Reconnaissance Flora and Vegetation Survey and Targeted Flora Search of the Road Reserve on Hairpin Road (SLK 2.88 to 7.01)

Prepared for: The City of Busselton

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1. Summary

Daniel Marsh Botanical Consulting undertook a Reconnaissance Flora and Vegetation Survey and Targeted Flora Search of the road reserve of Hairpin Road (SLK 2.88 to 7.01), between North Jindong Road and Kaloorup Road in the City of Busselton. The survey area comprised of approximately 6.05ha of road verge predominantly bordered by paddocks. Both sides of the road were traversed by foot and a total of 7 quadrats, 7 photo points, opportunistic recordings and collections were conducted. The sample intensity and time of survey was considered adequate for a Reconnaissance Flora and Vegetation Survey and Targeted Flora Search.

A total of 74 taxa representing 61 genera and 27 families were recorded within the survey area. No flora species listed as Threatened under the EPBC Act or the BC Act were recorded within the survey area. No Priority species listed by DBCA were recorded.

Thirty-six weed species were recorded within the survey area, one of which, **Asparagus asparagoides* is listed as a Declared Plant species in Western Australia pursuant to Section 22 of the State *Biosecurity and Agriculture Management Act 2007* and a Weed of National Significance (WoNS). **Asparagus asparagoides* is exempt from control or management requirements. Weeds were abundant throughout the survey area, dominating the understorey.

Five vegetation communities were defined within the survey area. All vegetation communities were assessed as either Degraded or Completely Degraded. Multivariate comparative analysis with the Swan Coastal Plain regional survey dataset grouped all quadrats established in the current survey with community types that are not congruent with descriptive characteristics, species composition and the distribution of these community types. The degraded nature of the survey area is likely to have influenced the classification of these quadrats because the lack of native species cause groupings to be calculated based on the composition of weeds. The vegetation communities recorded within the survey area were considered too degraded to meaningfully assign community types from the Swan Coastal Plain regional survey. Ultimately, the vegetation communities recorded in the survey area are poor examples of their original community type and would be difficult to regenerate to a state approaching good condition.

None of the vegetation communities recorded within the survey area were inferred to represent conservation significant ecological communities listed under the EPBC Act, the BC Act or by DBCA.

2. Introduction

2.1 Project background

Daniel Marsh Botanical Consulting (DMBC) understands that the City of Busselton is seeking approval to clear vegetation from the road verge either side of Hairpin Road (SLK 2.88 to 7.01), in between North Jindong Road and Kaloorup Road (the survey area), as part of their strategic approach to the upgrade of rural roads, particularly the upgrade of narrow sealed roads. To support this process, DMBC was engaged by Accendo to undertake a Reconnaissance Flora and Vegetation Survey and Targeted Flora Search within the survey area, the results of which will be included in the Native Vegetation Clearing Permit (NVCP).

The objective of this survey was to undertake a Reconnaissance Flora and Vegetation Survey and a Targeted Flora Search of the Hairpin Road survey area in accordance with the Environmental Protection Authority (EPA) *Technical Guide: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

2.2 Project area location

The survey area is located in Jindong, Western Australia (**Figure 1**). The survey area consists of road reserve either side of Hairpin Road, between North Jindong Road and Kaloorlup Road (**Figure 2**). The survey area covers a total of 6.05ha and is predominantly bordered by paddocks.

Figure 1: Location of survey area.

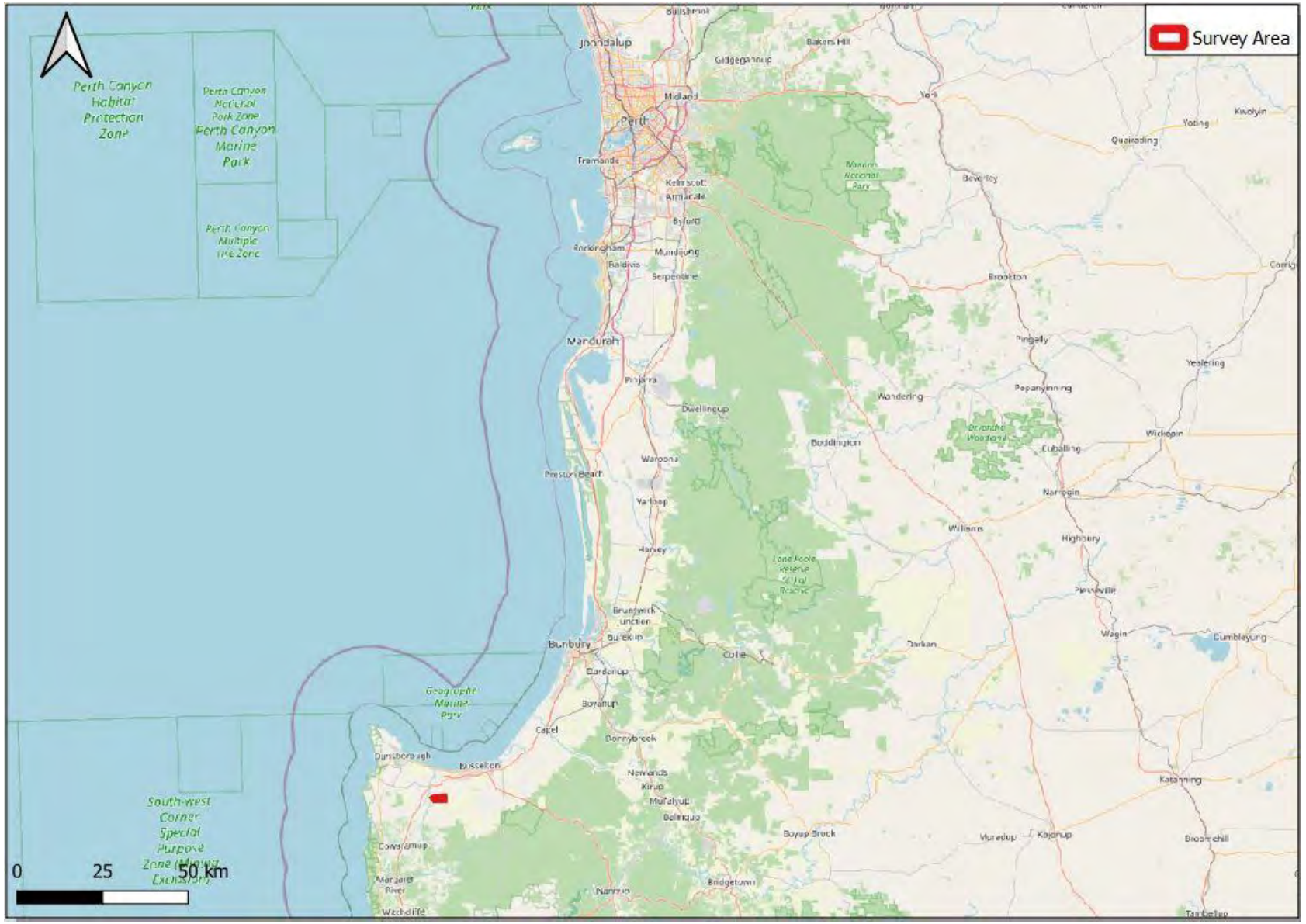


Figure 2: Survey area.

2.3 Desktop Assessment

2.3.1 Climate

The survey area is located in the Swan Coastal Plain bioregion (SWA 02 subregion) as defined by the Interim Biogeographic Regionalisation for Australia (IBRA; DotEE 2021a). This subregion is described as having a moderate warm Mediterranean type climate with a rainfall between 1000 and 600mm annually (Williams and Mitchell 2001).

Based on the nearby Jindong weather station (station number 9978, rainfall data 2002 – present, located approximately 3.0 km south of the project area), the local area receives, on average, a total of 776.0 millimetres (mm) of rainfall per year with most rainfall occurring during the winter months of June, July and August (137.2 mm, 152.4 mm and 122.3 mm respectively; Bureau of Meteorology [BoM] 2021; **Table 1**). A total of 426.8 mm of rainfall was received in the three months preceding the field survey (July to September), which is more than the average rainfall of 363.1 mm for the same period (BoM 2021).

Table 1: Rainfall data recorded at the Jindong weather station (9978) 12 months prior to the field survey compared to the long-term average (BoM 2021).

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Total monthly rainfall 2020-2021 (mm)	36.2	92.6	1.8	1.2	84.0	63.4	91.6	177.0	151.2	211.4	129.2	86.2	1125.8
Average monthly rainfall 2002-current	33.8	10.7	10.0	9.5	22.3	38.2	112.8	137.2	152.4	122.3	88.5	38.3	776.0

2.3.2 Landform, topography and soils

The Swan Coastal Plain bioregion broadly comprises of a low lying coastal plain, predominantly covered with woodlands. The colluvial and aeolian sand areas of the Swan Coastal Plain represent three phases of Quaternary marine sand dune development and include a series of seasonal fresh water wetlands, alluvial river flats, coastal limestones and offshore islands (Williams and Mitchell 2001).

2.3.3 Regional vegetation

2.3.3.1 IBRA subregion

Younger sandy areas and limestones of the Swan Coastal Plain are dominated by heath and/or tuart woodlands, while on the older dune systems, *Banksia* and jarrah-*Banksia* woodlands are found. Fine-textured outwash plains at the foot of the Darling Escarpment are extensive in the south. In the north-east, the plain rises to duricrusted Mesozoic sediments dominated by jarrah woodland. The Dandaragan

Plateau is the region's north-eastern corner and is characterised by *Banksia* low woodland, jarrah-marri woodland, marri woodland, and by scrub-heaths on laterite pavement and gravelly sandplains (Williams and Mitchell 2001).

2.3.3.2 Vegetation associations and Pre-European Vegetation Extent

Vegetation type and extent have been mapped at a regional scale by Beard (1979) who categorised vegetation into broad vegetation associations. Based on this mapping at a scale of 1:1,000,000, the Department of Primary Industries and Regional Development (DPIRD; previously Department of Agriculture and Food Western Australia [DAFWA]) has compiled a list of vegetation extent and types across WA (Shepherd et al. 2002).

One vegetation association occurs within the survey area, namely *'Pinjarra 1136 (Medium woodland, marri with some jarrah, wandoo, river gum and casuarina)'* **(Figure 3).** It is estimated 6.81% pre-European extent of the *Pinjarra 1136*, remains within the Swan Coastal Plain 02 subregion (Error! R eference source not found.; Government of Western Australia 2019). The current extent protected for conservation in SWA02 is 0.10%.

Table 2: Beard (1979) / Shepherd et al. (2002) vegetation associations occurring within project area

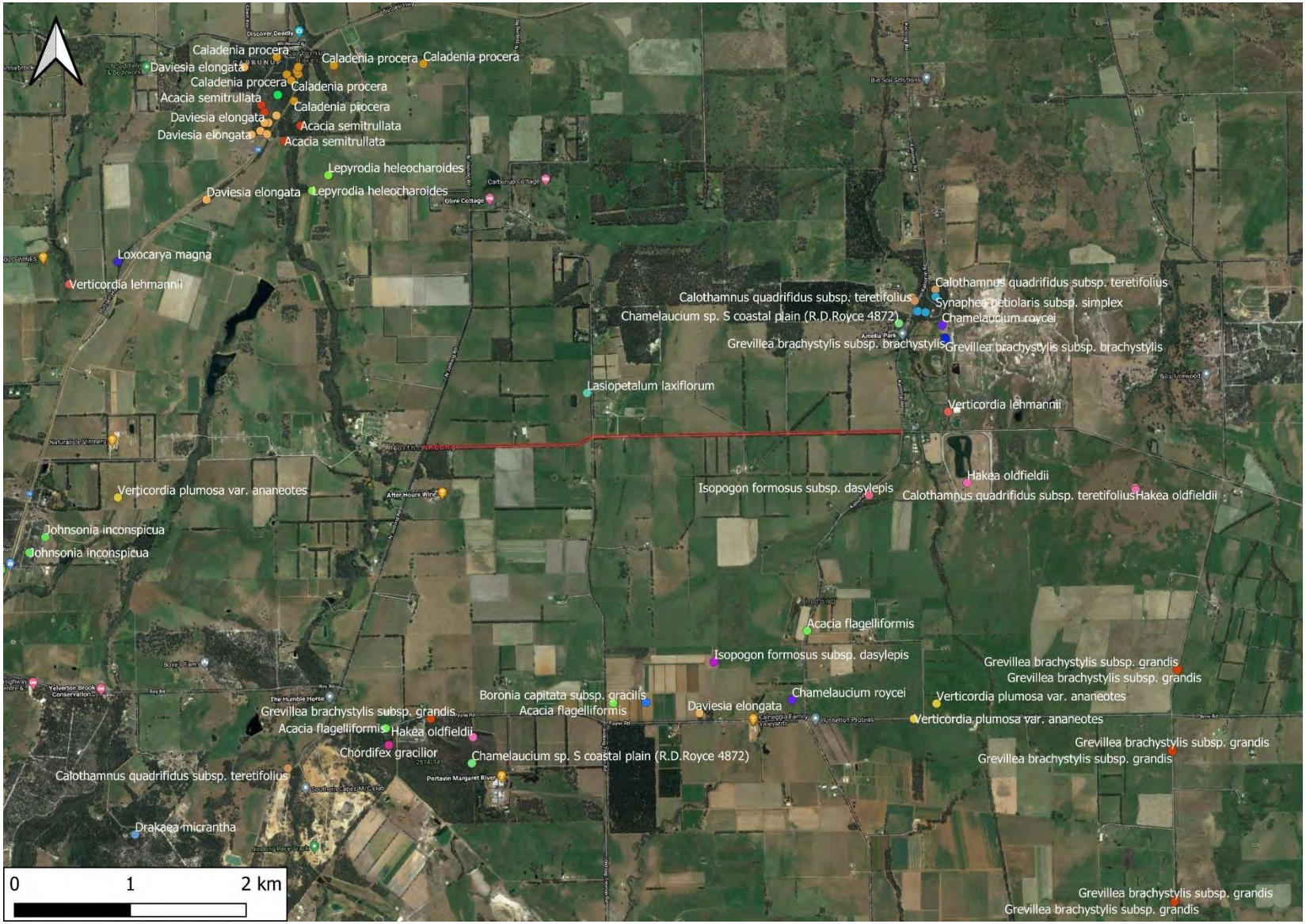
Vegetation association	Pre-European extent (ha) (Government of WA 2018)	Current extent (ha) (Government of WA 2018)	Remaining (%)	% Current Extent Protected for Conservation
Pinjarra 1136	43,400.15	2,954.98	6.81	0.10

2.3.4 Conservation Significant Flora

Database searches identified 71 conservation significant flora previously recorded within 10km of the survey area, or are considered 'likely to occur in the area'. After assessing the results of the database searches against the likelihood of occurrence assessment criteria (**Appendix A**), 42 conservation significant flora were considered to have the potential to occur within the survey area based on the presence of suitable habitat and proximity to the survey area (**Appendix B**). Previous records of conservation significant flora in proximity to the survey area are shown in **Figure 4** (DBCA 2021a).

Figure 3: Pre-european Extent of Vegetation Associations occurring in proximity to the survey area (DPIRD 2021a; DPIRD 006).

Figure 4: Conservation Significant Flora in proximity to the survey area (DBCA 2021a).



2.3.5 Conservation Significant Ecological Communities

Environmentally Sensitive Areas (ESAs) are defined in the Environmental Protection (Environmentally Sensitive Areas) Notice 2005 under section 51B of the State *Environmental Protection Act 1986* (EP Act). ESAs include areas declared as World Heritage, included on the Register of the National Estate, defined wetlands, vegetation containing rare (Threatened) flora and Threatened Ecological Communities (TECs).

Priority Ecological Communities (PECs) are vegetation communities that are recognised to be of significance, but do not meet the criteria for a TEC. There are five categories of PECs, none of which are currently protected under legislation.

The DBCA Threatened and Priority Communities database search (DBCA 2021b) identified 477 known occurrences of 17 conservation significant ecological communities or their buffers, within a 10 km radius of the survey area (**Table 3**)(**Figure 5**). The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) identified five conservation significant communities 'likely to occur in the area' (**Table 3**). The closest occurrences of conservation significant ecological communities are *Shrublands on southern Swan Coastal Plain Ironstones* and *Swan Coastal Plain Paluslope Wetlands* located approximately 0.4km to the south and *Banksia Woodlands of the Swan Coastal Plain ecological community* located 0.4km to north and 0.5km to the east of the survey area (DBCA 2021b; Figure 5; **Table 3**). There are no known TECs or PECs or their buffers within the survey area itself. For definitions of categories (Priority 1 etc.) refer to document entitled 'Definitions and Categories' (ATTACHMENT 1 (dpaw.wa.gov.au)).

Table 3: Conservation significant ecological communities within 10 km of the survey area (DBCA 2021b) and conservation significant communities 'likely to occur in the area' (DotEE 2021b).

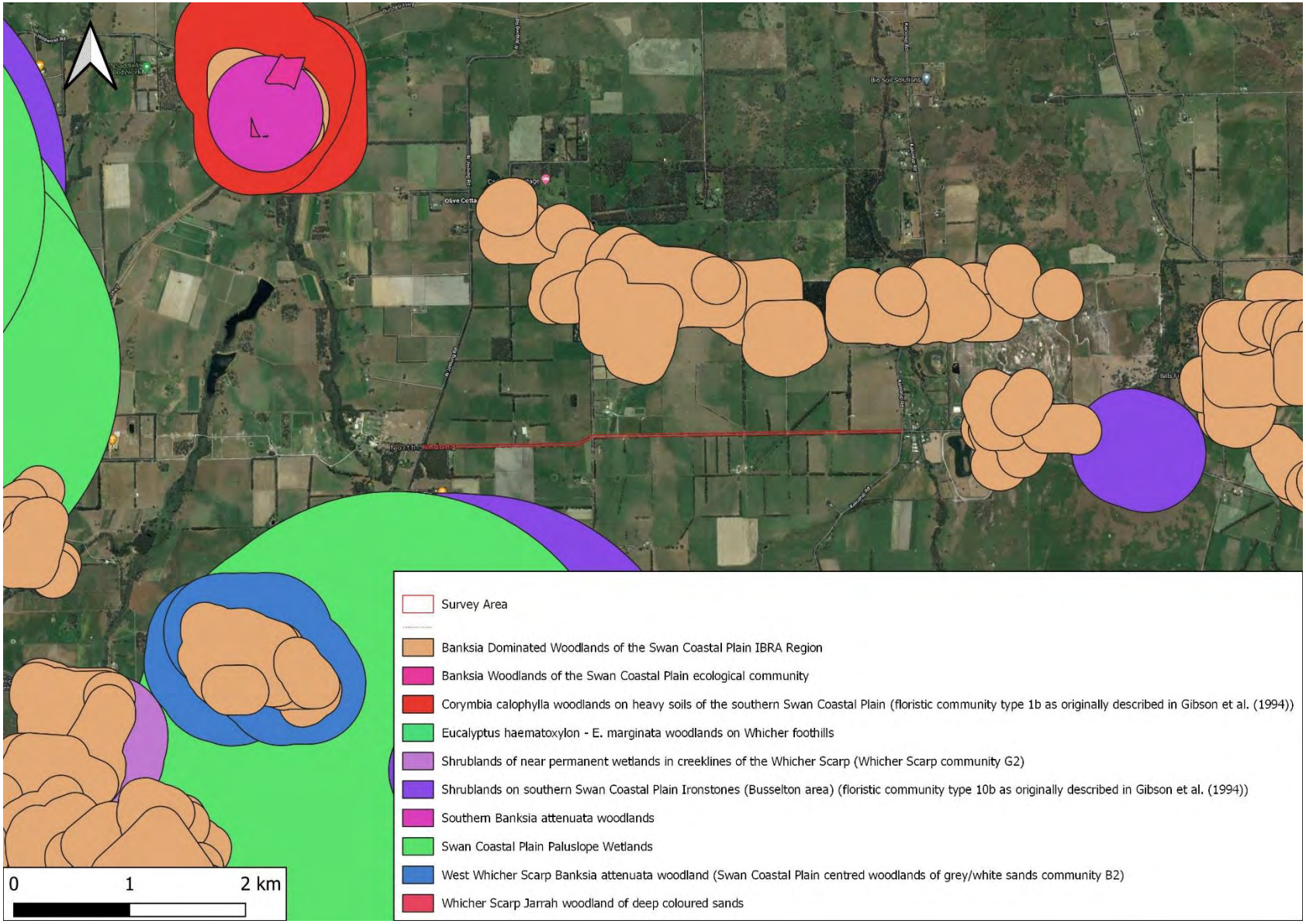
Community name	Conservation status (WA)	Conservation status (EPBC)	Closest occurrence
Shrublands on southern Swan Coastal Plain Ironstones (Busselton area) (floristic community type 10b as originally described in Gibson et al. (1994))^^*	Critically Endangered	Endangered	0.4km S
*Southern wet shrublands, Swan Coastal Plain (floristic community type 2 as originally described in Gibson et al. (1994))**	Endangered		6.8km E
Banksia Woodlands of the Swan Coastal Plain ecological community^^*	Priority 3	Endangered	0.4km N
*Herb rich saline shrublands in clay pans (floristic community type 7 as originally described in Gibson et al. (1994))**	Vulnerable	Critically Endangered	6.8km E
*Corymbia calophylla woodlands on heavy soils of the southern Swan Coastal Plain (floristic community type 1b as originally described in Gibson et al. (1994))**	Vulnerable		2.0km S
*Central Whicher Scarp Jarrah woodland**	Priority 1		7.7km SSE
*Eucalyptus patens, Corymbia calophylla, Agonis flexuosa Closed Low Forest**	Priority 1		5.4km N
*Eucalyptus rudis (flooded gum), Corymbia calophylla, Agonis flexuosa Closed Low Forest (near Busselton)**	Priority 1		9.1km NE
*Shrublands of near permanent wetlands in creeklines of the Whicher Scarp (Whicher Scarp community G2)**	Priority 1		3.9km SW
*Swan Coastal Plain Paluslope Wetlands**	Priority 1		0.4km S

Community name	Conservation status (WA)	Conservation status (EPBC)	Closest occurrence
*West Whicher Scarp Banksia attenuata woodland (Swan Coastal Plain centred woodlands of grey/white sands community B2)**	Priority 1	Endangered	1.5km SW
*Whicher Scarp Jarrah woodland of deep coloured sands**	Priority 1	Endangered	1.8km S
*Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region**	Priority 3 (i)	Endangered	0.4km N
*Eucalyptus haematoxylon - E. marginata woodlands on Whicher foothills**	Priority 3		1.9km S
*Quindalup Eucalyptus gomphocephala and/or Agonis flexuosa woodlands**	Priority 3	Endangered	7.1km N
*Southern Banksia attenuata woodlands**	Priority 3	Endangered	2.8km NW
*Claypans with mid dense shrublands of Melaleuca lateritia over herbs (classified as Clay Pans of the Swan Coastal Plain under EPBC Act)^^*	Priority 1	Critically Endangered (part)	13.5km NW
*Tuart (Eucalyptus gomphocephala) Woodlands and forests of the Swan Coastal Plain^^*	Priority 3	Critically Endangered	17km NE
*Subtropical and Temperate Coastal Saltmarsh^^*	Priority 3	Vulnerable	9.6km NE

* Conservation significant ecological communities within 10 km of the project area (DBCA 2021b)

^^ Conservation significant communities 'likely to occur in the area' identified by The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST; DotEE 2021b). Occurrences of these communities were not present within the DBCA dataset provided, therefore closest occurrence to the survey area could not be measured.

Figure 5: Conservation significant ecological communities (DBCA 2021b).



3. Methodology

3.1 Desktop review and likelihood of occurrence

Prior to the field survey, a desktop assessment was conducted to gather information on potentially occurring conservation listed flora species within the survey area. The following databases were searched:

- Commonwealth EPBC Act Protected Matters Search Tool (PMST) for Threatened species and communities listed under the EPBC Act (DotEE 2021b);
- DBCA and Western Australian Museum's NatureMap (DBCA 2007-2021);
- 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 2021a); and
- DBCA Threatened and Priority ecological communities database searches for TEC and PEC listed under Federal and State legislation (DBCA 2021b).

A 10 km buffer around the survey area was applied for each of the above database searches for flora and vegetation. These buffers were considered suitable based on species assemblages expected to occur within the survey area. Conservation listed flora in the database search results were further assessed for using likelihood of occurrence assessment criteria presented in **Appendix** .

3.2 Field survey

3.2.1 Survey team and timing

The field survey was conducted on the 11th, 12th and 15th of October 2021 by Daniel Marsh (Botanist). Daniel's relevant qualifications, experience and licences are provided in **Table 4**. Statistical analysis was conducted by Dr Shane Chalwell.

Table 4: Survey team's qualifications and relevant licences

Name	Qualifications	Relevant Experience	Licenses
Daniel Marsh	BSc. Hons. Biological Sciences	Daniel has experience undertaking flora and vegetation surveys across the Swan Coastal Plain.	Flora scientific collection license: FB62000074-2 DRF permit: TFL 182-1920

The Reconnaissance and Targeted Flora and Vegetation Survey and Targeted Flora Search was conducted in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). The survey area is located in the Swan Coastal Plain. Recommended survey timing for vegetation surveys in the South-West and Interzone is during Spring (September to November). The current survey complied with this recommendation.

3.2.2 Flora and vegetation survey

The desktop assessment, including a review of reports relevant to the survey area, aerial imagery and database searches, informed the targeted search and approximate number of quadrats required to describe vegetation communities within the survey area.

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

- Threatened flora or 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);
- PEC's endorsed by the Western Australian Minister for the Environment; and
- Priority (P) flora recognised by DBCA.

The vegetation on both sides of the road was traversed by foot to search for conservation significant flora (including habitat supporting these species), develop a list of flora species present within the survey area and to record opportunistic introduced flora (**Figure 6**). 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 collection 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).

Seven quadrats were established across the surevy area to broadly delineate and characterise vegetation communities (**Figure 7**). Quadrat size recommended for the Swan Coastal Plain is 10 x 10m^2. The road reserve either side of Hairpin Road is less than 10m wide so 5 x 20m^2 quadrats were established to achieve the same sampling area. 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, rock outcropping; and
- Biological information including vegetation structure, vegetation condition in accordance with Keighery (1994), degree of disturbance, dominant species present and species percentage cover of each stratum.

Seven photopoints were established to aid in mapping and to document the vegetation across the survey area. The following data was recorded within each photopoint:

- Site details (site name, site number, observers, date and location);
- Landform, vegetation condition and disturbance.

Figure 6: Survey effort – tracks.

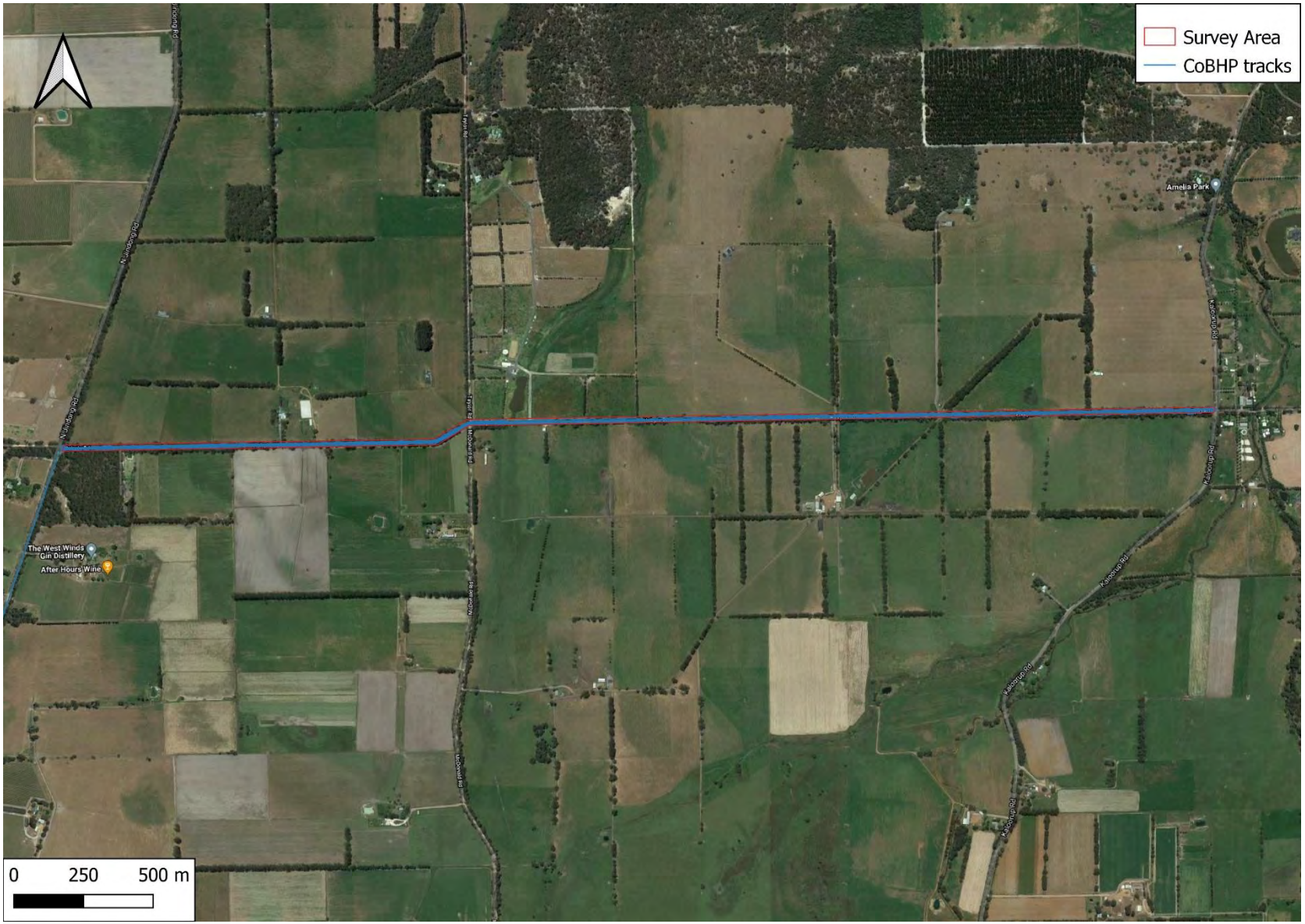
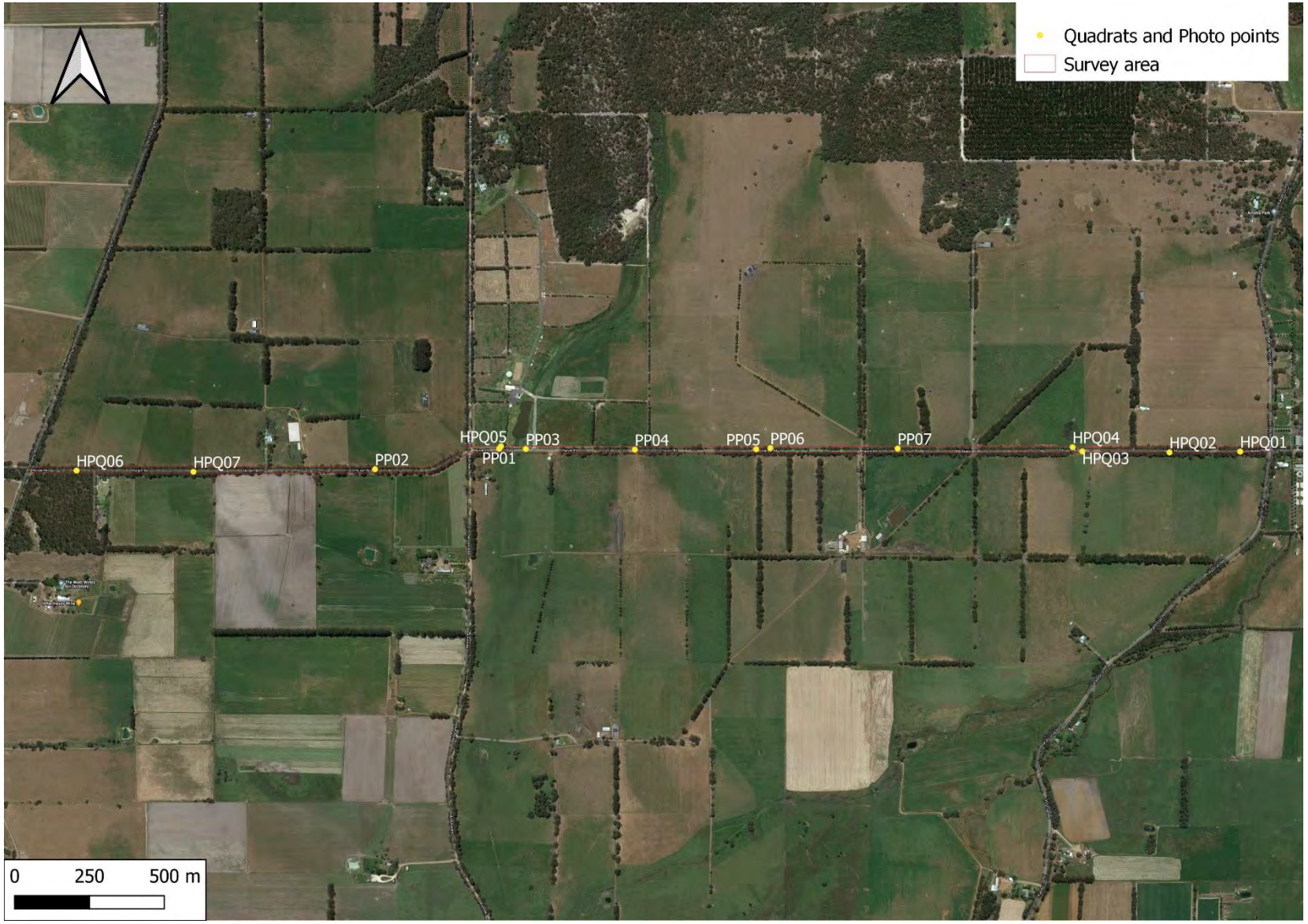


Figure 7: Survey effort – quadrat and photo point locations.



Specimen identification was undertaken by Daniel Marsh. Identification utilised taxonomic literature and keys and where required, specimens were confirmed using the Western Australian Herbarium (WAH) reference collection. One specimen of *Tetraria octandra* and five specimens of *Loxocarya cinerea* were submitted to the Western Australian Herbarium for paid identification to definitively exclude similar conservation significant flora identified in the desktop assessment as having the potential to occur in the survey area. Suitable material that meets WAH specimen lodgement requirements, such as flowering material and range extensions, will be submitted along with Threatened and Priority Report forms to DBCA, as required by conditions of collection licences issued under the BC Act.

3.3 Data analysis and Mapping

3.3.1 Plant community identification and description

Following the field survey, vegetation communities were defined using floristic composition vegetation classification and silhouette analysis with R packages Cluster and Vegan. Vegetation communities were described based on dominant flora species recorded in each stratum according to the National Vegetation Information System (NVIS; ESCAVI 2017). Vegetation community boundaries were defined using notes made in the field in conjunction with the use of recent and historical imagery.

3.3.2 Comparison with the Swan Coastal Plain regional survey dataset

The remnant vegetation of the southern Swan Coastal Plain (SCP) was surveyed by Gibson et al. (1994) to provide an understanding of the major floristic gradients across the region. The major plant communities (or FCTs) were defined by classifying the data according to the similarities in species composition between plots. When determining the FCT of a new record, a floristic analysis of species composition provides the most robust method that is consistent with the original classification, although presently a single consistent method for the determination of FCTs for vegetation data in the Swan Coastal Plain is not available.

Hierarchical agglomerative clustering is the usual first stage in classifying vegetation data into community types. This involves calculating the similarity (or more often, the dissimilarity) between plots within the dataset and then sequentially fusing the plots into groups according to their similarity. This type of method was used in the analysis of the original Swan Coastal Plain dataset (Gibson et al. 1994), but its use as the basis for assigning new plot data to the regional classification has some drawbacks. Firstly, a hierarchical clustering only applies to the relationships between plots, and the relative distances between them, within that particular dataset. The addition of new data often alters the relative distances and disrupts the clustering output. Secondly, as an unsupervised method, hierarchical clustering does not define rules for the membership of the defined groups, and so the addition of new plots requires the rebuilding of the entire hierarchy (De Cáceres and Wiser 2012).

The data for the Swan Coastal Plain regional survey (Gibson et al. 1994) was downloaded from the NatureMap website. This is largely similar to the original survey except for one site (OATES-1), which has now been excluded. The species nomenclature of the original dataset was updated to be consistent with current usage. Where original names could not be matched clearly to the updated usage, those taxa were removed from the analysis. The new data from the Hairpin Road survey was added to the matrix one plot at a time to remove any effect of spatial correlation between the new plots. Each new dataset was then analysed calculating the Bray-Curtis distance coefficient (or resemblance measure) and

the flexible beta linkage method (beta = -0.1). Assignment of the Hairpin Road quadrats was to the nearest distinct group by inspection of the resulting dendrogram. The analyses were undertaken using R packages Cluster and Vegan.

3.4 Survey 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 targeted priority flora survey for the study area are summarised in **Table 5.**

Table 5: Survey limitations

Limitation	Comment
Sources of information	**Not a constraint**. Information available was sufficient for the purposes of the work being undertaken and as such sources of information were not considered a major limitation.
Scope of works	**Not a constraint**. The survey requirement of a Reconnaissance Flora and Vegetation and Targeted Flora Survey within the survey area in accordance with relevant State and Commonwealth guidance was adequately met.
Completeness and intensity of survey	**Not a constraint**. The surveyarea was surveyed to the satisfaction of the scope and a Reconnaissance Flora and Vegetation Survey and Targeted Flora Search as per the relevant guidelines. The survey effort was adequately met. The survey area was searched for conservation significant species by undertaking traverses across the study area ensuring comprehensive coverage. Where habitat considered suitable for priority flora was present, survey effort was increased. This method provides an accurate assessment and likelihood of conservation significant species for the Swan Coastal Plain botanical province. An adequate number of quadrats were established to describe vegetation communities within the survey area.
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 6-8 weeks post wet season (September-November; EPA, 2016). The majority of conservation significant flora species identified in the desktop assessment as having the potential to occur within the survey area were described as flowering at the time of the survey. The survey timing was ideal for identifying the threatened orchids identified in the desktop survey as having the potential of occurring within the survey area. The remaining species were perennial species that could be observed outside their flowering period. During the survey, flora had sufficient material for identification at the WA Herbarium or had sufficient material to exclude threatened and priority flora species considered to have the potential to occur within the survey area.
Disturbances	**Potentially a constraint.** The vegetation within the survey area ranged from Degraded to Completely Degraded. The lack of native species recorded within the quadrats established during this survey is likely to have resulted in invalid grouping of all the Hairpin Road quadrats with The Swan Coastal Plain regional survey dataset Vegetation Community 11.
Resources	**Not a constraint.** The botanist conducting this field survey was suitably qualified to identify specimens, having previously undertaken numerous flora surveys in the Swan Coastal Plain botanical region of Western Australia. Where taxonomic assistance was required, specimens were submitted to the Western Australian Herbarium for paid identification.

Limitation	Comment
Accessibility/Remoteness	**Not a constraint.** All relevant areas in the survey area were accessed and able to be surveyed.

4. Results

4.1 Flora

A total of 74 taxa representing 61 genera and 27 families were recorded within the survey area. A complete flora species list is provided in **Appendix C**. Families with the highest number of species included Fabaceae (14 taxa), Poaceae (9), Cyperaceae (7), Asteraceae (5), Iridaceae (5), Proteaceae (5), and Myrtaceae (3). *Acacia* was the best represented genera with six species recorded, followed by *Briza* (2), *Isolepis* (2), *Juncus* (2), *Patersonia* (2), *Persoonia* (2), *Rumex* (2) and *Xanthorrhoea* (2).

No flora species listed as Threatened under the EPBC Act or the BC Act were recorded within the survey area. No Priority species listed by DBCA were recorded.

Thirty-six weed species were recorded within the survey area, one of which, **Asparagus asparagoides* is listed as a Declared Plant species in Western Australia pursuant to Section 22 of the State *Biosecurity and Agriculture Management Act 2007* (BAM Act; DPIRD 2021b) and a Weed of National Significance (WoNS). **Asparagus asparagoides* is exempt from control or management requirements (DPIRD 2021b). Weeds were abundant throughout the survey area, dominating the understorey.

4.2 Vegetation Communities

Five vegetation communities were delineated and mapped within the survey area (**Table 6; Figure 8; Figure 9**). Their extents within the survey area are listed in **Table 7**. The majority of the survey area comprised of vegetation community CcBgAeElAa: *Corymbia calophylla* mid open forest over isolated *Banksia grandis, Kingia australis* and/or *Xanthorrhoea preissii* over isolated *Acacia extensa* over **Ehrharta longiflora*, **Briza maxima* and **Bromus diandrus* low grassland over **Asparagus asparagoides*, **Hypochaeris glabra* and/or **Sparaxis bulbifera* low sparse forbland on loamy sand flats. This vegetation community consisted of a ubiquitous overstorey of *Corymbia calophylla* over a weedy understorey of grasses and herbs. Native shrubs and small trees were present but isolated throughout the survey area.

Vegetation community MrPdSb: *Melaleuca rhaphiophylla* tall shrubland over **Paspalum distichum*, **Ehrharta longiflora* and **Bromus diandrus* low closed grassland over **Sparaxis bulbifera*, **Arctotheca calendula*, **Sonchus oleraceus* low sparse forbland on sandy clay in open depressions was restricted to a small area to the eastern end of the survey area (**Figure 8**). *Melaleuca rhaphiophylla* was the only native species recorded in this vegetation community.

Vegetation community JpPdWmCc: Isolated clumps of *Juncus pallidus* over **Paspalum distichum*, **Holcus setigera*, **Anthoxanthum odoratum* low closed grassland over **Watsonia marginata*, **Rumex conglomeratus* tall sparse forbland over *Crassula closiana* and *Isolepis marginata* low sparse forbland

on clay in open depressions bordered vegetation community MrPdSb. The soil was waterlogged at the time of survey and a body of standing water was located to the north. This body of water lacked any riparian vegetation and was surrounded by pasture. This vegetation community was dominated by weeds with the only native species being isolated rushes/sedges/herbs.

Vegetation community AfElHg : *Agonis flexuosa* and *Corymbia calophylla* mid closed forest over **Ehrharta longiflora, *Briza maxima* and **Anthoxanthum odoratum* tall open grassland over **Hypochaeris glabra*, **Rumex conglomeratus* and **Lactuca serriola* low sparse forbland was isolated to the central part of the survey area. The only native species recorded in this vegetation community were the overstorey trees *Agonis flexuosa* and *Corymbia calophylla*.

Parts of the survey area consisted of cleared areas with no overstorey, with an understorey of lawn or introduced tussock grasses. These areas were classified as Vegetation Community C: Cleared areas with inadequate flora structure and composition to define.

Multivariate comparative analysis grouped quadrats HP02, HP03, HP04 and HP05 together and HP01, HP06 and HP07 together (**Appendix D**). Silhouette analysis indicated that quadrats 2 and 5 were misclassified and were more similar to group HP01, HP06 and HP07 (**Appendix E**). Therefore, quadrats HP01, HP02, HP06 and HP07 were grouped together. This grouping was congruent with observations in the field. HP05 was split as this was the only vegetation community with an overstorey of *Agonis flexuosa.*

Table 6: Vegetation communities recorded within the survey area.

Image	Vegetation community description	Quadrats
	**Vegetation community CcBgAeElAa**: *Corymbia calophylla* mid open forest over isolated *Banksia grandis*, *Kingia australis* and/or ***Xanthorrhoea preissii*** over isolated *Acacia extensa* over **Ehrharta longiflora, *Briza maxima and *Bromus diandrus low grassland* over **Asparagus asparagoides*, **Hypochaeris glabra* and/or **Sparaxis bulbifera* low sparse forbland on loamy sand flats.	1, 2, 6, 7
	**Vegetation community MrPdSb**: *Melaleuca rhaphiophylla* tall shrubland over **Paspalum distichum*, **Ehrharta longiflora* and **Bromus diandrus low closed grassland* over **Sparaxis bulbifera*, **Arctotheca calendula, *Sonchus oleraceus* low sparse forbland on sandy clay in open depressions.	3
	**Vegetation community JpPdWmCc**: Isolated clumps of *Juncus pallidus* over **Paspalum distichum*, **Holcus setigera*, **Anthoxanthum odoratum* low closed grassland over **Watsonia marginata*, **Rumex conglomeratus* tall sparse forbland over *Crassula closiana* and *Isolepis marginata* low sparse forbland on clay in open depressions.	4

Image	Vegetation community description	Quadrats
	**Vegetation community AfElHg** : *Agonis flexuosa* and *Corymbia calophylla* mid closed forest over **Ehrharta longiflora, *Briza maxima* and **Anthoxanthum odoratum* tall open grassland over **Hypochaeris glabra*, **Rumex conglomeratus* and **Lactuca serriola* low sparse forbland.	5
	**Vegetation Community C:** Cleared areas with inadequate flora structure and composition to define.	NA

Table 7: Extents of Vegetation Communities recorded during the current survey (m^2).

AfElHg	C	CcBgAeElAa	JpPdWmCc	MrPdSb
787.6 (1.3%)	4,088.1 (6.8%)	54,348.4 (89.9%)	347.8 (0.6%)	906.4 (1.5%)

Figure 8: Vegetation communities recorded during the current survey – Western part.

Figure 9: Vegetation communities recorded during the current survey – Eastern part.

4.3 Vegetation condition

Vegetation condition within the survey area ranged from Degraded to Completely Degraded (**Figure 10**) based on the condition scale adapted from Keighery (1994) described in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). Their extents within the survey area are listed in **Table 8.**

Vegetation community CcBgAeElAa was assessed as Degraded because while comprising of a native overstorey of *Corymbia calophylla*, the understorey comprised of predominantly introduced grasses and herbs. Native shrubs and small trees were present but isolated throughout the survey area. Species richness was highest in HPQ06 (9), located in the south-western corner of the survey area which is bordered by a block of remnant vegetation. This area of road verge however is infested with **Watsonia marginata*.

All other vegetation communities within the survey area were assessed as Completeley Degraded. Vegetation communities MrPdSb and AfEhHg possessed an overstorey of native trees however the structure of the understorey was no longer intact. Vegetation communities JpPdWmCc and C lacked any overstorey while the understorey was largely or completely devoid of native species.

Table 8: Extents of Vegetation Condition recorded during the current survey (m^2).

Degraded	Completely Degraded
54,348.4 (98.9%)	6129.9 (10.1%)

4.4 Comparison with Swan Coastal Plain regional survey dataset

Multivariate comparative analysis with the Swan Coastal Plain regional survey dataset (Gibson et al. 1994) broadly grouped all quadrats established in the current survey with vegetation community type 11: Wet forest and woodlands (**Appendix F**). Common species of this community type include *Astartea* aff. *fascicularis*, *Lepidosperma longitudinale* and *Pericalymma elliptica* and it is distributed from Bullsbrook south to Pinjarra with an outlying site south of Bunbury (Gibson et al. 1994).

HPQ03 and HPQ07 were most closely grouped with Pres-1 from the Swan Coastal Plain regional survey dataset. This site represents community type 29a: Coastal shrublands on shallow sands, southern Swan Coastal Plain (P3). This community is described as 'mostly heaths on shallow sands over limestone close to the coast. No single dominant but important species include *Spyridium globulosum*, *Rhagodia baccata*, and *Olearia axillaris*' (DBCA 2021c).

HPQ05 was mostly closely grouped with Possum5 from the Swan Coastal Plain regional survey dataset. This site represents community type 17: *Melaleuca rhaphiophylla-Gahnia trifida* seasonal wetlands. This community type is generally dominated by *Melaleuca rhaphiophylla* with *Gahnia trifida* usually dominant or subdominant in the understorey (Gibson et al. 1994).

No conservation significant ecological communities listed under the EPBC Act, the BC Act or by DBCA occur or were inferred to occur within the survey area.

Figure 10: Vegetation condition recorded during the current survey.

5. Discussion

Daniel Marsh undertook a Reconnaissance Flora and Vegetation and Targeted survey of the road verge of Hairpin Road between North Jindong Road and Kaloorup Road on the 11th, 12th and 15th of October 2021. No flora species listed as Threatened under the EPBC Act or the BC Act were recorded within the survey area. No Priority species listed by DBCA were recorded. The timing of the survey was considered ideal for identifying conservation significant flora species, particularly threatened orchids, identified in the desktop survey as having the potential of occurring within the survey area. Survey effort was considered adequate to describe the vegetation within the survey area and locate any conservation significant flora present. Species that were considered to have the potential to occur within the survey area are mostly conspicuous. As a result, it would be expected that the extensive foot-transverse of the survey area would have recorded individuals if they were indeed present.

Five vegetation communities were delineated and mapped within the surveyarea. All vegetation communities were assessed as either Degraded or Completely Degraded. Multivariate comparative analysis with the Swan Coastal Plain regional survey dataset broadly grouped all quadrats established in the current survey with community type 11: Wet forest and woodlands. This is not congruent with descriptive characteristics, species composition and locations of quadrats in the Swan Coastal Plain regional survey dataset or observations in the field.

HPQ03 and HPQ07 were most closely grouped with site Pres-1 from the Swan Coastal Plain regional survey dataset. This site represent community type 29a: Coastal shrublands on shallow sands, southern Swan Coastal Plain (P3). Pres-1 does not have any native taxa in common with HPQ03 or HPQ07 and had a high proportion of weeds recorded. In addition, community type 29a is restricted to the Quindalup system while the survey area is located on the Pinjarra Plain (Gibson et al. 1994). The vegetation at quadrats HPQ03 and HP07 is not considered to represent community type 29a Coastal shrublands on shallow sands, southern Swan Coastal Plain (P3).

HPQ05 was mostly closely grouped with Possum5 from the Swan Coastal Plain regional survey dataset. This site represent community type 17: *Melaleuca rhaphiophylla-Gahnia trifida* seasonal wetlands. HPQ05 was dominated by *Agonis flexuosa* while *Melaleuca rhaphiophylla* and *Gahnia trifida* were not present. *Agonis flexuosa* was recorded at Possum5 but was likely grouped with HPQ05 based on weed species present. In addition, community type 17 is restricted to the Spearwood, Quindalup and Vasse land systems close to the coast while the survey area is located on the Pinjarra Plain (Gibson et al. 1994). Vegetation at quadrat HPQ05 is not considered to represent community type 17: *Melaleuca rhaphiophylla-Gahnia trifida* seasonal wetlands.

The degraded nature of the survey area is likely to have influenced the classification of these quadrats. Degraded vegetation communities create problems with assigning community types from the Swan Coastal Plain regional survey dataset because the lack of native species causes groupings to be calculated based on weeds. The vegetation communities recorded within the survey area were considered too degraded to meaningfully assign community types from the Swan Coastal Plain regional survey. Ultimately, the vegetation communities recorded in the survey area are poor examples of their original community type and would be difficult to regenerate to a state approaching good condition.

None of the vegetation communities recorded within the survey area were inferred to represent conservation significant ecological communities listed under the EPBC Act, the BC Act or by DBCA.

For the purposes of a Reconnaissance and targeted flora and vegetation survey, adequate data was collected to define and assess the presence, extent and significance of flora and vegetation communities within the survey area. Taxa recorded are generally widespread throughout the region and vegetation within the survey is considered Degraded or Completely Degraded.

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Appendix A Likelihood of occurrence assessment criteria

Likelihood rating	Criteria
Recorded	The species has previously been recorded within survey area from DBCA database search results and/or from previous surveys of the survey area, and/or the species has been confirmed through a current vouchered specimen at WA Herbarium.
Potential	The species has not previously been recorded from within the survey area. However, (one or more criteria requires to be met): • targeted surveys may locate the species based on records occurring in proximity to the survey area and suitable habitat occurring in the project area • the survey area has been assessed as having potentially suitable habitat • the species is known to be cryptic and may not have been detected despite extensive surveys
Unlikely	The species has been recorded locally through DBCA database searches. However, it has not been recorded within the survey area and • it is unlikely to occur due to the site lacking critical habitat, having at best marginally suitable habitat, and/or being severely degraded • it is unlikely to occur due to few historic record/s and no other current collections in the local area. The species has been recorded within the bioregion based on literature review but has not been recorded locally or within the survey area through DBCA database searches. • The species has not been recorded in the survey area despite adequate survey efforts, such as a standardised methodology or targeted searching within potentially suitable habitat.

Appendix B Flora likelihood of occurrence assessment

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Brachyscias verecundus	CE	T	PMST	Moss swords on granite.	No	Oct, Nov, Feb	Yes	NA	Unlikely No suitable habitat
Caladenia procera	CE	T	Naturemap, PMST, WAHerb, TPFL	Rich clay loam,. Alluvial loamy flats, jarrah/marri/peppermint woodland, dense heath, sedges.	Yes	Sep-Oct	Yes	3.3km N	Potential
Grevillea brachystylis subsp. *grandis*	CE	T	Naturemap, PMST, WAHerb, TPFL	Dry red loam, wet brown sandy loam with ironstone gravel, grey-brown sand. Flats, drains, road verges, watercourses.	Yes	July to Jan	Yes	2.3km S	Potential
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CE	T	PMST	Sandy with lateritic pebbles. Near winter-wet flats, in low woodland with weedy grasses	Yes	Oct	Yes	NA	Unlikely Closest record >10km
Banksia squarrosa subsp. *argillacea*	VU	T	Naturemap, PMST, WAHerb, TPFL	Winter-wet flats, clay flats	Yes	Jun-Nov	Yes	2.3km S	Potential
Chamelaucium roycei (sp. S coastal plain (R.D.Royce 4872))	VU	T	Naturemap, PMST, WAHerb, TPFL	Sandy clay, clay, lateritic soils. Winter-wet flats, swamps, stream banks	Yes	Aug-Dec	Yes	0.9km N	Potential
Daviesia elongata	VU	T	Naturemap, PMST, WAHerb, TPFL	Sand, laterite	Yes	Sep-Feb	Yes	2.4km S	Potential
Diuris micrantha	VU	T	PMST	Brown loamy clay. Winter-wet swamps, in shallow water	Yes	Sep-Oct	Yes	NA	Unlikely Closest record >10km
Drakaea micrantha	VU	T	Naturemap, PMST, TPFL	White-grey sand	No	Sep to Oct	Yes	4.2km SW	Unlikely No suitable habitat

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Gastrolobium modestum	VU	T	Naturemap, PMST, WAHerb, TPFL	Shallow red clay-loam or grey sand, ironstone. Gullies and edges of flats	No	Sep to Nov	Yes	8.7km SE	Unlikely No suitable habitat
Grevillea elongata	VU	T	PMST	Gravelly clay, sandy clay, sand. Road verges, swamps, creek banks	Yes	Oct	Yes	NA	Unlikely Closest record >10km
Morelotia australiensis (Tetraria australiensis)	VU	T	Naturemap, PMST, TPFL	Sand, sandy loam. Flat plains, gentle slopes.	Yes	Nov to Dec	No	7.7km E	Potential
Banksia nivea subsp. *uliginosa*	EN	T	Naturemap, PMST, WAHerb, TPFL	Sandy clay, gravel. Swampy wetlands, wetland plains, shrublands, heathland, Jarri-Marri Forest	Yes	Aug-Sep	No	7.2km S	Potential
Caladenia busselliana	EN	T	Naturemap, PMST, WAHerb, TPFL	Winter-wet swamps	Yes	Sep-Oct	Yes	3.3km NW	Potential
Caladenia excelsa	EN	T	TPFL	White, grey or brown sand, sandy loam.	Yes	Sep to Oct	Yes	9km ENE	Potential
Caladenia hoffmanii	EN	T	PMST	Clay, loam, laterite, granite. Rocky outcrops and hillsides, ridges, swamps and gullies.	Yes	Aug-Oct	Yes	NA	Unlikely Closest record >10km
Caladenia huegelii	EN	T	Naturemap, PMST	Grey or brown sand, clay loam.	Yes	Sep-Oct	Yes	NA	Unlikely Closest record >10km
Caladenia viridescens	EN	T	PMST, TPFL	Loam, grey sand	Yes	Sep-Oct	Yes	8.7km NW	Potential
Drakaea elastica	EN	T	PMST	White or grey sand. Low-lying situations adjoining winter-wet swamps	Yes	Oct to Nov	Yes	NA	Unlikely Closest record >10km
Eucalyptus x phylacis	EN	T	PMST	Laterite, loam over granite. Coastal areas	No	May	No	NA	Unlikely Closest record >10km

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Gastrolobium papilio	EN	T	PMST	Sandy clay over ironstone and laterite. Flat plains	No	Oct to Dec	Yes	NA	Unlikely Closest record >10km
Lambertia echinata subsp. *occidentalis*	EN	T	PMST	White sandy soils over laterite, orange/brown-red clay over ironstone. Flats to foothills, winter-wet sites	No	Feb or Apr or Dec	No	NA	Unlikely Closest record >10km
Petrophile latericola	EN	T	PMST	Red lateritic clay. Winter-wet flats	No	Nov	No	NA	Unlikely Closest record >10km
Verticordia densiflora var. *pedunculata*	EN	T	Naturemap, PMST, WAHerb, TPFL	Grey/yellow sand, sandy loam. Winter-wet low-lying areas	Yes	Dec or Jan	No	4.7km ESE	Potential
Verticordia plumosa var. *ananeotes*	EN	T	Naturemap, PMST, WAHerb, TPFL	Sandy loam. Seasonally inundated plains	Yes	Nov to Dec	No	2.5km S	Potential
Verticordia plumosa var. *vassensis*	EN	T	Naturemap, PMST, WAHerb, TPFL	Sandy clay. Winter-wet plain	Yes	Jan	No	4.7km E	Potential
Andersonia ferricola	NA	P1	Naturemap, WAHerb, TPFL	White sand or red-brown loam over ironstone. Seasonally wet flats	Yes	Oct	Yes	7.2km S	Potential
Loxocarya striata subsp. *implexa*	NA	P1	Naturemap, WAHerb	Red clay over ironstone, silty soil over laterite. Winter wet flats	Yes	March	No	8.8km SSE	Potential
Schoenus sp. Jindong (R.D. Royce 2485)	NA	P1	Naturemap, WAHerb	Red loamy soil, grey sand clay. Stream banks, valley flats.	Yes	Unknown	Unknown	2.3km S	Potential
Stylidium ferricola	NA	P1	Naturemap, WAHerb	Shallow red-brown clay loam over ironstone. Seasonally wet poorly-drained slopes	No	July and Nov	Yes	8.7km SE	Unlikely Closest record >10km

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Thysanotus formosus	NA	P1	WAHerb	Clayey sand, sandy loam. In situations often inundated in winter.	Yes	Nov to Dec or Jan	No	8.8km SSE	Potential
Actinotus whicheranus	NA	P2	Naturemap, WAHerb	White sand pockets over laterite	Yes	Dec or Jan to Mar	No	7.2km S	Potential
Andersonia barbata	NA	P2	Naturemap, WAHerb, TPFL	White sand. Swampy areas	Yes	Nov	No	8.0km E	Potential
Calystegia sepium subsp. roseata	NA	P2	Naturemap, WAHerb	Black calcareous sandy clay over clay. Winter wet swamp, flowline	No	Oct	Yes	8.9km NE	Unlikely No suitable habitat
Leptomeria furtiva	NA	P2	Naturemap, WAHerb, TPFL	Grey or black peaty sand. Winter-wet flats	No	Aug to Oct	Yes	7.0km E	Unlikely No suitable habitat
Lepyrodia extensa	NA	P2	Naturemap, WAHerb	Sand & sandy peat. Seasonally inundated swamps	No	Sep, Oct, Dec, Feb	Yes	8.2km E	Unlikely No suitable habitat
Leucopogon sp. Busselton (D. Cooper 243)	NA	P2	Naturemap, WAHerb	Seasonally wet, white/grey/black sand, sandy clay. Seasonal dampland	Yes	Aug to Oct	Yes	4.8km SE	Potential
Melaleuca incana subsp. Gingilup (N. Gibson & M. Lyons 593)	NA	P2	WAHerb	Red-grey sand, sandy clay over ironstone. Seasonally wet flats.	No	May to Jun	No	7.5km S	Unlikely No suitable habitat
Acacia inops	NA	P3	TPFL	Black peaty sand, clay. Swamps, creeks.	No	Sep to Nov	Yes	9.1km W	Unlikely No suitable habitat
Acacia lateriticola var. Glabrous variant (B.R.Maslin 6765)	NA	P3	Naturemap, WAHerb	Lateritic soils	Yes	Aug or Oct	Yes	7.4km NE	Potential
Boronia capitata subsp. *gracilis*	NA	P3	Naturemap, WAHerb, TPFL	White/grey or black sand. Winter-wet swamps, hillslopes	Yes	Jun to Nov	Yes	2.3km S	Potential

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Boronia tetragona	NA	P3	Naturemap, WAHerb	Black/white sand, laterite, brown sandy loam. Winter-wet flats, swamps, open woodland	Yes	Oct to Dec	Yes	6.8km E	Potential
Calothamnus lateralis var. *crassus*	NA	P3	Naturemap, TPFL	Clay and sand, sandy peat, loam. Winter-wet flats, plains, riverbanks, swamps, depressions	Yes	June, Aug, Sep, Oct, Jan	Yes	7.2km S	Potential
Chordifex gracilior	NA	P3	Naturemap, WAHerb, TPFL	Peaty sand. Swamps	No	Sep to Dec	Yes	2.6km S	Unlikely No suitable habitat
Cyathochaeta teretifolia	NA	P3	Naturemap, WAHerb, TPFL	Grey sand, sandy clay. Swamps, creek edges	Yes	Jan, May, Sep, Oct	Yes	0.5km S	Potential
Grevillea brachystylis subsp. *brachystylis*	NA	P3	Naturemap, WAHerb, TPFL	Black sand, sandy clay. Swampy situations.	Yes	Aug to Nov	Yes	0.9km NNE	Potential
Grevillea bronwenae	NA	P3	WAHerb	Grey sand over laterite, lateritic loam. Hillslopes	No	Jun to Dec	Yes	7.9km E	Unlikely No suitable habitat
Hakea oldfieldii	NA	P3	Naturemap, WAHerb, TPFL	Red clay or sand over laterite. Seasonally wet flats	Yes	Aug to Oct	Yes	0.7km SE	Potential
Isopogon formosus subsp. *dasylepis*	NA	P3	Naturemap, WAHerb, TPFL	Sand, sandy clay, gravelly sandy soils over laterite. Often swampy areas	Yes	Jun to Dec	Yes	0.5km S	Potential
Jacksonia gracillima	NA	P3	Naturemap, WAHerb	Sandy loam, sand, peaty sand. Sandplains, mid-slopeswinter-wet flats	Yes	October and November	Yes	7.9km NE	Potential
Johnsonia inconspicua	NA	P3	Naturemap, WAHerb, TPFL	White-grey or black sand. Low dunes, winter-wet flats	No	Oct to Nov	Yes	3.5km ESE	Unlikely No suitable habitat
Lasiopetalum laxiflorum	NA	P3	Naturemap, WAHerb	Sand, sandy clay, clay often over laterite. Plains, slopes, road verges, watercoures.	Yes	October or November	Yes	0.4km N	Potential

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Lepyrodia heleocharoides	NA	P3	Naturemap, WAHerb, TPFL	Moist peaty sand. Dry or seasonally inundated heath or woodland, swamps	No	Dec	No	2.5km NNW	Unlikely No suitable habitat
Loxocarya magna	NA	P3	Naturemap, WAHerb, TPFL	Sand, loam, clay, ironstone. Seasonally inundated or damp habitats	Yes	Sep or Nov	Yes	3.1km NW	Potential
Olearia strigosa	NA	P3	WAHerb	Sandy loam. Open forest.	Yes	Dec or Jan to May	No	3.4km NW	Potential
Pimelea ciliata subsp. *longituba*	NA	P3	Naturemap, WAHerb	Grey sand over clay, loam. Plains, slopes	Yes	Oct to Dec	Yes	2.3km S	Potential
Pithocarpa corymbulosa	NA	P3	Naturemap	Gravelly or sandy loam. Amongst granite outcrops	No	Jan to Apr	No	NA	Unlikely No suitable habitat
Pultenaea pinifolia	NA	P3	Naturemap, WAHerb, TPFL	Loam or clay. Floodplains, swampy areas	Yes	Oct to Nov	Yes	5.1km N	Potential
Schoenus benthamii	NA	P3	Naturemap, WAHerb	White, grey sand, sandy clay. Winter-wet flats, swamps	Yes	Oct to Nov	Yes	5.0km SE	Potential
Synaphea decumbens	NA	P3	WAHerb	Sand over laterite	No	Sep to Oct	Yes	8.0km S	Unlikely No suitable habitat
Synaphea hians	NA	P3	Naturemap, WAHerb	Sandy soils. Rises	No	Jul or Sep to Nov	No	0.5km S	Unlikely No suitable habitat
Synaphea petiolaris subsp. *simplex*	NA	P3	Naturemap, WAHerb, TPFL	Sandy soils. Flats, winter-wet areas	Yes	Sep to Oct	Yes	1.0km N	Potential
Acacia flagelliformis	NA	P4	Naturemap, WAHerb, TPFL	Sandy soils. Winter-wet areas	Yes	May to Sep	No	1.7km S	Potential
Acacia semitrullata	NA	P4	Naturemap, WAHerb, TPFL	White/grey sand, sometimes over laterite, clay. Sandplains, swampy areas	Yes	May to Oct	Yes	3.0km NNW	Potential

Species	Conservation Status		Source[4]	Habitat	Suitable Habitat Present	Flowering Period	Flowering Y/N	Closest Record	Likelihood of occurrence
	EPBC Act[1]	BC Act[2]/ DBCA[3]							
Calothamnus quadrifidus subsp. *teretifolius*	NA	P4	Naturemap, WAHerb, TPFL	Sand, clay, loam often over laterite. Flats, hills, wetlands.	Yes	Oct to Dec, Jan	Yes	1.1km N	Potential
Chamelaucium erythrochlorum (Chamelaucium sp. Yoongarillup (G.J. Keighery 3635))	NA	P4	Naturemap, TPFL	Sandy loam, clayey sand. Riverbanks, ridges, slopes	No	Nov to Feb	No	9.6km SE	Unlikely No suitable habitat
Lambertia rariflora subsp. *rariflora*	NA	P4	Naturemap, TPFL	Red-brown clay soils, black organic loam, laterite. Near intermittent streams	No	Feb to Mar or May	No	9.8km S	Unlikely No suitable habitat
Ornduffia submersa	NA	P4	Naturemap, TPFL	Clay. winter wetlands, clay flats, ephemeral creeks	Yes	Aug to Dec	Yes	7.0km NNE	Potential
Stylidium leeuwinense	NA	P4	Naturemap, WAHerb	Grey to black peaty sand. Winter-wet habitats and depressions. Shrubland, heath, sedgeland or low woodland	No	Feb to May	No	2.6km S	Unlikely No suitable habitat
Thysanotus glaucus	NA	P4	Naturemap, TPFL	White, grey or yellow sand, sandy gravel	Yes	Oct to Dec or Jan to Mar	Yes	9.5km SW	Potential
Verticordia lehmannii	NA	P4	Naturemap, WAHerb, TPFL	Sandy clay. Winter-wet flats	Yes	Jan or Apr to Jun or Aug or Dec	No	0.4km ENE	Potential

[1]EPBC Act = Flora listed under the *Environment Protection and Biodiversity Conservation Act 1999*

CE = listed as Endangered under the EPBC Act, EN = listed as Endangered under the EPBC Act, VU = listed as Endangered under the EPBC Act

[2]BC Act = Flora listed under the State *Biodiversity Conservation Act 2016*.

S1 = Schedule 1: Flora that are considered likely to become extinct or rare, as critically endangered flora

S2 = Schedule 2: Flora that are considered likely to become extinct or rare, as endangered flora

S3 = Schedule 3: Flora that are considered likely to become extinct or rare, as vulnerable flora

[3]DBCA = Flora listed as Priority species under the DBCA

P1 = Priority 1: Poorly known taxa, P2 = Priority 2: Poorly known taxa, P3 = Priority 3: Poorly known taxa, P4 = Priority 4: Rare, Near Threatened and other species in need of monitoring.

[4]TPFL = Department of Biodiversity, Conservation and Attractions Threatened and Priority Flora database search (DBCA 2019a); WA Herb = Western Australian Herbarium Specimen database for Threatened and Priority flora species (DBCA 2019a); NatureMap = NatureMap database search (DBCA 2007-2019); PMST = EPBC Act Protected Matters Search Tool report (DoEE 2019

Appendix C Species List

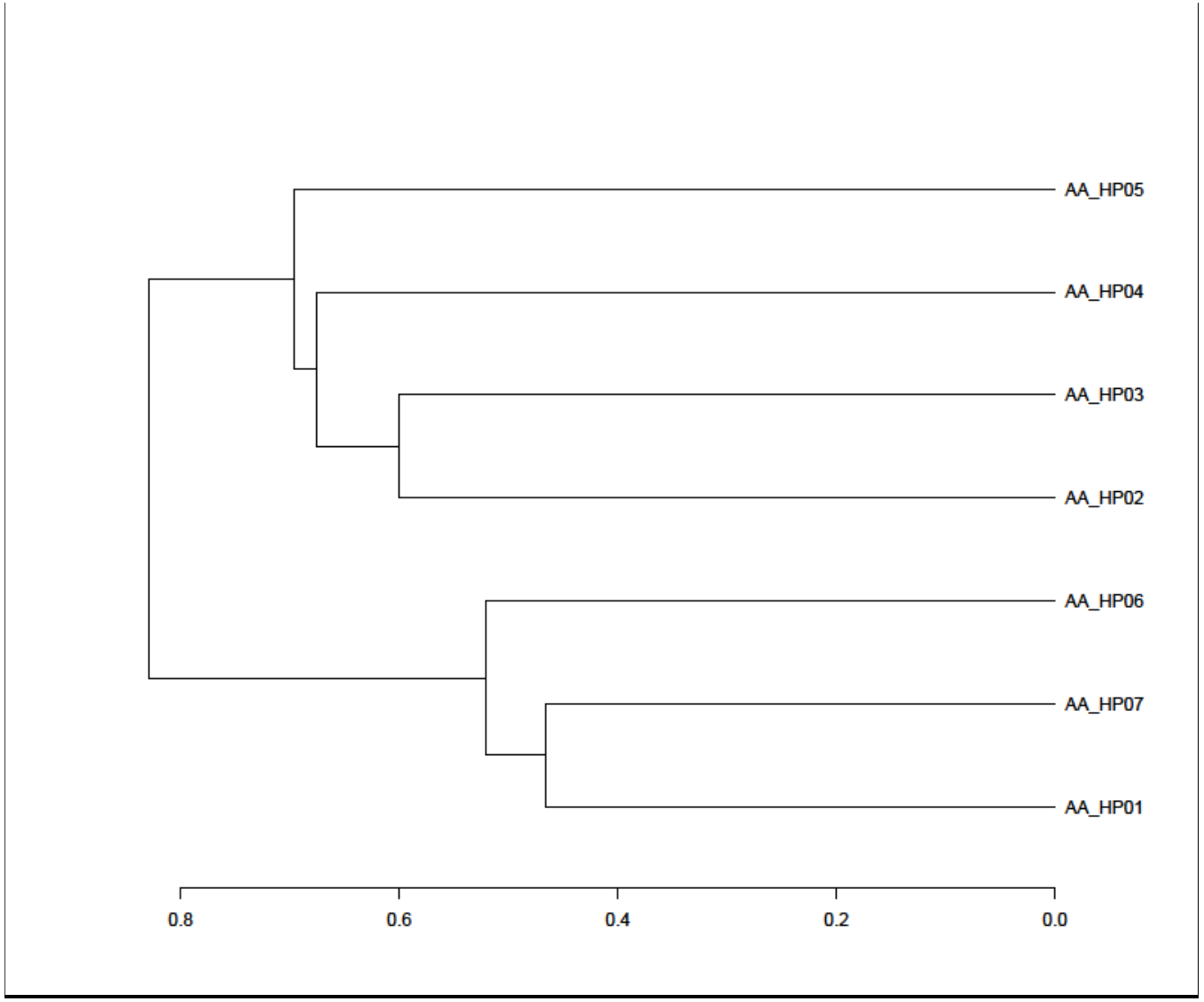
Species	HPQ01	HPQ01Opp	HPQ02	HPQ02Opp	HPQ03	HPQ03Opp	HPQ04	HPQ04Opp	HPQ05	HPQ06	HPQ06Opp	HPQ07	Opp
**Acacia ?dealbata*											X		
Acacia divergens	X												
Acacia extensa	X									X			
**Acacia longifolia*													X
Acacia pulchella var. glaberrima		X											
Acacia saligna				X									
Agonis flexuosa									X				
**Anthoxanthum odoratum*	X				X		X		X			X	
**Arctotheca calendula*					X								
**Asparagus asparagoides*										X		X	
**Avena barbata*	X		X		X							X	
Banksia grandis		X									X	X	
Bossiaea ornata										X			X
**Brassica tournefortii*													X
**Briza maxima*	X		X		X		X		X	X		X	
**Briza minor*													X
**Bromus diandrus*	X		X		X		X			X		X	
**Callitriche stagnalis*		X											
**Cerastium glomeratum*								X	X				

Species	HPQ01	HPQ01Opp	HPQ02	HPQ02Opp	HPQ03	HPQ03Opp	HPQ04	HPQ04Opp	HPQ05	HPQ06	HPQ06Opp	HPQ07	Opp
**Chamaecytisus palmensis*													X
Corymbia calophylla	X		X						X	X		X	
**Cotula turbinata*						X							
Crassula closiana							X						
Cyathochaeta avenacea													X
Dasypogon hookeri													X
**Ehrharta longiflora*	X		X		X				X	X		X	
Eucalytpus marginata	X												
*Ficus carica													X
**Fumaria capreolata*													X
Gastrolobium capitatum								X					
Geranium retrorsum													X
Hakea lasianthoides													X
**Holcus setiger*							X			X		X	
**Hypochaeris glabra*	X								X	X		X	
Isolepis cernua var. setiformis									X				
Isolepis marginata							X						X
Juncus pallidus				X			X						
Kennedia coccinea subsp. coccinea										X			
Kingia australis	X		X								X		
**Lactuca serriola*									X				

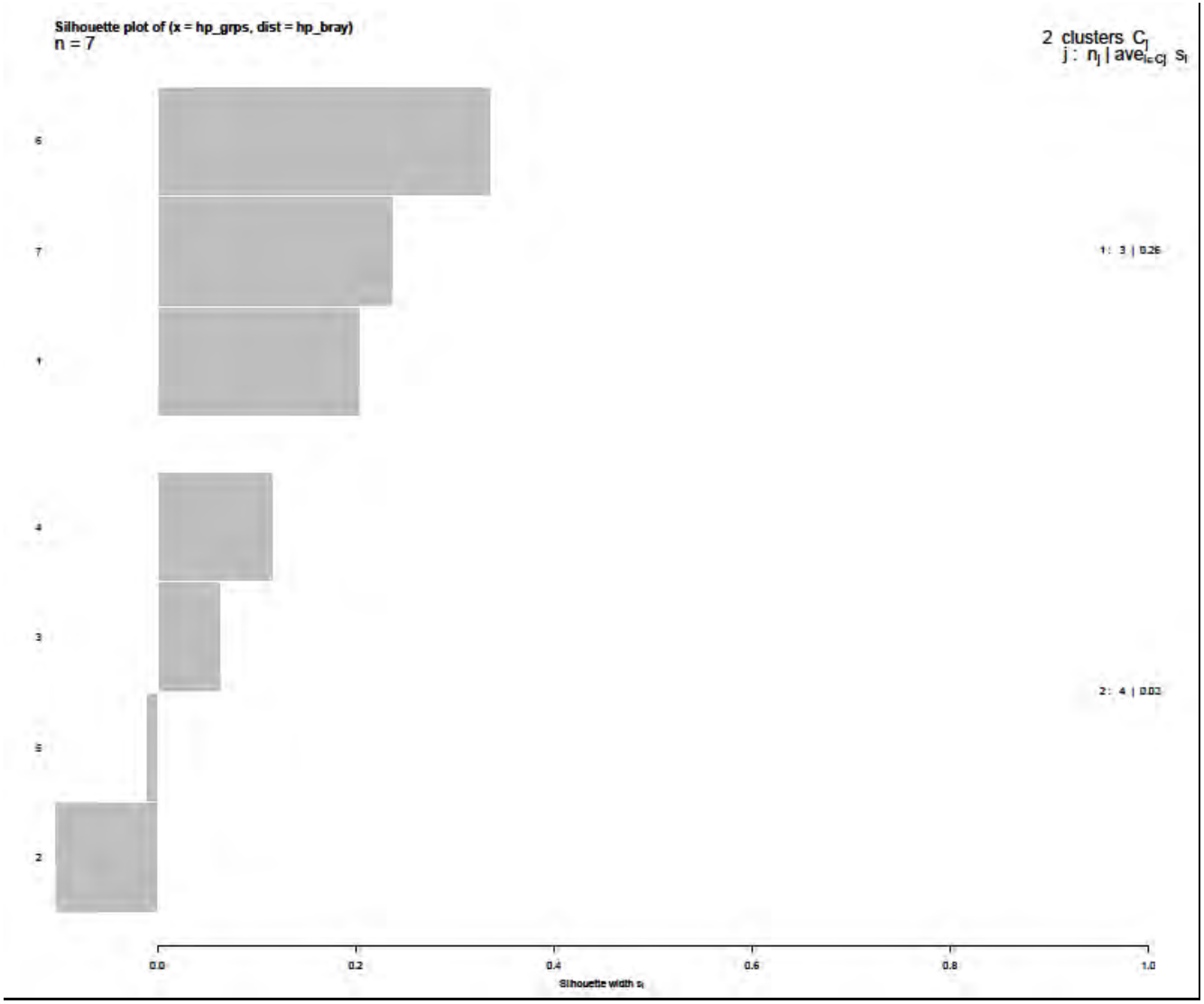
Species	HPQ01	HPQ01Opp	HPQ02	HPQ02Opp	HPQ03	HPQ03Opp	HPQ04	HPQ04Opp	HPQ05	HPQ06	HPQ06Opp	HPQ07	Opp
Lepidosperma pubisquameum													X
Leucopogon verticillatus										X			
Lomandra preissii													X
Loxocarya cinerea										X		X	
Melaleuca rhaphiophylla					X								
Mesomelaena tetragona													X
Mirbelia dilatata											X		
Netrostylis sp. Jarrah Forest										X			
Nuytsia floribunda											X		
**Olea europaea*													X
**Ornithopus pinnatus*								X					
*Oxalis pes-caprae													X
**Paspalum distichum*					X		X						
Patersonia occidentalis													X
Patersonia umbrosa var. xanthina													X
Persoonia elliptica													X
Persoonia longifolia	X									X			
**Petrorhagia dubia*						X							
**Poa annua*									X				
Pteridium esculentum													X
**Romulea rosea*										X			
**Rumex acetosella*													X

Species	HPQ01	HPQ01Opp	HPQ02	HPQ02Opp	HPQ03	HPQ03Opp	HPQ04	HPQ04Opp	HPQ05	HPQ06	HPQ06Opp	HPQ07	Opp
**Rumex conglomeratus*				X			X		X				
**Solanum nigrum*	X												
**Sonchus oleraceus*					X				X				
**Sparaxis bulbifera*	X		X		X								
**Trifolium campestre*						X		X					
**?Trifolium sp.*							X						
**Watsonia marginata*							X			X			
Xanthorrhoea gracilis													x
Xanthorrhoea preissii	X		X										
Xylomelum occidentale												X	

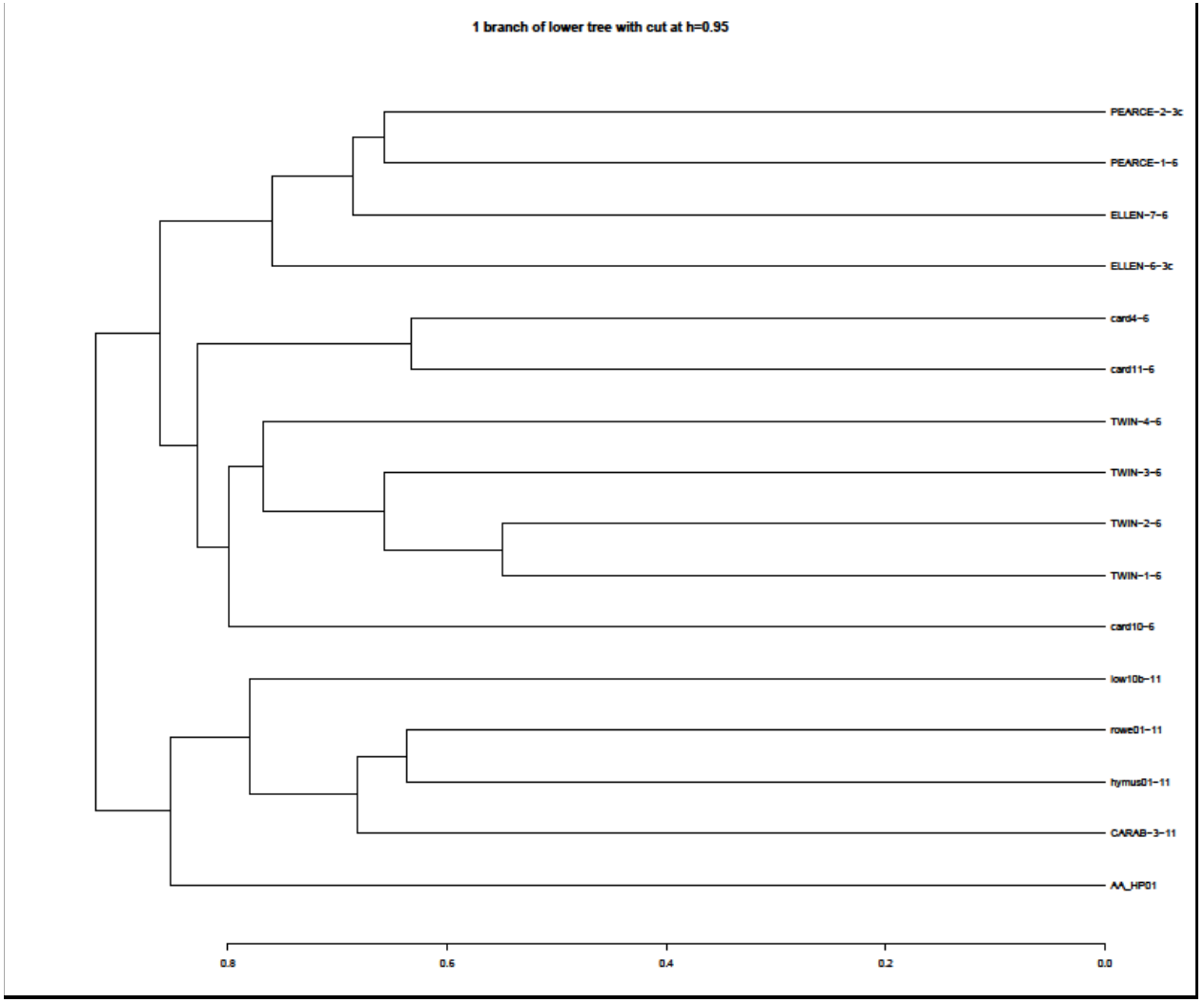
Appendix D Dendogram of sites established in the current survey

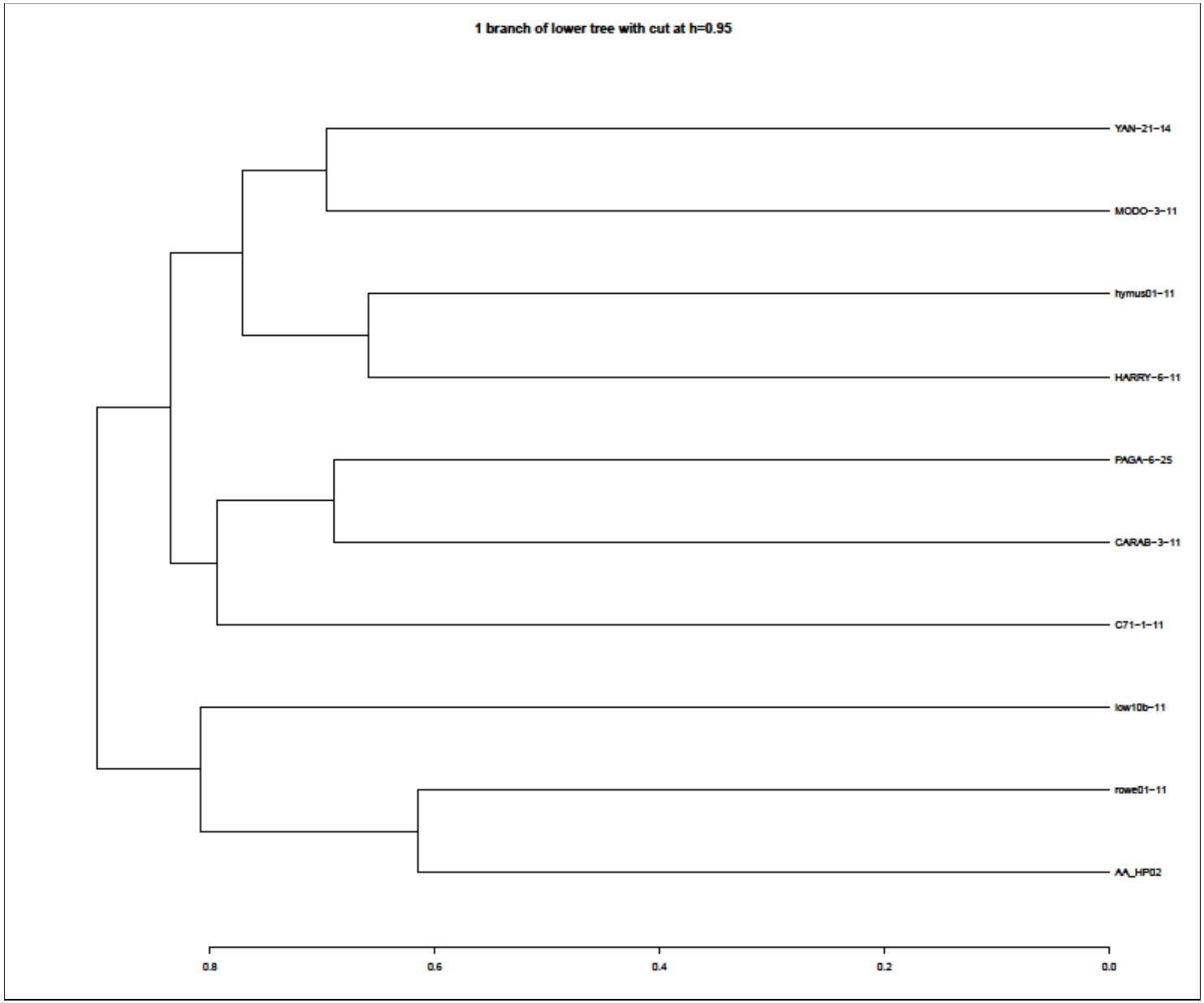


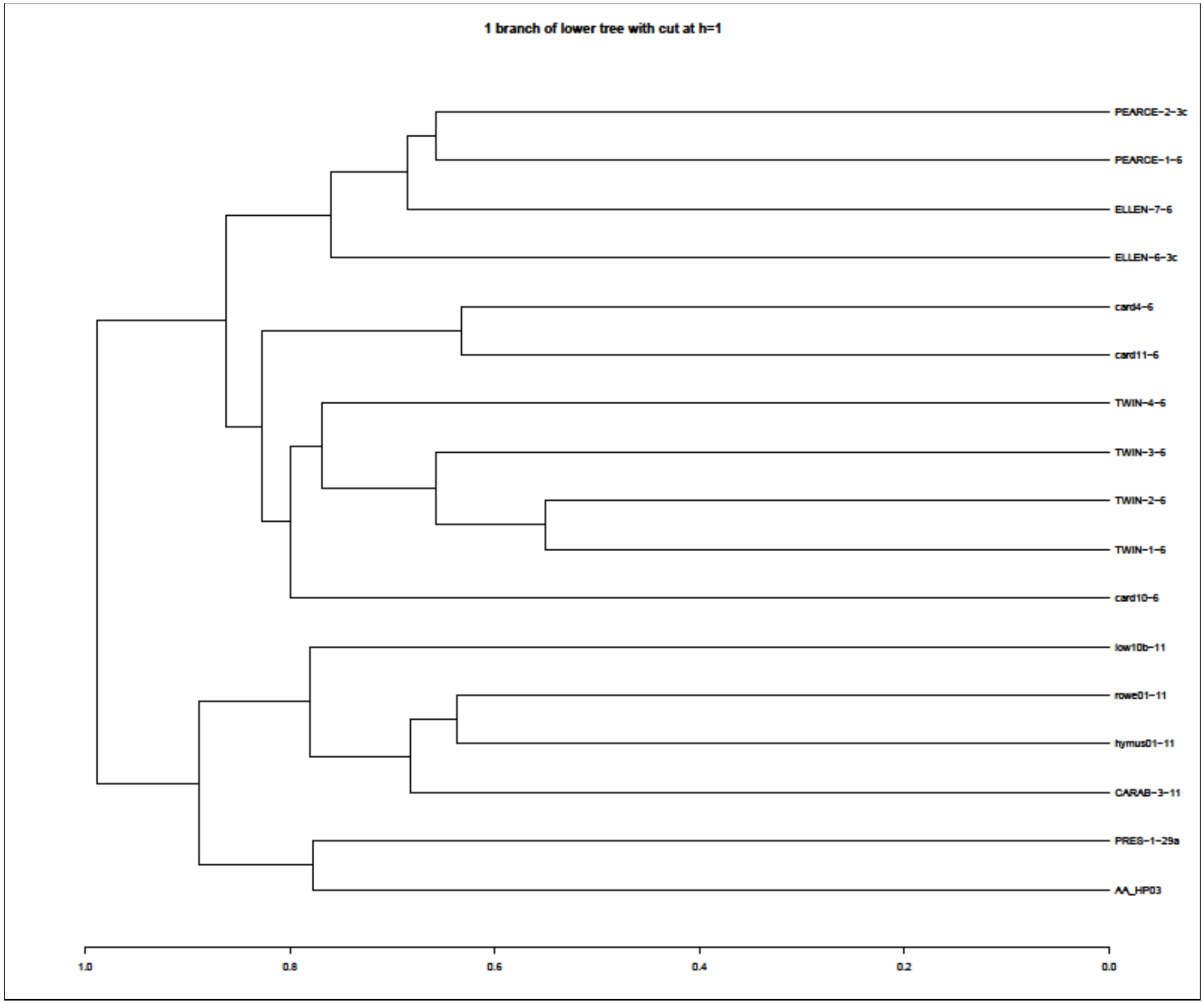
Appendix E Silohuette Analysis of sites established in the current survey

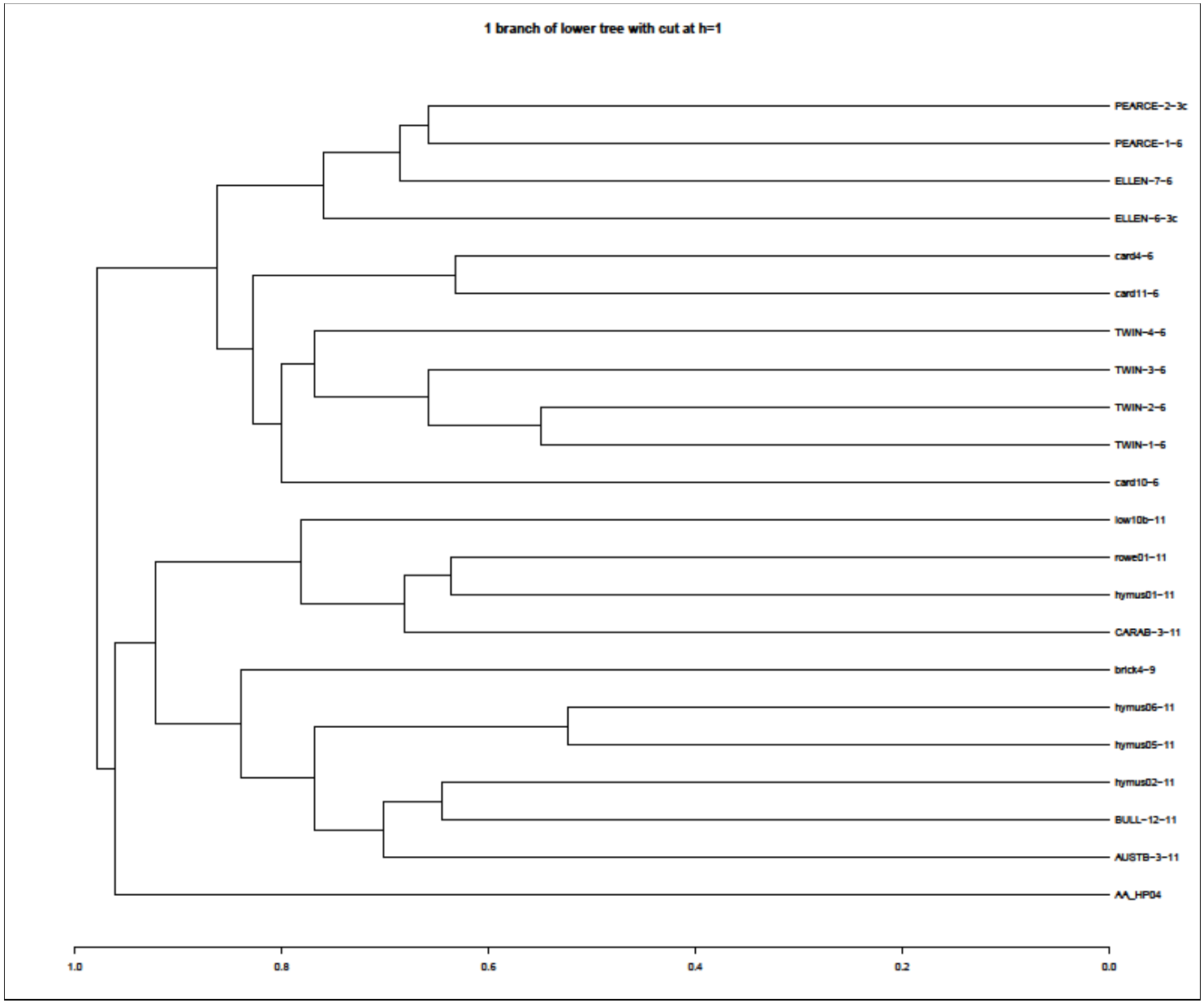


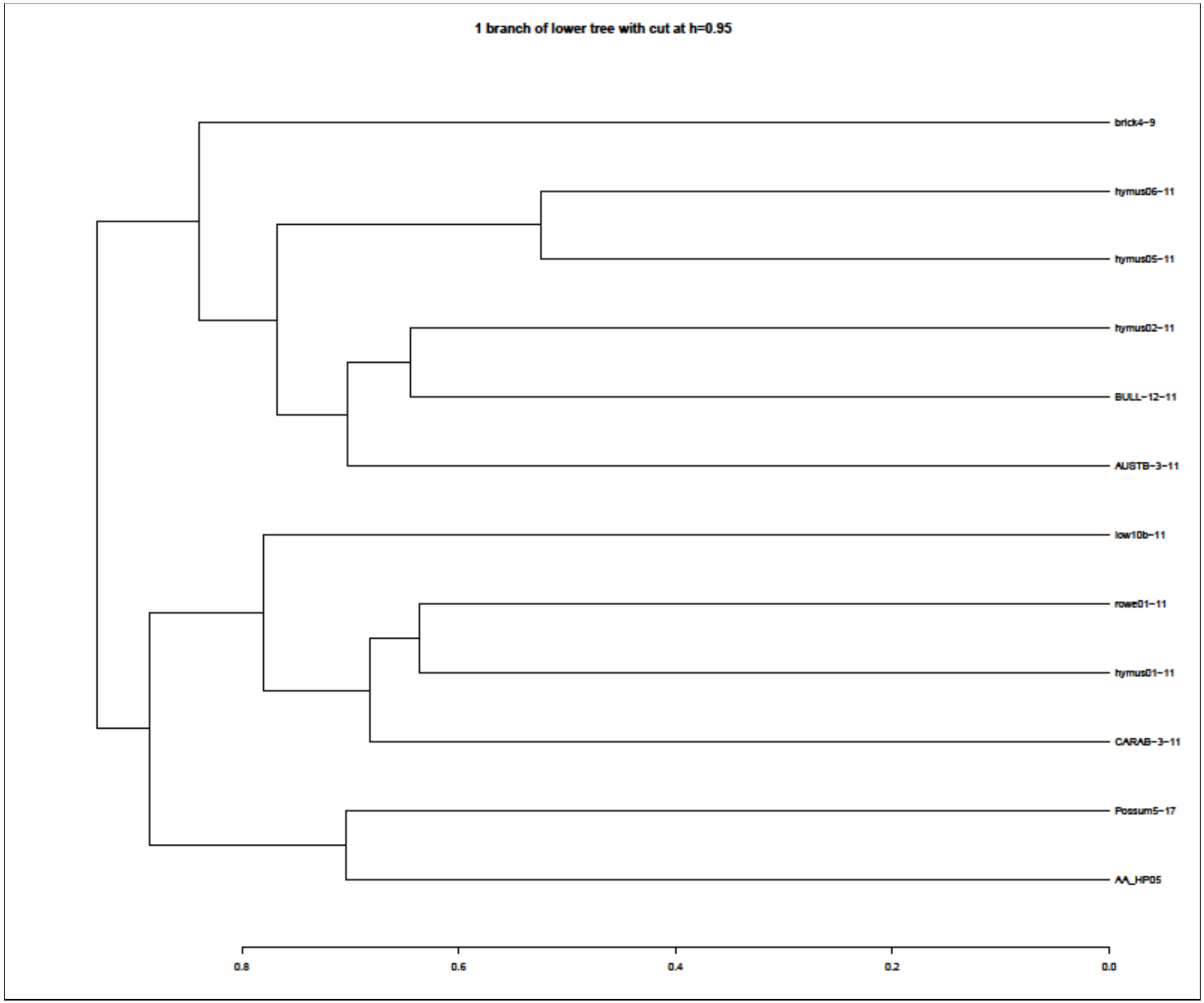
Appendix F Dendogram of sites established in the current survey compared to the Swan Coastal Plain survey dataset

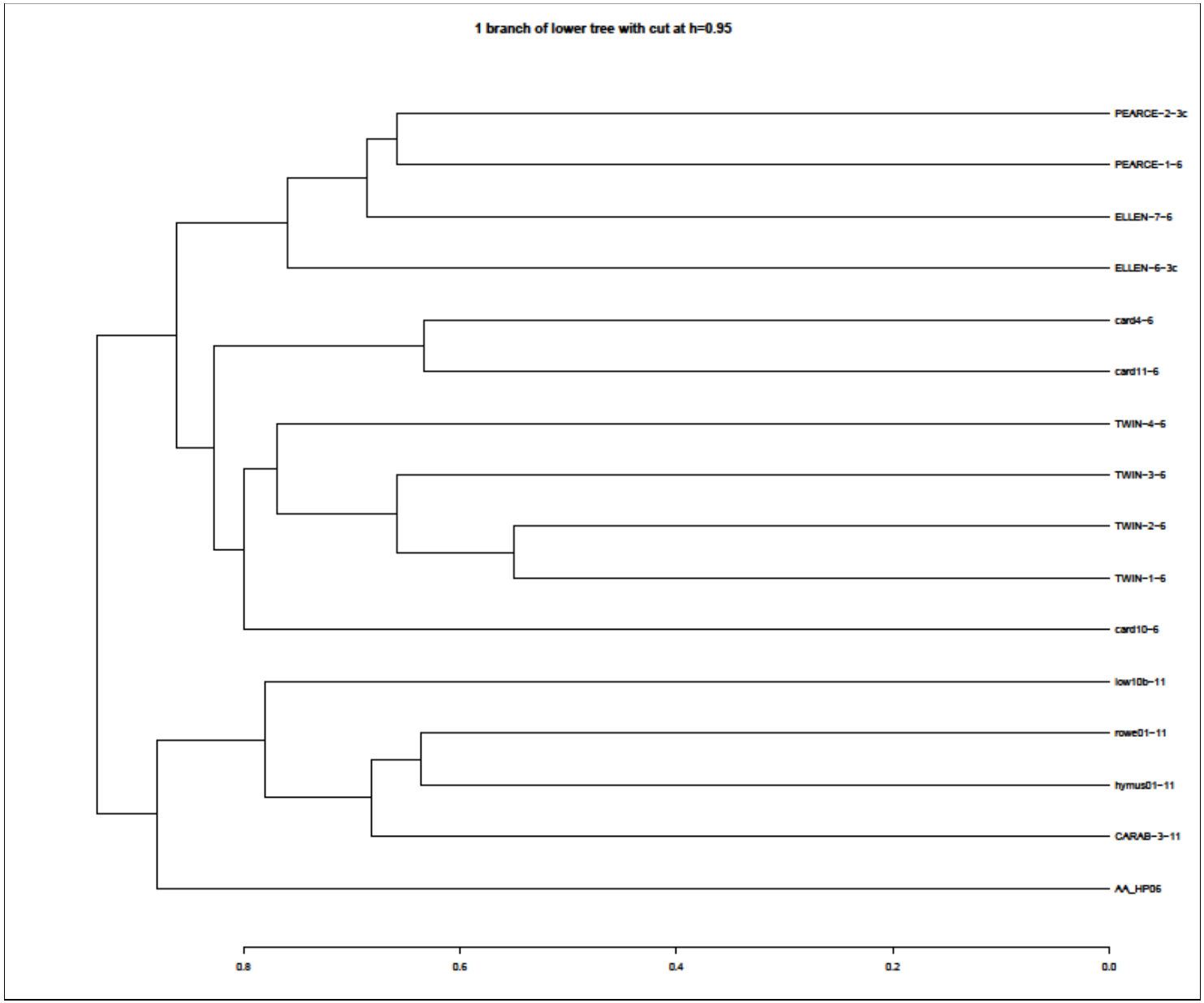


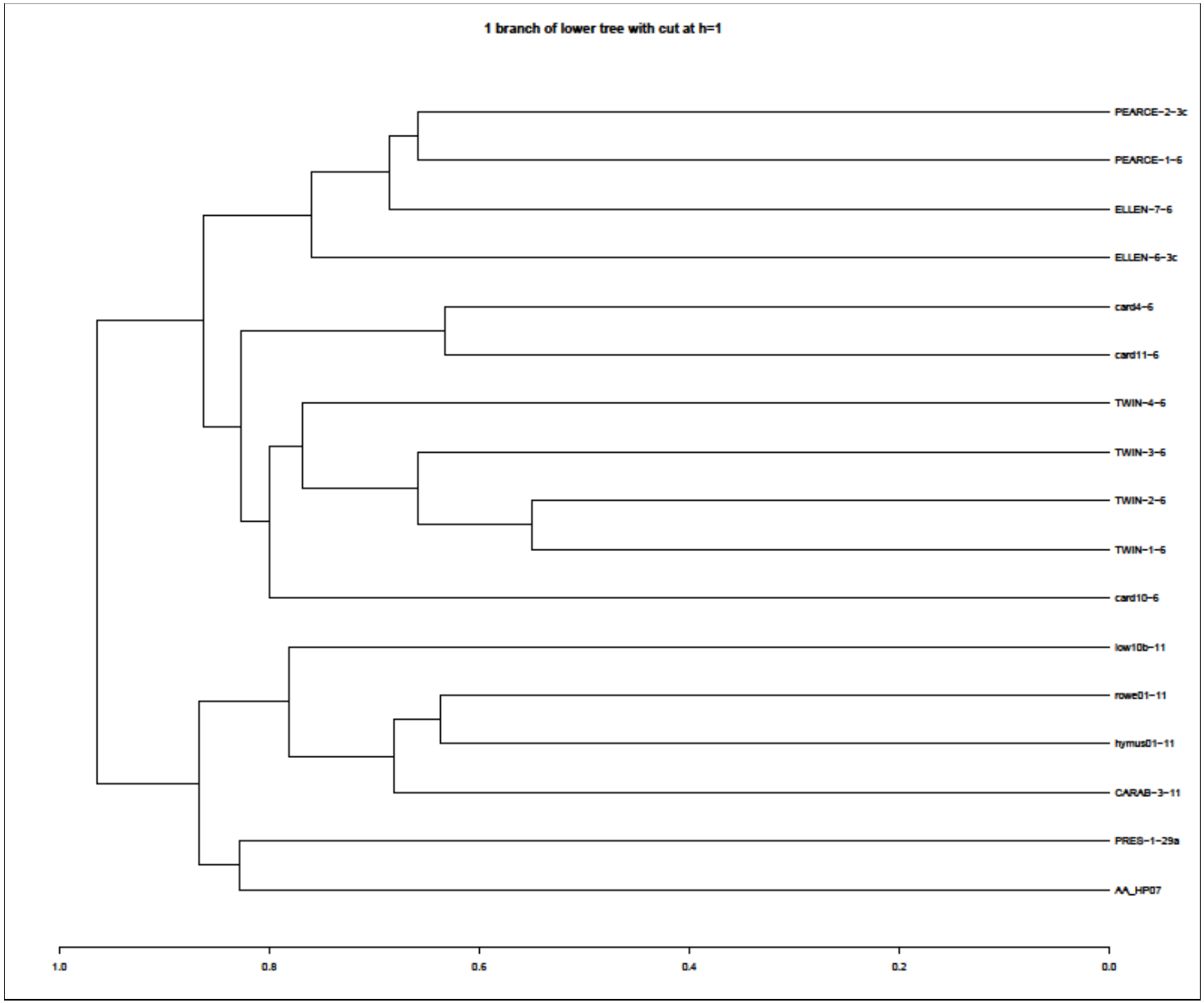

1 branch of lower tree with cut at h=0.95
YAN-21-14
MODO-3-11
hymus01-11
HARRY-6-11
PAGA-6-25
CARAB-3-11
C71-1-11
low10b-11
rowe01-11
AA_HP02
0.8
0.6
0.4
0.2
0.0


1 branch of lower tree with cut at h=1
PEARCE-2-3c
PEARCE-1-6
ELLEN-7-6
ELLEN-6-3c
card4-6
card11-6
TWIN-4-6
TWIN-3-6
TWIN-2-6
TWIN-1-6
card10-6
low10b-11
rowe01-11
hymus01-11
CARAB-3-11
PRES-1-29a
AA_HP03
1.0
0.8
0.6
0.4
0.2
0.0


1 branch of lower tree with cut at h=1
PEARCE-2-3c
PEARCE-1-6
ELLEN-7-6
ELLEN-6-3c
card4-6
card11-6
TWIN-4-6
TWIN-3-6
TWIN-2-6
TWIN-1-6
card10-6
low10b-11
rowe01-11
hymus01-11
CARAB-3-11
brick4-9
hymus06-11
hymus05-11
hymus02-11
BULL-12-11
AUSTB-3-11
AA_HP04
1.0
0.8
0.6
0.4
0.2
0.0


1 branch of lower tree with cut at h=0.95
brick4-9
hymus06-11
hymus05-11
hymus02-11
BULL-12-11
AUSTB-3-11
low10b-11
rowe01-11
hymus01-11
CARAB-3-11
Possum5-17
AA_HP05
0.8
0.6
0.4
0.2
0.0


1 branch of lower tree with cut at h=0.95
PEARCE-2-3c
PEARCE-1-6
ELLEN-7-6
ELLEN-6-3c
card4-6
card11-6
TWIN-4-6
TWIN-3-6
TWIN-2-6
TWIN-1-6
card10-6
low10b-11
rowe01-11
hymus01-11
CARAB-3-11
AA_HP06
0.8
0.6
0.4
0.2
0.0


1 branch of lower tree with cut at h=1
PEARCE-2-3c
PEARCE-1-6
ELLEN-7-6
ELLEN-6-3c
card4-6
card11-6
TWIN-4-6
TWIN-3-6
TWIN-2-6
TWIN-1-6
card10-6
low10b-11
rowe01-11
hymus01-11
CARAB-3-11
PRES-1-29a
AA_HP07
1.0
0.8
0.6
0.4
0.2
0.0

Appendix G Quadrat Data

Site name and number	Date	Site type	Quadrat Dimensions
HPQ01	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Observer**
Degraded	Weeds, rubbish	10-20 years	DM
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Dark brown	Flat	Loamy sand	Moist
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
Lateritic gravel	0	337219	6266471

Species	Lifeform	Introduced	Flowering	Height (m)	% Cover
Corymbia calophylla	Tree		N	11	45
Eucalytpus marginata	Tree		N	11	5
Banksia grandis (Opp)	Tree		N		
Kingia australis	Tree		Y	1.6	1
Persoonia longifolia	Tree		N	1.6	0.1
Xanthorrhoea preissii	Tree		Y	1.6	2
Acacia extensa	Shrub		Y	1.6	0.1
Acacia divergens	Shrub		Y	0.3	0.01
Acacia pulchella var. glaberrima (Opp)	Shrub		Y		
**Avena barbata*	Grass	Yes	Y	0.5	1
**Ehrharta longiflora*	Grass	Yes	Y	0.4	20
**Anthoxanthum odoratum*	Grass	Yes	Y	0.4	10
**Bromus diandrus*	Grass	Yes	Y	0.3	1
**Briza maxima*	Grass	Yes	Y	0.2	3

Species	Lifeform	Introduced	Flowering	Height (m)	% Cover
**Briza maxima*	Grass	Yes	Y	0.1	0.1
**Solanum nigrum*	Herb	Yes	Y	0.2	0.01
**Sparaxis bulbifera*	Herb	Yes	Y	0.3	0.1
**Hypochaeris glabra*	Herb	Yes	Y	0.1	0.1
**Callitriche stagnalis* (Opp)	Aquatic herb	Yes	N		

Site name and number	Date	Site type	Quadrat Dimensions
HPQ02	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Observer**
Degraded	Weeds, rubbish	10-20 years	DM
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Dark brown	Flat	Loamy sand	Moist
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
Lateritic gravel	0	336982	6266465

Species	Lifeform	Introduced	Flowering/Fruiting	Height	% Cover
Corymbia calophylla	Tree		No	12	60
Kingia australis	Tree		Yes	2.3	1
Xanthorrhoea preissii	Tree		No	0.5	0.1
Acacia saligna (Opp)	Shrub		No		
**Avena barbata*	Grass	Yes	Yes	0.6	0.2
**Briza maxima*	Grass	Yes	Yes	0.3	0.1
**Ehrharta longiflora*	Grass	Yes	Yes	0.3	35
**Bromus diandrus*	Grass	Yes	Yes	0.4	5
**Sparaxis bulbifera*	Herb	Yes	Yes	0.4	0.2
**Zantedeschia aethiopica*	Herb	Yes	Yes	0.2	0.01
**Rumex conglomeratus* (Opp)	Herb	Yes	Yes		
Juncus pallidus (Opp)	Sedge		Yes		

Site name and number	Date	Site type	Quadrat Dimensions
HPQ03	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Observer**
Completely Degraded	Weeds, rubbish	10-20 years	DM
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Dark brown	Open depression	Sandy clay	Moist
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
None	0	336691	6266463

Species	Lifeform	Introduced	Flowering/Fruiting	Height	% Cover
Melaleuca rhaphiophylla	Shrub		Yes	5	35
**Avena barbata*	Grass	Yes	Yes	0.6	1
**Briza maxima*	Grass	Yes	Yes	0.5	5
**Briza maxima*	Grass	Yes	Yes	0.3	1
**Ehrharta longiflora*	Grass	Yes	Yes	0.6	10
**Anthoxanthum odoratum*	Grass	Yes	Yes	0.5	5
**Paspalum distichum*	Grass	Yes	No	0.4	50
**Bromus diandrus*	Grass	Yes	Yes	1.2	13
**Arctotheca calendula*	Herb	Yes	Yes	0.3	0.1
**Sparaxis bulbifera*	Herb	Yes	Yes	0.5	1
**Sonchus oleraceus*	Herb	Yes	Yes	1	0.1
**Cotula turbinate* (Opp)	Herb	Yes	Yes		
**Trifolium campestre* (Opp)	Herb	Yes	Yes		
**Petrorhagia dubia* (Opp)	Herb	Yes	Yes		

Site name and number	Date	Site type	Quadrat Dimensions
HPQ04	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Vegetation type**
Completely Degraded	Weeds	10-20 years	CH + PLF
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Greyish brown	Open depression	Clay	Waterlogged
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
None	0	336658	6266476

Species	Lifeform	Introduced	Flowering/Fruiting	Height (m)	% Cover
**Briza maxima*	Grass	Yes	Yes	0.3	5
**Holcus setiger*	Grass	Yes	Yes	1.1	10
**Anthoxanthum odoratum*	Grass	Yes	Yes	0.6	5
**Paspalum distichum*	Grass	Yes	No	0.4	60
**Bromus diandrus*	Grass	Yes	Yes	0.4	1
Crassula closiana	Herb		Yes	0.05	0.01
**?Trifolium sp.*	Herb	Yes	No	0.1	0.1
**Rumex conglomeratus*	Herb	Yes	Yes	0.5	0.3
**Watsonia marginata*	Herb	Yes	No	0.6	3
Isolepis marginata	Sedge		Yes	0.05	0.01
Juncus pallidus	Sedge		Yes	1.3	1
Gastrolobium capitatum (Opp)	Shrub		Yes		
**Trifolium campestre* (Opp)	Herb	Yes	Yes		
**Cerastium glomeratum* (Opp)	Herb	Yes	Yes		
**Ornithopus pinnatus* (Opp)	Herb	Yes	Yes		

Site name and number	Date	Site type	Quadrat Dimensions
HPQ05	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Observer**
Completely Degraded	Weeds	10-20 years	DM
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Brown	Flat	Clay loam	Moist
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
None	0	334747	6266447

Species	Lifeform	Introduced	Flowering/Fruiting	Height	% Cover
Agonis flexuosa	Tree		No	10	60
Corymbia calophylla	Tree		No	16	20
**Briza maxima*	Grass	Yes	Yes	0.6	1
**Briza maxima*	Grass	Yes	Yes	0.5	0.1
**Ehrharta longiflora*	Grass	Yes	Yes	0.6	15
**Anthoxanthum odoratum*	Grass	Yes	Yes	0.3	0.1
**Poa annua*	Grass	Yes	Yes	0.4	0.1
**Hypochaeris glabra*	Herb	Yes	No	0.1	0.3
**Lactuca serriola*	Herb	Yes	No	0.3	0.1
**Rumex conglomeratus*	Herb	Yes	No	0.5	0.1
**Sonchus oleraceus*	Herb	Yes	No	0.4	0.01
**Cerastium glomeratum*	Herb	Yes	Yes	0.2	0.01
Isolepis cernua var. setiformis	Sedge		Yes	0.1	0.01

Site name and number	Date	Site type	Quadrat Dimensions
HPQ06	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Observer**
Degraded	Weeds	10-20 years	DM
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Dark brown	Flat	Loamy sand	Moist
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
Lateritic gravel	0	333330	6266341

Species	Lifeform	Introduced	Flowering/Fruiting	Height	% Cover
Corymbia calophylla	Tree		No	16	45
Persoonia longifolia	Tree		Yes	2	1
Acacia extensa	Shrub		Yes	1.6	0.2
Bossiaea ornata	Shrub		Yes	0.5	0.2
Kennedia coccinea subsp. coccinea	Shrub		Yes	0.3	0.1
Leucopogon verticillatus	Shrub		Yes	1.3	1
**Briza maxima*	Grass	Yes	Yes	0.3	5
**Ehrharta longiflora*	Grass	Yes	Yes	0.5	0.1
**Holcus setiger*	Grass	Yes	Yes	0.6	1
**Bromus diandrus*	Grass	Yes	Yes	0.5	0.1
**Asparagus asparagoides*	Herb	Yes	No	0.3	0.2
**Hypochaeris glabra*	Herb	Yes	Yes	0.1	0.1
Loxocarya cinerea	Herb		Yes	0.4	3
**Watsonia marginata*	Herb	Yes	Yes	1.5	15
**Romulea rosea*	Herb	Yes	Yes	0.1	0.01
Netrostylis sp. Jarrah Forest	Sedge		Yes	0.6	0.5

Species	Lifeform	Introduced	Flowering/Fruiting	Height	% Cover
Tetraria octandra	Sedge		Yes	0.3	0.1
**Acacia ?dealbata* (Opp)	Shrub	Yes	No		
Banksia grandis (Opp)	Tree		Yes		
Kingia australis (Opp)	Tree		Yes		
Mirbelia dilatate (Opp)	Shrub		No		
Nuytsia floribunda (Opp)	Tree		No		

Site name and number	Date	Site type	Quadrat Dimensions
HPQ07	15/10/2021	Quadrat	5 x 20m
Vegetation condition	**Disturbance notes**	**Age since fire**	**Observer**
Degraded	Weeds	10-20 years	DM
Soil colour	**Landform unit**	**Soil type**	**Soil condition**
Dark brown	Flat	Loamy sand	Moist
Rock type	**Outcropping %**	**Easting (GDA 94)**	**Northing (GDA 94)**
Lateritic gravel	0	333721	6266344

Species	Lifeform	Introduced	Flowering/Fruiting	Height	% Cover
**Asparagus asparagoides*	Herb	Yes	No	0.2	5
**Avena barbata*	Grass	Yes	Yes	0.6	10
Banksia grandis	Tree		No	5.5	1.5
**Briza maxima*	Grass	Yes	Yes	0.3	2
Corymbia calophylla	Tree		Yes	16	50
**Ehrharta longiflora*	Grass	Yes	Yes	0.4	10
**Hypochaeris glabra*	Herb	Yes	Yes	0.1	0.2
**Holcus setiger*	Grass	Yes	Yes	0.6	20
Loxocarya cinerea	Herb		No	0.4	3
**Anthoxanthum odoratum*	Grass	Yes	Yes	0.5	1
**Bromus diandrus*	Grass	Yes	Yes	0.4	2
Xylomelum occidentale	Tree		No	0.3	0.1

Appendix E Photo point data

Site name and number	Date	Site type	Landform Unit
HPPP01	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Completely Degraded	Weeds, clearing	334741	6266439

Site name and number	Date	Site type	Landform Unit
HPPP02	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Completely Degraded	Weeds	334327	6266363

Site name and number	Date	Site type	Landform Unit
HPPP03	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Completely Degraded	Weeds, clearing	334831	6266439

Site name and number	Date	Site type	Landform Unit
HPPP04	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Completely Degraded	Weeds, clearing	335195	6266443

Site name and number	Date	Site type	Landform Unit
HPPP05	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Degraded	Weeds	335600	6266452

Site name and number	Date	Site type	Landform Unit
HPPP06	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Degraded	Weeds	335648	6266456

Site name and number	Date	Site type	Landform Unit
HPPP07	15/10/2021	Photo point	Flat
Vegetation condition	**Disturbance notes**	**Easting (GDA 94)**	**Northing (GDA 94)**
Degraded	Weeds	336073	6266462