Coast

Drive. The City's declared pest plant, *Tribulus terrestris* (Caltrop), was not recorded previously (Emerge Associates) or during the current survey within the survey area.

5.2. Vegetation

A total of four vegetation communities were delineated and mapped within the survey area. Quadrats previously established by Emerge Associates (2020) were re-surveyed (twelve in total), with a minimum of three quadrats established per vegetation community, as specified in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). Vegetation codes and descriptions previously described by Emerge Associates (2020) remained valid between the two survey periods and as such were retained for consistency.

A comparison of vegetation communities between the current survey and those recorded by Emerge Associates was undertaken as part of this assessment. Extent of vegetation communities recorded within the survey area has remained relatively consistent since the 2019 assessment (Emerge Associates 2020), with minor differences accounted for in the increased survey area size (9.88 ha compared with 8.09 ha). Vegetation community ScOaAp has decreased in size from 0.82 ha (Emerge Associates 2020) to 0.79 ha, following refinement of vegetation community boundaries during the current assessment. For the purposes of this assessment, only current revegetation works have been identified, however it was noted by the City (pers comms; 4/1/2024) that vegetation in the northern section of the survey area was artificially created by the City, with infill undertaken by the Friends of Sorrento Beach and Marmion Foreshore group.

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994). Multivariate analysis showed that quadrats within vegetation communities Sc, Ar and ScOaAp had a moderate to weak affiliation with Floristic Community Type 29a. Floristic Community Type 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community. These communities, covering a total of 1.36 ha, 0.90 ha and 0.79 ha respectively, (3.05 ha total; 30.9% of the survey area) are considered to represent floristic aspects of FCT 29a. Common species recorded include *Bromus diandrus*, *Crassula glomerata*, *Lysimachia arvensis*, *Sonchus oleraceus*, *Acanthocarpus preissii*, *Hardenbergia comptoniana*, *Rhagodia baccata* and *Spyridium globulosum* (Gibson *et al.* 1994). These results support findings by Emerge Associates, with plant communities Ar, ScOaAp and Sc (totalling 2.99 ha, 36.96% of the survey area) determined to represent FCT 29a (Emerge Associates 2020).

Quadrats within vegetation community Sl were unable to be assessed against FCTs defined by Gibson *et al*. (1994) due to poor condition and low species diversity. Quadrats within vegetation community Sl are, subjectively, likely to represent Supergroup 4: S14: *Spinifex longifolius* grassland and low shrublands, based on species (*Spinifex longifolius*), location (Quindalup South System) and landform (foredunes; Keighery *et al*. 2012; Government of Western Australia 2000). Supergroup 4: S14 is not listed as a Threatened or Priority Ecological Community. These results support findings by Emerge Associates, with plant community Sl (totalling 1.52 ha, 18.79% of the survey area) determined to represent FCT S14 (Emerge Associates 2020).

Vegetation within the survey area does not represent the Banksia Woodlands of the Swan Coastal Plain TEC due to the absence of key diagnostic Banksia species present within the survey area (e.g., *Banksia attenuata*, *B. menziesii*, *B. prionotes*, *B. ilicifolia*; TSSC 2016). As such, the full four-stage

assessment for this TEC, as outlined in the approved conservation advice (TSSC 2016), was not completed for the survey area.

Vegetation within the survey area is not considered to represent the Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain TEC due to the absence of *Eucalyptus gomphocephala* trees within the survey area. As such, the full assessment for this TEC, as outlined in the approved conservation advice (DotEE 2019), was not completed for the survey area.

It is noted that the Honeymyrtle shrubland on limestone ridges of the Swan Coastal Plain Bioregion was listed as a TEC in effect under the EPBC Act 1999 from 15 November 2023 (post-field survey). As such, an assessment against diagnostic characteristics listed in the approved conservation advice (DCCEEW 2023), was not completed. In WA the nationally defined Honeymyrtle shrubland ecological community is typically identified and mapped as FCT 26a *Melaleuca huegelii* – *M. systena* shrublands of limestone ridges (Gibson 1994; DCCEEW 2023). Vegetation within the survey area is not considered as likely representing the TEC, due to there being no vegetation dominated by *Melaleuca huegelii* (chenille honeymyrtle), and/or *M. systena* (coastal honeymyrtle), and/or *Banksia sessilis* (parrot bush), and due to FCT analysis of the patch finding no affiliation with FCT 26a.

Vegetation condition within the survey area ranged from Good to Very Good condition, based on the Keighery (1994) vegetation scale provided in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). Majority of the survey area was observed to be Very Good (4.02 hectares; 40.7% of the survey area). Vegetation condition within the survey area has remained relatively consistent since the 2019 assessment (Emerge Associates 2020), with majority of the survey area recorded in Very Good (3.98 ha; 49.45%) and Good (0.51 ha; 6.3%) condition by Emerge Associates (Emerge Associates 2020). Areas classed as being in 'Good' condition showed higher levels of disturbance (weed cover, lower native species diversity and higher levels of bare ground). A slight increase of areas classed as Very Good and Good condition in 2023 may be attributed to the increase in survey area size compared with that of Emerge Associates in 2020 (9.88 ha compared to 8.07 ha), weed management or dune management activities undertaken within the survey area between survey periods. Areas of vegetation previously assigned to 'Completely Degraded' condition were reclassified into 'Other' for 2023, as non-vegetated areas were not given a condition rating.

Disturbances within the survey area included the presence of weeds, edge effects (lesser condition) adjacent to tracks/cleared areas, grazing on vegetation by rabbits, erosion, and minor rubbish dumping (general waste).   Further dune stabilisation works within the survey area (e.g., planting works, matting) can be undertaken to reduce erosion of the sand dunes. In addition, unauthorised access to the dunes may prevent establishment of vegetation in these areas, due to disturbance and trampling. Repair and maintenance of fencing around the dunes, including clearly marked authorised tracks, will reduce the risk of dune disturbance and increase the success of dune stabilisation works.

5.3. Recommendations

Based on results of the current survey, the following recommendations have been made to assist in the conservation of native flora, vegetation and environmental values present within Sorrento Foreshore Reserve:

- Continue long-term monitoring of weed populations within the survey area. Implement weed control, particularly for City of Joondalup priority weeds. Concentrate weed control activities along track edges and boundaries between remnant bushland and cleared areas.
- Prioritise maintenance of the vegetation at Sorrento Foreshore Reserve due to the presence of the Floristic Community Type 29a Priority 3 Ecological Community.
- It is recommended to continue monitoring for evidence of pathogens, and to maintain correct hygiene practices within the survey area.
- It is recommended to monitor the dumping of rubbish and remove where necessary.
- It is recommended to limit uncontrolled access to the dunes (establish/repair fencing where necessary), and to clearly mark authorised tracks to reduce the risk of dune disturbance.
- Continue dune stabilisation works (e.g., planting, matting) to reduce erosion, where required.
- Undertake feral animal control for rabbits within the survey area to reduce grazing pressure and risks to revegetation works.

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Appendix A Framework for conservation significant flora and fauna ranking

CATEGORIES OF THREATENED SPECIES UNDER THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

Threatened fauna and flora may be listed in any one of the following categories as defined in Section 179 of the EPBC Act. Species listed as 'conservation dependent' and 'extinct' are not Matters of National Environmental Significance and therefore do not trigger the EPBC Act.

Category	Definition
Extinct (EX)	There is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Taxa known to survive only in captivity or as a naturalised population well outside its past range; or taxa has not been recorded in its known and/or expected habitat at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	Taxa considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Taxa considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Taxa considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	Taxa has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	Taxa has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	There is inadequate information to make a direct, or indirect, assessment of taxa's risk extinction based on its distribution and/or population status.
Not Evaluated (NE)	Taxa has not yet been evaluated against the criteria.
Migratory (M)	Not an IUCN category.
	Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including:
	• the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state;
	• the agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their environment (CAMBA);
	• the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); or
	• the agreement between Australia and the Republic of Korea to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (ROKAMBA).

CONSERVATION CODES FOR WESTERN AUSTRALIA FLORA AND FAUNA

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Specially protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

Threatened species (T)
Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

Category	Code	Description
Critically Endangered species	CR	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines".
		Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
Endangered species	EN	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines".
		Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.

Category	Code	Description
Vulnerable species	VU	Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines".
		Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild, as follows:

Category	Code	Description
Extinct species	EX	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
Extinct in the wild species	EW	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).
		Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

Categories are detailed below.

Category	Code	Description
Migratory species	M	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).
		Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.
		Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Species of special conservation interest (conservation dependent fauna)	CD	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).
		Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Other specially protected species	OS	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).
		Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

Priority species (P)

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Category	Code	Definition
Priority 1	P1	*Poorly-known species*
		Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	P2	*Poorly-known species*
		Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	P3	*Poorly-known species*
		Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Category	Code	Definition
Priority 4	P4	*Rare, Near Threatened and other species in need of monitoring*
		(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
		(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
		(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix B Flora species list

Family	Species	Common name	Conservation status			Reference		
			EPBC Act	BC Act	Weed	City of Joondalup (2015)	Emerge (2020)	ELA (2023)
Aizoaceae	*Carpobrotus edulis*	Hottentot Fig			*	X		
Aizoaceae	*Tetragonia decumbens*	Sea spinach			*	X	X	X
Aizoaceae	*Carpobrotus virescens*	Native pigface				X	X	X
Araliaceae	*Trachymene pilosa*	Native Parsnip					X	
Asparagaceae	*Acanthocarpus preissii*					X	X	X
Asparagaceae	*Lomandra maritima*	Maritime Mat Rush				X	X	X
Asphodelaceae	*Trachyandra divaricata*	Dune onion weed			*	X	X	X
Asteraceae	*Erigeron* sp.				*		X	X
Asteraceae	*Erigeron sumatrensis*				*			X
Asteraceae	*Gazania linearis*	Gazania			*	X	X	X
Asteraceae	*Lactuca serriola*	Prickly lettuce			*		X	X
Asteraceae	*Sonchus asper*	Rough sowthistle			*	X	X	X
Asteraceae	*Sonchus oleraceus*	Sowthistle			*	X	X	X
Asteraceae	*Leucophyta brownii*					X	X	X
Asteraceae	*Olearia axillaris*	Coastal daisybush				X	X	X
Asteraceae	*Senecio pinnatifolius*						X	X
Brassicaceae	*Brassica tournefortii*	Mediterranean turnip			*	X	X	X
Brassicaceae	*Cakile maritima*	Sea rocket			*	X	X	X
Brassicaceae	*Lobularia maritima*	Alyssum			*	X		
Chenopodiaceae	*Atriplex cinerea*	Grey Saltbush						X
Chenopodiaceae	*Atriplex isatidea*	Coast saltbush				X	X	X
Chenopodiaceae	*Rhagodia baccata*	Berry saltbush				X	X	X
Chenopodiaceae	*Threlkeldia diffusa*	Coast bonefruit				X	X	X
Crassulaceae	*Crassula glomerata*				*	X	X	X
Cyperaceae	*Ficinia nodosa*	Knotted club sedge				X	X	X

Family	Species	Common name	Conservation status	Reference		
Cyperaceae	*Isolepis marginata*	Coarse club-rush			X	X
Cyperaceae	*Lepidosperma gladiatum*	Coastal sword sedge		X	X	X
Ericaceae	*Acrotriche cordata*	Coast ground berry			X	X
Euphorbiaceae	*Euphorbia paralias*	Sea spurge	*	X	X	X
Euphorbiaceae	*Euphorbia peplus*	Petty spurge	*	X	X	X
Euphorbiaceae	*Euphorbia terracina*	Geraldton Carnation Weed	*	X		X
Fabaceae	*Acacia cochlearis*	Rigid Wattle				X
Fabaceae	*Acacia lasiocarpa* var. *lasiocarpa*					X
Fabaceae	*Acacia rostellifera*	Summer scented wattle		X	X	X
Fabaceae	*Hardenbergia comptoniana*	Native wisteria		X	X	X
Frankeniaceae	*Frankenia pauciflora*	Seaheath			X	X
Geraniaceae	*Pelargonium capitatum*	Rose pelargonium	*	X	X	X
Goodeniaceae	*Scaevola crassifolia*	Thick-leaved fan-flower		X	X	X
Haemodoraceae	*Conostylis aculeata* subsp. *cygnorum*	Prickly conostylis		X	X	X
Haemodoraceae	*Conostylis candicans* subsp. *calcicola*					X
Iridaceae	*Romulea rosea* var. *australis*	Guildford grass	*		X	X
Montiaceae	*Calandrinia brevipedata*	Short-stalked Purslane				X
MYRTACEAE	*Melaleuca huegelii*	Chenille Honeymyrtle		X		
Myrtaceae	*Melaleuca lanceolata*	Rottnest teatree			X	X
Myrtaceae	*Melaleuca systena*	Coastal Honeymyrtle		X	X	X
Onagraceae	*Oenothera drummondii*	Beach evening primrose	*	X		X
Oxalidaceae	*Oxalis pes-caprae*	Soursob	*			X
Papaveraceae	*Fumaria muralis*	Wall fumitory	*		X	X
Poaceae	*Avena barbata*	Wild oats	*	X		X
Poaceae	*Bromus diandrus*	Brome grass	*	X	X	X
Poaceae	*Cenchrus clandestinus*	Kikuyu grass	*		X	X
Poaceae	*Cynodon dactylon*	Couch	*	X		X
Poaceae	*Ehrharta longiflora*	Annual veldt grass	*	X	X	X
Poaceae	*Hordeum leporinum*	Barley grass	*	X	X	X

Family	Species	Common name	Conservation status	Reference		
Poaceae	*Lagurus ovatus*	Hare's tail grass	*	X		X
Poaceae	*Lolium rigidum*	Rye grass	*	X	X	
Poaceae	*Stenotaphrum secundatum*	Buffalo grass	*	X	X	X
Poaceae	*Vulpia bromoides*	Squirrel tail fescue	*		X	X
Poaceae	*Spinifex hirsutus*	Hairy spinifex		X	X	X
Poaceae	*Spinifex longifolius*	Beach spinifex		X	X	X
Primulaceae	*Lysimachia arvensis* var. *caerulea*	Blue pimpernel	*	X	X	X
Proteaceae	*Grevillea crithmifolia*				X	X
Rhamnaceae	*Spyridium globulosum*	Basket bush		X	X	X
Santalaceae	*Exocarpos sparteus*	Broom ballart			X	
Scrophulariaceae	*Dischisma arenarium*		*		X	X
Scrophulariaceae	*Myoporum insulare*	Blueberry tree		X	X	X
Solanaceae	*Solanum nigrum*	Black berry nightshade	*		X	
Thymelaeaceae	*Pimelea ferruginea*				X	X
Thymelaeaceae	*Pimelea rosea* subsp. *rosea*	Rose Banjine		X		

Appendix C Species by site matrix

Family	Species name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Oppo
Aizoaceae	*Tetragonia decumbens*	X	X	X	X	X	X	X	X	X			X	
Aizoaceae	*Carpobrotus virescens*	X		X	X		X			X	X	X	X	
Asparagaceae	*Acanthocarpus preissii*					X	X						X	
Asparagaceae	*Lomandra maritima*						X							
Asphodelaceae	*Trachyandra divaricata*		X	X	X	X	X	X			X	X	X	
Asteraceae	*Erigeron* sp.		X											
Asteraceae	*Erigeron sumatrensis*													X
Asteraceae	*Gazania linearis*													X
Asteraceae	*Lactuca serriola*													X
Asteraceae	*Sonchus asper*	X	X	X		X	X	X				X	X	
Asteraceae	*Sonchus oleraceus*	X	X	X	X	X	X	X	X	X	X		X	
Asteraceae	*Leucophyta brownii*	X					X					X	X	X
Asteraceae	*Olearia axillaris*	X			X	X		X	X			X	X	
Asteraceae	*Senecio pinnatifolius*	X	X		X	X					X	X		
Brassicaceae	*Brassica tournefortii*						X					X		
Brassicaceae	*Cakile maritima*			X				X	X	X	X			
Chenopodiaceae	*Atriplex cinerea*													X
Chenopodiaceae	*Atriplex isatidea*													X
Chenopodiaceae	*Rhagodia baccata*	X	X	X	X	X	X				X		X	X
Chenopodiaceae	*Threlkeldia diffusa*		X	X			X							
Crassulaceae	*Crassula glomerata*	X	X	X		X	X	X			X	X		X
Cyperaceae	*Ficinia nodosa*	X				X			X	X	X	X	X	
Cyperaceae	*Isolepis marginata*										X			
Cyperaceae	*Lepidosperma gladiatum*					X	X						X	
Ericaceae	*Acrotriche cordata*													X
Euphorbiaceae	*Euphorbia paralias*							X	X	X				

Family	Species name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Oppo
Euphorbiaceae	*Euphorbia peplus*					X	X						X	
Euphorbiaceae	*Euphorbia terracina*		X	X	X						X			
Fabaceae	*Acacia cochlearis*													X
Fabaceae	*Acacia lasiocarpa* var. *lasiocarpa*													X
Fabaceae	*Acacia rostellifera*	X	X	X	X	X	X		X			X	X	
Fabaceae	*Hardenbergia comptoniana*						X							
Frankeniaceae	*Frankenia pauciflora*													X
Geraniaceae	*Pelargonium capitatum*	X	X		X		X				X	X		
Goodeniaceae	*Scaevola crassifolia*	X	X	X	X	X	X	X	X	X	X	X	X	
Haemodoraceae	*Conostylis aculeata* subsp. *cygnorum*													X
Haemodoraceae	*Conostylis candicans* subsp. *calcicola*													X
Iridaceae	*Romulea rosea*										X			
Montiaceae	*Calandrinia brevipedata*		X			X	X					X		
Myrtaceae	*Melaleuca lanceolata*													X
Myrtaceae	*Melaleuca systena*					X								
Onagraceae	*Oenothera drummondii*													X
Oxalidaceae	*Oxalis pes-caprae*													X
Papaveraceae	*Fumaria muralis*						X							
Poaceae	*Avena barbata*													X
Poaceae	*Bromus diandrus*			X		X					X			
Poaceae	*Cenchrus clandestinus*													X
Poaceae	*Cynodon dactylon*													X
Poaceae	*Ehrharta longiflora*					X	X							
Poaceae	*Hordeum leporinum*													X
Poaceae	*Lagurus ovatus*				X	X	X							
Poaceae	*Stenotaphrum secundatum*													X
Poaceae	*Stenotaphrum secundatum*		X											
Poaceae	*Vulpia bromoides*											X		X
Poaceae	*Spinifex hirsutus*							X	X					

Family	Species name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Oppo
Poaceae	*Spinifex longifolius*	X	X	X	X			X	X	X	X	X		
Primulaceae	**Lysimachia arvensis*					X	X						X	
Proteaceae	*Grevillea crithmifolia*													X
Rhamnaceae	*Spyridium globulosum*			X		X								
Scophulariaceae	**Dischisma arenarium*	X		X	X		X				X			
Scophulariaceae	*Myoporum insulare*	X				X	X							
Thymelaeaceae	*Pimelea ferruginea*													X

Appendix D Quadrat data

Quadrat	Date	Site type	Observer
Q1	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Rabbit scats, wind, erosion	No evidence	Sc
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
White sand	5	W	Primary dune
Easting		**Northing**	
381398		6477510	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Scaevola crassifolia	60	M	Shrubs <1m
Olearia axillaris	4	M	Shrubs <1m
Leucophyta brownii	0.5	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	0.2	M	Shrubs <1m
*Tetragonia decumbens	0.1	M	Shrubs <1m
Rhagodia baccata	0.1	M	Shrubs <1m
Myoporum insulare	0.05	M	Shrubs <1m
Ficinia nodosa	0.1	G	Sedges
Spinifex longifolius	0.3	G	Grasses
Carpobrotus virescens	2.5	G	Herbs
*Pelargonium capitatum	0.2	G	Herbs
*Crassula glomerata	0.1	G	Herbs
*Dischisma arenarium	0.1	G	Herbs
*Sonchus oleraceus	0.1	G	Herbs
Senecio pinnatifolius	0.1	G	Herbs
*Sonchus asper	0.02	G	Herbs

Quadrat	Date	Site type	Observer
Q2	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Weeds, Shrub deaths	No evidence	Ar
Soil description	**Leaf litter**	**Aspect / slope (°)**	**Landform**
White sand	70	W	Primary dune
Easting		**Northing**	
381431		6477453	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	65	M	Shrubs 1-2m
Scaevola crassifolia	15	M	Shrubs <1m
Rhagodia baccata	5	M	Shrubs <1m
Tetragonia decumbens	0.5	M	Shrubs <1m
Spinifex longifolius	2	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Stenotaphrum secundatum	0.02	G	Grasses
Threlkeldia diffusa	0.5	G	Herbs
Pelargonium capitatum	0.2	G	Herbs
Sonchus oleraceus	0.2	G	Herbs
Crassula glomerata	0.1	G	Herbs
Euphorbia terracina	0.1	G	Herbs
Trachyandra divaricata	0.1	G	Herbs
Calandrinia brevipedata	0.1	G	Herbs
Erigeron sp.	0.05	G	Herbs
Senecio pinnatifolius	0.05	G	Herbs
Sonchus asper	0.02	G	Herbs

Quadrat	Date	Site type	Observer
Q3	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Tracks, Blowout	No evidence	Ar
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
White sand	15	W	Primary dune
Easting		**Northing**	
381542		6477408	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	40	M	Shrubs 1-2m
Spyridium globulosum	5	M	Shrubs 1-2m
Scaevola crassifolia	15	M	Shrubs <1m
Rhagodia baccata	1.5	M	Shrubs <1m
*Tetragonia decumbens	0.2	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spinifex longifolius	0.5	G	Grasses
*Bromus diandrus	0.1	G	Grasses
Carpobrotus virescens	5	G	Herbs
*Crassula glomerata	0.1	G	Herbs
*Euphorbia terracina	0.1	G	Herbs
*Trachyandra divaricata	0.1	G	Herbs
*Cakile maritima	0.05	G	Herbs
*Sonchus oleraceus	0.05	G	Herbs
*Dischisma arenarium	0.02	G	Herbs
*Sonchus asper	0.02	G	Herbs
Threlkeldia diffusa	0.02	G	Herbs

Quadrat	Date	Site type	Observer
Q4	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Wind, Erosion, Weeds	No evidence	Ar
Soil description	**Leaf litter**	**Aspect / slope (°)**	**Landform**
White sand	50	W	Primary dune
Easting		**Northing**	
381477		6477375	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	80	M	Shrubs 1-2m
Olearia axillaris	5	M	Shrubs <1m
Scaevola crassifolia	0.5	M	Shrubs <1m
*Tetragonia decumbens	0.1	M	Shrubs <1m
Rhagodia baccata	0.1	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spinifex longifolius	0.2	G	Grasses
*Lagurus ovatus	0.1	G	Grasses
*Pelargonium capitatum	0.1	G	Herbs
*Sonchus oleraceus	0.1	G	Herbs
*Trachyandra divaricata	0.1	G	Herbs
Carpobrotus virescens	0.1	G	Herbs
*Dischisma arenarium	0.05	G	Herbs
*Euphorbia terracina	0.05	G	Herbs
Senecio pinnatifolius	0.05	G	Herbs

Quadrat	Date	Site type	Observer
Q5	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Tracks, Blowout	No evidence	ScOaAp
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
Light grey sand	10	W	Foredune
Easting		**Northing**	
381660		6476985	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	60	M	Shrubs 1-2m
Myoporum insulare	4	M	Shrubs 1-2m
Spyridium globulosum	2	M	Shrubs 1-2m
Scaevola crassifolia	15	M	Shrubs <1m
Rhagodia baccata	5	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Tetragonia decumbens	0.5	M	Shrubs <1m
Acanthocarpus preissii	0.5	M	Shrubs <1m
Olearia axillaris	0.2	M	Shrubs <1m
Melaleuca systena	0.1	M	Shrubs <1m
Lepidosperma gladiatum	5	G	Sedges
Ficinia nodosa	0.2	G	Sedges
Bromus diandrus	0.1	G	Grasses
Ehrharta longiflora	0.1	G	Grasses
Lagurus ovatus	0.1	G	Grasses
Euphorbia peplus	0.2	G	Herbs
Lysimachia arvensis	0.2	G	Herbs
Calandrinia brevipedata	0.2	G	Herbs
Crassula glomerata	0.1	G	Herbs
Sonchus oleraceus	0.1	G	Herbs
Trachyandra divaricata	0.1	G	Herbs
Senecio pinnatifolius	0.1	G	Herbs
Sonchus asper	0.05	G	Herbs

Quadrat	Date	Site type	Observer
Q6	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Tracks, Blowout, Rabbit scat	No evidence	ScOaAp
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
White sand	5	W	Foredune
Easting	**Northing**		
381634	6477041		

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	65	M	Shrubs 1-2m
Scaevola crassifolia	20	M	Shrubs <1m
Rhagodia baccata	3	M	Shrubs <1m
Myoporum insulare	2.5	M	Shrubs <1m
Acanthocarpus preissii	1.5	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Tetragonia decumbens	0.2	M	Shrubs <1m
Leucophyta brownii	0.1	M	Shrubs <1m
Lepidosperma gladiatum	3	G	Sedges
Ehrharta longiflora	0.1	G	Grasses
Lagurus ovatus	0.1	G	Grasses
Threlkeldia diffusa	1.5	G	Herbs
Crassula glomerata	0.2	G	Herbs
Euphorbia peplus	0.2	G	Herbs
Lysimachia arvensis	0.2	G	Herbs
Lomandra maritima	0.2	G	Herbs
Brassica tournefortii	0.1	G	Herbs
Dischisma arenarium	0.1	G	Herbs
Pelargonium capitatum	0.1	G	Herbs
Sonchus oleraceus	0.1	G	Herbs
Trachyandra divaricata	0.1	G	Herbs
Calandrinia brevipedata	0.1	G	Herbs
Carpobrotus virescens	0.1	G	Herbs
Hardenbergia comptoniana	0.1	G	Herbs
Fumaria muralis	0.05	G	Herbs
Sonchus asper	0.05	G	Herbs

Quadrat	Date	Site type	Observer
Q7	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Tracks, Blowout	No evidence	Sl
White sand	0.5	W	Foredune
White sand	0.5	W	Foredune
Easting		**Northing**	
381523		6477276	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	15	M	Shrubs <1m
Scaevola crassifolia	0.5	M	Shrubs <1m
*Tetragonia decumbens	0.2	M	Shrubs <1m
Spinifex longifolius	45	G	Grasses
Spinifex hirsutus	0.5	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Cakile maritima	0.5	G	Herbs
Trachyandra divaricata	0.2	G	Herbs
Crassula glomerata	0.1	G	Herbs
Euphorbia paralias	0.1	G	Herbs
Sonchus oleraceus	0.1	G	Herbs
Sonchus asper	0.05	G	Herbs

Quadrat	Date	Site type	Observer
Q8	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Weeds, Erosion, Wind, Rabbit scats	No evidence	Sl
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
White sand	0.5	W	Foredune
Easting		**Northing**	
381387		6477490	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	20	M	Shrubs <1m
Scaevola crassifolia	1	M	Shrubs <1m
Acacia rostellifera	0.2	M	Shrubs <1m
*Tetragonia decumbens	0.1	M	Shrubs <1m
Ficinia nodosa	0.1	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spinifex longifolius	10	G	Grasses
Spinifex hirsutus	2.5	G	Grasses
*Cakile maritima	2	G	Herbs
*Sonchus oleraceus	0.1	G	Herbs
*Euphorbia paralias	0.05	G	Herbs

Quadrat	Date	Site type	Observer
Q9	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Rubbish, Weeds, Light erosion	No evidence	Sl
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
White sand	2	W	Foredune
Easting		**Northing**	
380953		6478138	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Scaevola crassifolia	0.5	M	Shrubs <1m
*Tetragonia decumbens	0.1	M	Shrubs <1m
Rhagodia baccata	0.1	M	Shrubs <1m
Ficinia nodosa	10	G	Sedges
Spinifex longifolius	70	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Carpobrotus virescens	2.5	G	Herbs
*Sonchus oleraceus	0.2	G	Herbs
*Cakile maritima	0.1	G	Herbs
*Crassula glomerata	0.1	G	Herbs
*Euphorbia paralias	0.05	G	Herbs

Quadrat	Date	Site type	Observer
Q10	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Track, Erosion	No evidence	Sc
Soil description	**Leaf litter**	**Aspect / slope (°)**	**Landform**
White sand	10	W	Foredune
Easting		**Northing**	
381059		6478047	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Scaevola crassifolia	70	M	Shrubs <1m
Ficinia nodosa	1.5	G	Sedges
Isolepis marginata	0.1	G	Sedges
Spinifex longifolius	20	G	Grasses
*Bromus diandrus	0.1	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Carpobrotus virescens	0.5	G	Herbs
Cakile maritima	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Dischisma arenarium	0.1	G	Herbs
Sonchus oleraceus	0.1	G	Herbs
Trachyandra divaricata	0.1	G	Herbs
Senecio pinnatifolius	0.1	G	Herbs
Euphorbia terracina	0.05	G	Herbs
Pelargonium capitatum	0.05	G	Herbs
Romulea rosea	0.02	G	Herbs

Quadrat	Date	Site type	Observer
Q11	21/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Track, Erosion, Weeds	No evidence	Sc
Soil description	**Leaf litter**	**Aspect / slope (º)**	**Landform**
White sand	5	W	Foredune
Easting		**Northing**	
381185		6477873	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Scaevola crassifolia	30	M	Shrubs <1m
Olearia axillaris	10	M	Shrubs <1m
Acacia rostellifera	0.1	M	Shrubs <1m
Rhagodia baccata	0.1	M	Shrubs <1m
Ficinia nodosa	2.5	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spinifex longifolius	20	G	Grasses
*Vulpia bromoides	0.1	G	Grasses
*Pelargonium capitatum	0.1	G	Herbs
*Sonchus oleraceus	0.1	G	Herbs
*Trachyandra divaricata	0.1	G	Herbs
Carpobrotus virescens	0.1	G	Herbs

Quadrat	Date	Site type	Observer
Q12	27/9/2023	Quadrat (10 x 10m)	Jeff Cargill
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Erosion, Track, Weeds	No evidence	ScOaAp
Soil description	**Leaf litter**	**Aspect / slope (°)**	**Landform**
White sand	5	W	Foredune
Easting		**Northing**	
381667		6476932	

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	20	M	Shrubs 1-2m
Acacia rostellifera	15	M	Shrubs 1-2m
Scaevola crassifolia	60	M	Shrubs <1m
Leucophyta brownii	2	M	Shrubs <1m
Acanthocarpus preissii	0.5	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Rhagodia baccata	0.5	M	Shrubs <1m
*Tetragonia decumbens	0.1	M	Shrubs <1m
Ficinia nodosa	1.5	G	Sedges
Lepidosperma gladiatum	0.5	G	Sedges
*Crassula glomerata	0.1	G	Herbs
*Lysimachia arvensis	0.1	G	Herbs
Calandrinia brevipedata	0.1	G	Herbs
Carpobrotus virescens	0.1	G	Herbs
*Euphorbia peplus	0.05	G	Herbs
*Sonchus oleraceus	0.05	G	Herbs
*Trachyandra divaricata	0.05	G	Herbs
*Brassica tournefortii	0.02	G	Herbs
*Sonchus asper	0.02	G	Herbs

Appendix E Weed mapping

Figure: Records of *_Avena barbata_ (Wild Oats) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location
- _Avena barbata_ (Wild Oats)

Weed coverage
- 0 - 5%

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

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Figure: Records of *Cakile edentula (Sea Rocket) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location
- *Cakile edentula* (Sea Rocket)

Weed coverage
- 0 - 5%
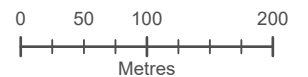
0   50   100   200
Metres

Datum/Projection: GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

N

eco logical
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Figure: Records of *_Ehrharta longiflora_ (Annual Veldt Grass) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location

Ehrharta longiflora (Annual Veldt Grass)

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

eco
logical
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Figure: Records of *_Euphorbia paralias_ (Sea Spurge) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location

Euphorbia paralias (Sea Spurge)

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 21/12/2023

Figure: Records of *_Euphorbia terracina_ (Geraldton Carnation Weed) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location

Euphorbia terracina (Geraldton Carnation Weed)

Weed coverage

0 - 5%

6 - 75%

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

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Figure: Records of *_Fumaria capreolata_ (Fumitory) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location

Fumaria capreolata (Fumitory)

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

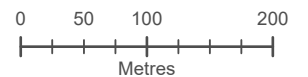23PER6239-GM   Date: 27/02/2024

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Figure: Records of *Oxalis pes-caprae* (Soursob) in Sorrento Reserve

Legend

Sorrento Foreshore
Reserve

Weed location

Oxalis pes-caprae
(Soursob)

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

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Figure: Records of *_Pelargonium capitatum_ (Rose Pelargonium) in Sorrento Reserve

Legend

☐ Sorrento Foreshore Reserve

Weed location

● _Pelargonium capitatum_ (Rose Pelargonium)

0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

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Figure: Records of *Tetragonia decumbens* (Sea Spinach) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed location

● *Tetragonia decumbens* (Sea Spinach)

Weed coverage

0 - 5%

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

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Figure: Records of *_Trachyandra divaricata_ (Onion Weed) in Sorrento Reserve

Legend

Sorrento Foreshore Reserve

Weed coverage

0 - 5%

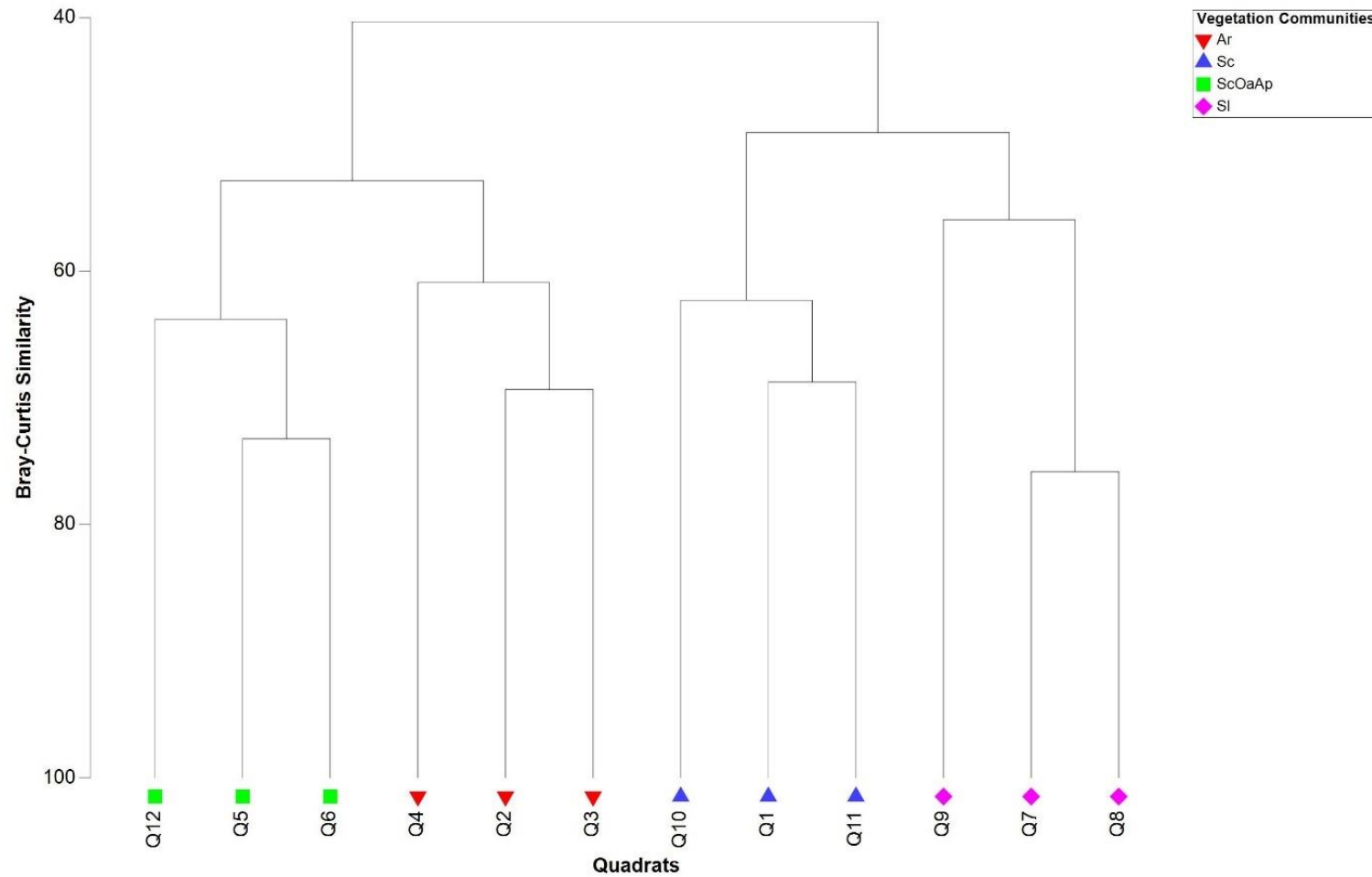0   50   100   200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

23PER6239-GM   Date: 20/12/2023

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Appendix F Hierarchical clustering dendrogram

Appendix G MDS: Relationship between ELA vegetation communities and Floristic Community Types (FCTs) defined by Gibson *et al*. (1994)