

Vegetation and flora of a diverse upland remnant of the Western Australian wheatbelt (Nature Reserve A21064).

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Abstract

In the Western Australian wheatbelt, small intact remnants of bushland can contribute significantly to overall biodiversity. Our comprehensive vascular flora survey of Nature Reserve A21064, a reserve of 110 hectares near the town of Arthur River, has highlighted this aspect. Comprehensive surveys of selective wheatbelt reserves provide benchmarks to help us better understand the flora and vegetation in this highly cleared and fragmented agricultural landscape. In the diverse flora of this relatively undisturbed upland remnant ten distinct plant communities encompassing heaths, herbfields, mallee and woodlands can be recognised. The survey identified 323 vascular plant taxa including one rare species, seven priority species and a number of taxa of special interest recorded from 51 families. Weeds accounted for 22 species (6.8% of total flora), however, the extent of invasion is relatively low.

Keywords: Vegetation and flora survey, upland remnant, biodiversity, wheatbelt woodlands

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Introduction

Nature Reserve A21064 is an upland bush remnant of high conservation value (*i.e.* "A" class nature reserve) with a diverse flora (see species list in Appendix 1). It is approximately 110 ha in area and is located about 190 km directly south-east of Perth near the town of Arthur River, Western Australia (Fig 1). The district has a dry Mediterranean type climate with very warm, dry summers and cool, wet winters. Average annual rainfall for the reserve is about 470 mm, which is typical of the wetter western (inner) margins of the wheatbelt.

The reserve is situated at the end of an eroded and generally flattened ridgeline and its upper slopes; the ridge is the watershed between Mailling Gully to the south and a smaller unnamed tributary to the north. These streams eventually drain into the Arthur River about 7 km west of the reserve. The Arthur River and adjacent Norcott Plains also run north of the reserve, about 3 km away. The reserve is a small L-shaped remnant with the longest east-west boundary (1.9 km) roughly parallel to the ridgeline/plateau. The north-south arm of the L measures approximately 1.2 km (Fig 2). Slopes descend gently off the ridgeline and the predominant aspect is north or north-west. A pattern of low undulating hills/ridges with interspersed small valleys and/or plains is typical locally and is a familiar topography for much of this inner wheatbelt region. Granite outcrops and/or lateritic breakaways are often found on the upper slopes or hilltops. Historically, many upland areas were not cleared for cropping because of

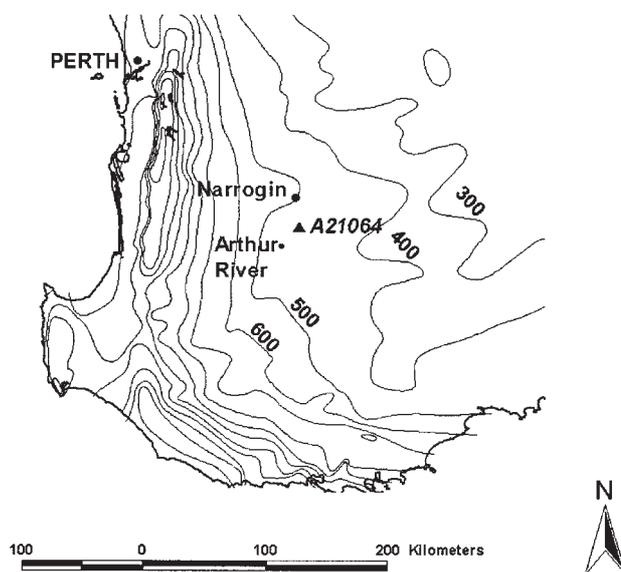


Figure 1. Location of A21064 Nature Reserve, near Arthur River, in the south-west of Western Australia; also shown are 100 mm rainfall isohyets.

the rougher topography. Also upland areas were generally abundant in the poisonous *Gastrolobium* species that killed domestic stock. Alternatively, some were left as 'shade and shelter belts'. Today, very few of these upland remnants have survived completely intact. Significant numbers have had a reduction in tree cover due to past logging (*e.g.* for timber and fence posts), insect pests, disease *etc.*, and this has occurred in a

relatively short time frame (Landsberg *et al.* 1990). The majority of these remnants are also depauperate in understorey taxa due to selective clearing (*e.g.* of 'poison plants'), frequent grazing by domestic stock, changed burning regimes, nutrient enrichment, weed invasion, and other human influenced disturbances (Hobbs & Atkins 1988; Hobbs 1993; Panetta & Hopkins 1991; Pigott 1994; Yates & Hobbs 1997; Yates *et al.* 1999; Yates *et al.* 2000).

The wheatbelt region as a whole has been altered from a mosaic of perennial native vegetation to predominantly cleared agricultural land with fragmented small bushland remnants (Hobbs 1998; Scanlan *et al.* 1992). A21064, which is surrounded by agricultural land, is no different. Beard (1980a) mapped the pre-existing vegetation cover of this entire region using aerial photography in conjunction with a wide-ranging examination of the remaining bushland remnants and their preferred habitat requirements (*i.e.* soil, slope, aspect, elevation *etc.*). These vegetation maps show the reserve's wider surrounding district as predominantly York gum (*Eucalyptus loxophleba*) and wandoo (*E. wandoo*) woodland, while several local upland areas (including A21064) are mapped as wandoo and mallet (*Eucalyptus astringens*) woodland. This is a reasonably accurate representation, although these upland areas also contain significant patches of sheoak (*Allocasuarina huegeliana*). Approximately 20-25 km west of the reserve, wandoo woodland predominates, but marri (*Corymbia calophylla*) and jarrah (*Eucalyptus marginata*) become more common about another 20 km further westwards within Hillman and Godfrey State Forest Blocks (Smith 1974). Powder bark wandoo (*E. accedens*) is more abundant amongst the York gums around the Narragin area, about 35 km north of the reserve (Beard 1980b). Salmon gum (*E. salmonophloia*) tends to replace wandoo further east (25-35 km), while the Beaufort River area, about 30 km south of the reserve, has a mix of wandoo, yate (*E. occidentalis*), teatree (*Melaleuca* sp.), *Casuarina obesa* and samphire flats (Beard 1980a). Overall, the district was once dominated by open woodlands; however, patches of heath (often *Dryandra* dominated), herbfield and mallee were also relatively common.

Flora surveys of wheatbelt remnants are sparse (Obbens *et al.* 2001). Although not intensive, Muir's (1977a) pioneering surveys of 24 wheatbelt reserves are a notable exception. There are very few flora surveys of remnants from around this district, reflecting the high costs of surveying remnants within this vast wheatbelt region (*i.e.* 18 million hectares). The soon to be released Salinity Action Plan (SAP) surveys will change this situation. While larger remnants (*i.e.* >2000 ha) are certainly important for conserving biodiversity and helping to maintain many of the ecological processes of this region, this paper aims to highlight the important contribution of smaller remnants to regional biodiversity, particularly if they remain intact. A further aim is to present more botanical survey data for this significant region.

Methods

The vegetation communities of Nature Reserve A21064 were interpreted from a 1996 aerial photograph

and confirmed in the field during 1999 and 2002. Classification of these vegetation communities is based on Muir (1977b). This classification assesses vegetation structure by taking measures of lifeform/height class and canopy cover/density class to produce a vegetation type. For example, trees 15-30 m with a 10-30% canopy cover were designated woodlands, while the same trees with a canopy cover of 2-10% would be designated as open woodlands. To a significant extent this classification also reflects the species compositional differences. Additionally, brief investigations were made of the soils in each vegetation community. The soil surface was inspected and then shallow holes (3-5 cm depth) were made to assess soil texture and colour.

The flora survey and collections were accomplished by walking along 13 transects (10 spaced at 150 m apart and 3 spaced at 100 m apart) that spanned the full width of the reserve in a north-south orientation. The first transect proceeded in a southerly direction from Noble Road and approximately 50 m in from the reserve's north-east corner. Subsequent transects crossed every vegetation type several times using this technique. This transect survey was undertaken during mid/late spring (*i.e.* October and November 1998). An additional 8 surveys were also carried out between the summer of 1998 and the spring of 2002. On these occasions a 'randomized stratified walk' technique (Hopper *et al.* 1997) was used. This method involves specimen collections via random walks in each vegetation community. The purpose of this intensive surveying was to obtain a voucher specimen of each taxa and to compile a more complete vascular flora list.

All specimens were submitted for incorporation at the WA Herbarium. The species names follow the currently accepted botanical binomials of WACENSUS (WA Herbarium census of Western Australian vascular plants), while conservation status of species is according to the Department of Conservation and Land Management's (CALM) Declared Rare Flora and Priority Flora list (Atkins 2001). The authors also received invaluable information from WA Herbarium database records (WAHERB and FLORABASE). The term "total 'Liliaceae'" refers to the number of closely related, but different new families that have been split from Liliaceae in recent years. For A21064 this includes the families Anthericaceae, Boryaceae and Phormiaceae.

Results

Vegetation and habitat.

Interpretation of the aerial photograph and site survey indicated ten major vegetation communities (Fig 2), including four variants (all explained below). However, there is considerable variability within some communities and at differing locations throughout the reserve. Additionally, there was a range of community boundaries, some very distinct (*e.g.* between pure mallet stands and wandoo woodland or when pure *Allocasuarina huegeliana* stands surround granite-exposed herbfield areas). However, diffuse boundaries have been drawn at roughly midpoint where any two communities overlapped (*e.g.* as demonstrated when Low Woodland and Low Forest communities merge).

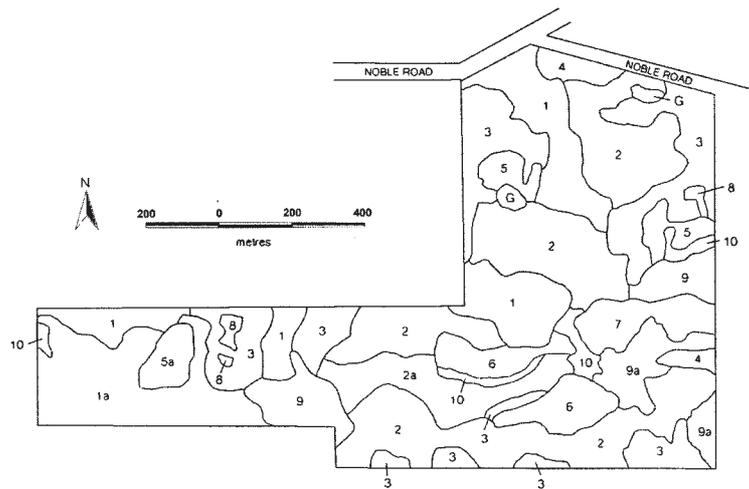


Figure 2. Map of vegetation communities of A21064 Nature Reserve that include 1 and 1a Open Woodland, 2 and 2a Low Woodland, 3 Low Forest, 4 Woodland, 5 and 5a Heath, 6 Low Heath, 7 Thicket (Tall Heath), 8 Herbfield, 9 and 9a Mallet Woodland, 10 Mallee Woodland and G Rehabilitated gravel pits. Communities are described below.

1 Open Woodland. Dominated by *Eucalyptus wandoo* with a generally very open, but variable understorey. This includes areas of almost pure *Gastrolobium trilobum* or *Melaleuca* aff *uncinata* or 'parkland-like' areas with numerous orchids/annuals/grasses and smaller shrubs. Many trees are large to 25 m high with a canopy density about 5 – 15% (*i.e.* very sparse to sparse). Soils are either grey coarse sandy loams or, at the reserve's western end, brown coarse loams with some lateritic gravels. This community represents the top end of shallow drainage lines that form defined creeks further down slope outside the reserve boundaries.

1a Open Woodland. A variant of above, again, dominated by *Eucalyptus wandoo* of generally smaller stature and with a denser canopy cover, about 10 – 25% (*i.e.* sparse). Lying entirely on lateritic ridge country, it demarcates itself from community 1 along the line of a small breakaway. A sparse to mid dense understorey of predominately *Dryandra* species occur on exposed lateritic boulders with residual soils on the top edge of the breakaway and up slope at the ridgeline. Elsewhere is fairly open with various scattered shrubs and some annuals on soils of red-brown clay loam with numerous gravels.

2 Low Woodland. A mixed woodland with a mid dense canopy cover (*i.e.* about 30 – 70%) consisting of almost equal proportions of *Eucalyptus wandoo* (up to 20 m high) and *Allocasuarina huegeliana* on grey-brown sandy loams sometimes with varying amounts of gravel. Understorey is variable including open areas of low shrubs, annuals and some grasses to mid dense areas of *Acacia* or *Gastrolobium*.

2a Low Woodland. A mixed woodland variant of above with mid dense canopy consisting of *Eucalyptus wandoo* (up to 20 m high) and interspersed individuals or patches of *Eucalyptus astringens* subsp *astringens* (Brown Mallet) and occasionally with scattered *Allocasuarina huegeliana*. Again, a variable understorey ranging mostly open to mid dense in parts. Soils are red-brown coarse clay loams with gravels and sometimes there is exposed lateritic hardcap.

3 Low Forest. Predominantly pure stands of *Allocasuarina*

huegeliana with occasional scattered *Eucalyptus wandoo* and generally mid dense to dense canopy cover (*i.e.* > 70%). Soils are grey-brown to red-brown sandy or clayey sand loams sometimes with a little gravel. The understorey canopy cover is open to mid dense, including numerous annuals and commonly a tall *Lepidosperma* sp (FO204/98), *Agrostocrinum scabrum* and *Hypocalymma angustifolium*. This community occurs where granite is close to the surface and often outcropping or boulder stacks are nearby.

4 Woodland. Composed of pure stands of tall (*i.e.* 25 – 30 m) *Eucalyptus longicornis* with a very sparse understorey of *Acacia erinacea*, *Acacia lasiocarpa* var. *sedifolia*, a few sedges and annuals found on red-brown clay loams. These areas appear to be associated with shallow drainage zones.

5 Heath. A heath of mid dense to dense canopy cover containing a diverse mix of shrubs about 1 – 2 m high on grey-brown sandy clay loams with some gravel content. The families Myrtaceae, Proteaceae, Goodeniaceae, Papilionaceae and Stylidiaceae are well represented along with many others. This community occurs on the gentle mid slope areas of the reserve and never appears on the ridge top.

5a Heath. A variant of the above comprising a diverse mix of shrubs (about 1 – 2 m) with interspersed emergent shrubs (to about 3.5 m) namely *Dryandra sessilis* and *Nuytsia floribunda*. This unusual combination occurs on a localised sheet of white sand, which probably overlays lateritic and/or granitic profiles seen adjacent to this community. *Eremaea pauciflora* dominates although many other species are present.

6 Low Heath. A very diverse mix of small to mid sized shrubs (about 0.25 – 1.5 m) with a mid dense canopy cover found on white-grey clayey loams with occasional gravel content. This soil profile is possibly exposed and eroding kaolin, and occurs extensively on lower parts of the flattened ridgeline. This community contains the same families as outlined for community 5; however, it also has a marginally greater diversity of taxa than the above heaths.

7 Thicket (Tall Heath). Comprising a dense mix of taller shrubs (about 1.5 – 3.0 m) dominated by *Dryandra*, particularly *D. armata* and *D. nobilis*, but including some other tall Proteaceae species (e.g. *Adenanthos cygnorum* and *Hakea trifurcata*) and occasionally interspersed mallees. These thickets are located on the flattened ridgeline. The soils are red-brown to grey-brown coarse clayey loams or sandy loams with abundant lateritic gravels, rocks and some exposed hardcap.

8 Herbfield. Exposed or near-surface granite sheets with some residual surface soil or soil pockets frequently covered by *Borya sphaerocephala*, mosses and lichens, but including numerous annual herbs and some sedges. Generally abutting or surrounded by *Allocasuarina* woodland.

9 Mallet Woodland. Dense pure stands of *Eucalyptus astringens* subsp *astringens* (about 10 to 20 m) with an almost absent understorey except for a few resilient shrubs and abundant bark litter. Soils are red-brown to brown coarse clay loams with numerous gravels. All occurrences in the reserve are on the ridgeline including one area adjacent to and on a lateritic breakaway slope.

9a Mallet Woodland. This community, a variant of the above, comprises more open and generally taller (about 15 to 25 m) stands of *Eucalyptus astringens* subsp *astringens* often interspersed with *E. wandoo* or *Allocasuarina huegeliana* and with variable canopy cover ranging from open to mid dense. The open to mid dense understorey includes *Acacia celastrifolia*, *A. pulchella*, *Nemcia obovata*, *Dryandra nobilis* and many others. Soils are red-brown to grey-brown clayey loams containing numerous gravels with rocks/hardcap regularly occurring within this ridgeline community.

10 Mallee Woodland. Consisting of various mallee species, but occasionally pure stands to 4 m high and sometimes with other tree species interspersed or with tall shrubs. In the western end of the reserve these mallees tend to be *Eucalyptus aspersa*, *E. falcata*, *E. latens* and *E. thamnooides* subsp *megista* while in other areas mainly *E. incrassata* and *E. pluricaulis* subsp *pluricaulis*. This community is located either on the ridge or the

adjacent upper slope areas where the soils are red-brown loams with gravels. .

G Rehabilitated gravel pits. Old gravel extraction sites that have been deep ripped and allowed to regenerate naturally. At this stage, the flora comprises mainly pioneer species and limited occurrences of several weed species.

Flora.

A total of 323 vascular plant taxa (including 22 weed species) from 51 families was listed for Nature Reserve A21064 with dicots and shrub species being the predominant taxa for the reserve (Table 1).

The most represented families were Myrtaceae (39), Proteaceae (29), Papilionaceae (26), Orchidaceae (26), Poaceae (20), total 'Liliaceae' (20), Asteraceae (17), Stylidaceae (17), Cyperaceae (16), and Goodeniaceae (12). Nine Poaceae and three Asteraceae species recorded are weeds.

The genera with the greatest number of species were *Stylidium* (15), *Eucalyptus* (12), *Acacia* (10), *Caladenia* (9), *Hakea* (8), *Lepidosperma* (8), *Dryandra* (7), *Drosera* (6) and *Austrostipa*, *Leucopogon*, *Dampiera*, *Goodenia*, *Melaleuca*, *Daviesia* and *Petrophile* with five species each.

One declared rare species (*Conostylis drummondii*) and seven priority species (*Dryandra rufistylis*, *Eucalyptus aspersa*, *E. latens*, *Leucopogon florulentus*, *L* sp Dongolocking, *Microcorys lenticularis* and *Thysanotus cymosus*) were recorded for the reserve.

Discussion

Vegetation and habitat.

The vegetation of the reserve is not unique because similar vegetation types or variants thereof can be found in other upland remnants in this region. Overall the vegetation of the reserve is relatively pristine and contains a wide representation of upland communities for its small size. This alone makes it quite special in

Table 1

Plant type and lifeform for all taxa collected at A21064.

Taxa	Total	Dicotyledons	Monocotyledons	Gymnosperms	Pteridophytes
Families	51	37	12	1	1
Genera	155	98	55	1	1
Taxa:					
(a) native	301	211	88	1	1
(b) exotic	22	11	11	0	0
Lifeform					
Tree	8	8	0	0	0
Mallee/Tree	1	1	0	0	0
Mallee	7	7	0	0	0
Tall shrub	19	18	0	1	0
Low shrub	113	112	1	0	0
Herb (annual)	42	33	9	0	0
Herb (perennial)	127	37	89	0	1
Vine	6	6	0	0	0
TOTAL	323				

terms of value as public conservation estate. These woodlands can be moderately diverse due to the abundant annuals present, but more frequently it is the open heaths and patches of other communities within these woodlands that account for the greater proportion of species diversity, particularly perennial species (Yates *et al.* 1999). Table 1 also reaffirms this with 131 perennial shrub taxa listed, the next highest being perennial herbs at 127 taxa, but with significantly less vegetative cover overall than the shrubs produce.

Flora.

We consider Nature Reserve A21064, with 323 taxa located within 110 ha, as exceptionally diverse for an upland area. It is always difficult to compare flora surveys because of the different methodologies applied, the differences in the vegetation communities surveyed and the differences in surveying intensity and season (Obbens *et al.* 2001). Nonetheless, a quadrat-based flora survey of 3 remnants within the Cartmesticup sub-catchment, Shire of Woodnilling (about 35 km south-east of A21064) by Gunness (1999) found 266 vascular taxa in 130 ha although less than 40% of this survey was upland habitat. In 2001, the Western Australian Herbarium had 358 individual vascular plant species recorded for the Highbury State Forest, a large collection of woodland remnants (4028 ha) with significant upland areas just south of Narrogin (about 20 km north of A21064). For this survey, we found new taxa on every visitation and even after many visits the last survey still produced over 30 new taxa. Our experience is that intense surveying appears to overcome the shortfalls of annual/seasonal variation or of detecting cryptic/short-lived species *etc.* Most surveys do not have the resources for such intensive work and hence record significantly less. In fact, Nilsson & Nilsson (1985) reported that standardised surveys by professional botanists estimate only 79% at best of total plant diversity. Consequently, most survey results somewhat underrate the biodiversity present and hence the conservation value of the areas surveyed. Even this intensive surveying program cannot be considered as 100% conclusive in detecting all the vascular plant taxa within A21064.

Declared Rare Flora.

One declared rare taxon (*Conostylis drummondii*) is listed for the reserve. Within the reserve it occurs in one heath community only, while there are several populations recorded mostly on roadside situations (WAHERB data). This species has an IUCN ranking of endangered.

Priority species.

Seven priority taxa have been identified and, along with the rare flora, reaffirming the high conservation value of the reserve.

Dryandra rufistylis. Priority 2. Seven small or medium sized populations are known from degraded roadsides mainly around Woodanilling with a few populations recorded further east to Nyabing. The A21064 population is the most western population and the second to be discovered on a reserve.

Eucalyptus aspersa. Priority 4. A reasonably widespread mallee species (77 WAHERB collections) ranging from

Julimar State Forest in the north to Frankland in the south. Most populations are apparently small groves and distributed unevenly.

Eucalyptus latens. Priority 4. Again, this is a fairly widespread mallee species (57 WAHERB collections). The four limits of its distribution are roughly North Bannister, Kulin, Tarin Rock and Arthur River/Darkin area. Most populations have small numbers of individuals.

Leucopogon florulentus. Priority 2. This taxon is currently under review (M Hislop, WA Herbarium). There is some taxonomic uncertainty regarding the boundaries of this species, with two variants noted. The more western/inland variant (*i.e.* Bannister, Cordering, Dryandra State Forest, Dumbleyung and A21064) is potentially a different taxon from the more eastern/south coastal variant (*i.e.* Ongerup to east of Esperance) which represents the typical *L. florulentus* populations. At present, the A21064 population consisting of thousands of plants represents a significant find.

Leucopogon sp Dongolocking. Priority 2. This taxon belongs to the 'Gynoconus' group of Leucopogons and is most closely related to *L. pogonocalyx* and another unnamed taxon *L. sp* Wandering (M Hislop, WA Herbarium personal communication). It is currently known from two localities, Dongolocking and A21064 nature reserves. The species has a low sprawling habit and is difficult to find amongst other shrubs, so numbers of individuals in the A21064 populations are not exactly known at present.

Microcorys lenticularis. Priority 2. There are several populations of this taxon in scattered locations ranging from Hyden in the east to Boxwood Hills in the south to Tarin Rock and Ongerup areas. A21064 is now an additional population and the most western distribution for the species. Most populations have few individuals and are located on degraded roadsides.

Thysanotus cymosus. Priority 3. First collected by NH Brittan in 1958 south of Kulin. There are now five known locations (*i.e.* Popanyinning, Muntadgin, Hyden, north of Kojonup and A21064). *Thysanotus cymosus* appears to grow in sandy clay loams often associated with nearby granite outcrops.

Species of interest.

A small shrub with yellow/dark brown pea flowers was listed as *Pultenaea aff. ericifolia*. This unnamed species belongs to the *Pultenaea verruculosa/ericifolia* group of species currently under taxonomic revision. It is probably closely related to the south coast species that has been known erroneously as *P. vestita*. The true *P. vestita* does not occur in Western Australia (M Hislop, WA Herbarium personal communication). However, this specimen and another northern collection differ from *P. vestita* in having distinctive recurved leaf tips and different floral bract morphology.

Two variants of *Baeckea crispiflora* occur within the reserve, one with the usual narrow leaf and the other a wider, round-leafed variant (probably another unnamed taxon; M Trudgen, WA Herbarium personal communication). Rounded and pointed leaf variants of *Synaphea aff. interioris* have also been recorded. Range extensions were recorded for *Allocasuarina campestris*,

Desmocladus fascicularis, *Dryandra lindleyana* subsp. *sylvestris*, *Stylidium carnosum*, *Tetraria octrandra* and *Thelymitra crinita*. Most range extensions were significant increases in easterly occurrence for species with a deep southwest distribution, while only *Allocasuarina campestris* significantly increased its westerly position from its more inland distribution.

Patterns of species distributions

The A21064 locality represents the limits of distribution for a number of taxa including *Eucalyptus argyryphaea* (western edge), *Lomandra suaveolens* and *Hemiandra linearis* (eastern edge), and *Conospermum stoechadis* subsp. *sclerophyllum* and *Isopogon dubius* (southern edge). Approximately 24% of the reserve's species list have a distribution pattern located within the wetter portion of the South West Botanical Province (*i.e.* roughly NW/SW orientated, often occurring near coastal and extending inland to the inner/mid wheatbelt regions). Another 28% have a similar orientated distribution pattern, but these are located within the drier portion of the South West Botanical Province (*i.e.* occurring from the inner/mid wheatbelt areas and extending eastwards and sometimes overlapping into the more arid Eremaean Province). The latter distribution pattern frequently extends to the coast north of the Eneabba area or to the coast east of Albany. A widespread distribution within the South West Botanical Province and adjacent Eremaean Province accounted for 22% of the species distributions of the reserve. Additional distribution patterns include the geographically restricted (*i.e.* about 100-150 km radius) accounting for 6% of the reserve's flora, south coastal and adjacent agricultural districts accounting for 5%, localised distributions (*i.e.* about 50 km radius) accounting for 3% while various other distributions accounted for the remainder.

The first two patterns of distribution accounted for 52% of the taxa listed for the reserve and are common distribution patterns for many taxa of the southwest. The area where the edges of these distributions overlap represents a 'transitional zone'. A21064 sits squarely within this narrow zone. It is also located within the western limits of Beard's 1980 map of the South West Botanical Province's Avon district.

Introduced weeds.

There were 22 weed species (about 6.8% of the flora) recorded for the reserve, most occurring in disturbed boundary areas adjacent to farmland or beside tracks or within old gravel extraction pits. Many are common agricultural weeds such as the broadleaves *Arctotheca calendula* (Capeweed), *Hypochaeris glabra* (Flatweed), *Erodium botrys* and *Trifolium campestre*, or grasses, such as *Avena barbata*, *Bromus diandrus* and *Lolium rigidum*. Although weeds are common in these boundary areas their extent elsewhere is very limited, apart from the orchid *Disa bracteata* which is scattered throughout several communities. Overall, the vast majority of the reserve is in near pristine condition.

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Appendix 1

The vascular plant taxa recorded for A21064 Nature Reserve listed in alphabetical order by family. Threatened or priority status of taxa is recorded for those relevant species. The * symbol represents species which are naturalized weeds. The collector's number for each specimen is included in parentheses after species authority name.

Adiantaceae

Cheilanthes austrotenuifolia HM Quirk & TC Chambers (FO218/98)

Amaranthaceae

Ptilotus declinatus Nees (FO72/02)
Ptilotus manglesii (Lindl) F Muell (LWS1099)

Anthericaceae

Agrostocrinum scabrum (R Br) Baill (FO228/98)
Caesia occidentalis R Br (LWS1411)
Chamaescilla corymbosa (R Br) Benth. (FO310/99)
Chamaescilla spiralis (Endl) Benth (LWS1236)
Corynotheca micrantha var *elongata* RJF Hend (LWS1414)
Dichopogon fimbriatus (R Br) JF Macbr (LWS1410)
Laxmannia grandiflora Lindl (FO40/01)
Laxmannia squarrosa Lindl (LWS1217)
Sowerbaea laxiflora Lindl (FO321/99)
Thysanotus cymosus Brittan (P3) (FO50/02)
Thysanotus patersonii R Br (FO331/99)
Thysanotus thyrsoides Baker (FO281/98)
Tricoryne elatior R Br (FO279/98)

Apiaceae

Trachymene ornata (Endl) Druce (FO319/99)
Trachymene pilosa Sm (FO215/98)

Asteraceae

- * *Arctotheca calendula* (L) Levyns (FO222/98)
- Argentipallium niveum* (Steetz) Paul G Wilson (LWS1098)
- Blennospora drummondii* A Gray (FO324/99)
- Brachyscome glandulosa* (Steetz) Benth (FO34/01)
- Helichrysum leucosideum* DC (FO274/98)
- * *Hypochaeris glabra* L (FO233/98)
- Lagenophora huegelii* Benth (LWS1499)
- Lawrencella rosea* Lindl (FO333/99)
- Millotia tenuifolia* Cass var *tenuifolia* (FO38/01)
- Podolepis canescens* DC (LWS1096)
- Podolepis gracilis* (Lehm) Graham (LWS1095)
- Podolepis lessonii* (Cass) Benth (FO304/99)
- Pterochaeta paniculata* Steetz (FO302/98)
- Rhodanthe citrina* (Benth) Paul G Wilson (LWS1097)
- Rhodanthe manglesii* Lindl (LWS1093)
- Siloxerus multiflorus* (Nees) PS Short (FO28/01)
- * *Ursinia anthemoides* (L) Poir (FO230/98)

Boryaceae

Borya sphaerocephala R Br (FO234/98)

Casuarinaceae

Allocasuarina campestris (Diels) LAS Johnson (FO67/02)
Allocasuarina huegeliana (Miq) LAS Johnson (LWS1247)
Allocasuarina humilis (Otto & F Dietr) LAS Johnson (LWS1246)
Allocasuarina microstachya (Miq) LAS Johnson (FO250/98)

Crassulaceae

Crassula colorata (Nees) Ostenf (FO225/98B)
Crassula decumbens Thunb (FO35/01)
Crassula exserta (Reader) Ostenf (FO225/98A)

Cupressaceae

Callitris roei (Endl) F Muell (FO2/01)

Cyperaceae

Caustis dioica R Br (FO21/01)
Lepidosperma aff *costale* (LWS1431)
Lepidosperma brunonianum Nees (FO287/98)
Lepidosperma costale Nees (FO205/98)
Lepidosperma leptostachyum Benth (FO252/98)
Lepidosperma sp (small sedge) (FO203/98)
Lepidosperma sp (large sedge around granites) (FO204/98)
Lepidosperma sp K Boorabbin (KL Wilson 2579) (LWS1432)
Lepidosperma tuberculatum Nees (LWS1503)
Mesomelaena stygia (R Br) Nees subsp *stygia* (FO32/01)
Schoenus aff *brevisetis* (FO260/98)
Schoenus aff *subflavus* (FO48/02)
Schoenus armeria Boeck (FO251/98)
Schoenus minutulus F Muell (LWS1422)
Tetraria capillaris (F Muell) JM Black (FO259/98)
Tetraria octandra (Nees) Kuk (LWS1224)

Dasypogonaceae

Chamaexeros serra (Endl) Benth (FO293/98)
Lomandra effusa (Lindl) Ewart (FO24/01)
Lomandra micrantha (Endl) Ewart subsp *micrantha* (LWS1427)
Lomandra suaveolens (Endl) Ewart (LWS1519)

Dilleniaceae

Hibbertia aff *recurvifolia* (FO262/98)
Hibbertia commutata Steud (LWS1238)
Hibbertia hemignosta (Steud) JR Wheeler (LWS1417)
Hibbertia microphylla Steud (FO309/99)
Hibbertia rupicola (S Moore) CA Gardner (LWS1062)

Droseraceae

Drosera androsacea Diels (FO326/99)
Drosera bulbosa Hook subsp *bulbosa* (FO28/99)
Drosera glanduligera Lehm (FO12/01)
Drosera macrantha Endl subsp *macrantha* (FO13/01)
Drosera menziesii DC subsp *menziesii* (FO332/99)
Drosera subhirtella Planch (FO322/99)

Epacridaceae

Andersonia parvifolia R Br (FO62/02)
Astroloma cataphractum AJG Wilson ms (FO20/99)
Astroloma serratifolium (DC) Druce (FO229/98)
Leucopogon cymbiformis DC (LWS1440)
Leucopogon dielsianus E Pritz (LWS1516)
Leucopogon fimbriatus Stschegl (FO8/01)
Leucopogon florulentus Benth (P2) (FO22/99)
Leucopogon sp Dongolocking (P2) (LWS1495)
Lysinema ciliatum R Br (FO323/99)

Fumariaceae

* *Fumaria capreolata* L (FO29/01)

Geraniaceae

* *Erodium botrys* (Cav) Bertol (FO83/02)
Pelargonium havlasae Domin (FO209/98)

Goodeniaceae

- Anthotium odontophyllum* Sage (LWS1409)
Dampiera haematotricha de Vriese subsp *haematotricha* (LWS1058)
Dampiera juncea Benth (LWS1057)
Dampiera lavandulacea Lindl (LWS1056)
Dampiera lindleyi de Vriese (LWS1055)
Dampiera sacculata Benth (FO55/02)
Goodenia incana R Br (LWS1054)
Goodenia pulchella subsp *Wheatbelt* (LW Sage & F Hort 795) (LWS1059)
Goodenia scapigera R Br subsp *scapigera* (LWS1060)
Goodenia watsonii subsp *glandulosa* Carolin (LWS1406)
Lechenaultia biloba Lindl (FO277/98)
Velleia trinervis Labill (LWS1061)

Haemodoraceae

- Anigozanthos humilis* Lindl subsp *humilis* (LWS1066)
Conostylis aculeata subsp *bromelioides* (Endl) JW Green (LWS1087)
Conostylis drummondii Benth (R) (FO61/02)
Conostylis pusilla Endl (LWS1086)
Haemodorum discolor T Macfarlane (LWS1434)

Haloragaceae

- Glischrocaryon aureum* (Lindl) Orchard (FO11/02)

Hypoxidaceae

- Hypoxis glabella* R Br var *glabella* (FO1/01)

Iridaceae

- Orthrosanthus laxus* var *gramineus* (Endl) Geerinck (FO306/99)
Patersonia juncea Lindl (FO283/98)
Patersonia occidentalis R Br (LWS1089)
 * *Romulea rosea* (L) Eckl (FO220/98)

Lamiaceae

- Chloanthes coccinea* Bartl (LWS1065)
Hemiandra linearis Benth (FO57/02)
Hemigenia humilis Benth (FO68/02)
Hemigenia incana (Lindl) Benth (LWS1072)
Microcorys lenticularis F Muell (P2) (FO85/02)

Lobeliaceae

- Isotoma hypocrateriformis* (R Br) Druce (FO210/98)
Lobelia rarifolia E Wimm (FO47/02)

Loganiaceae

- Phyllangium sulcatum* Dunlop (FO320/99)

Loranthaceae

- Nuytsia floribunda* (Labill) Fenzl (LWS1517)

Mimosaceae

- Acacia acuminata* Benth (FO257/98)
Acacia applanata Maslin (FO37/01)
Acacia browniana var *intermedia* (E Pritz) Maslin (FO289/98)
Acacia celastrifolia Benth (LWS1426)
Acacia erinacea Benth (LWS1237)
Acacia lasiocalyx CRP Andrews (FO11/01)
Acacia lasiocarpa var *sedifolia* (Meisn) Maslin (LWS1248)
Acacia microbotrya Benth (FO16/99)
Acacia pulchella var *glaberrima* Meisn (FO286/98)
Acacia stenoptera Benth (FO25/99)

Myrtaceae

- Baeckea crispiflora* F Muell (round leaf variant) (FO78/02)
Baeckea crispiflora F Muell (narrow leaf variant) (FO76/02)
Baeckea preissiana (Schauer) Domin (FO272/98)
Beaufortia bracteosa Diels (LWS1212)
Beaufortia incana (Benth) AS George (LWS1206)
Beaufortia micrantha var *puberula* Benth (LWS1424)
Callistemon phoeniceus Lindl (LWS1419)
Calothamnus planifolius Lehm (LWS1220)
Calothamnus quadrifidus R Br (LWS1219)

- Calothamnus sanguineus* Labill (FO3/01)
Calytrix breviseta subsp *stipulosa* (W Fitzg) Craven (LWS1202)
Calytrix leschenaultii (Schauer) Benth (FO318/99)
Eremaea pauciflora (Endl) Druce var *pauciflora* (LWS1423)
Eucalyptus argyphaea LAS Johnson & KD Hill (FO69/02)
Eucalyptus aspersa Brooker & Hopper (P4) (LWS1442)
Eucalyptus astringens (Maiden) Maiden subsp *astringens* (FO27/01)
Eucalyptus falcata Turcz subsp *falcata* (LWS1243)
Eucalyptus incrassata Labill (LWS1208)
Eucalyptus latens Brooker (P4) (LWS1441)
Eucalyptus longicornis (F Muell) Maiden (LWS1491)
Eucalyptus phenax Brooker & Slee (FO73/02)
Eucalyptus pluricaulis Brooker & Hopper subsp *pluricaulis* (LWS1508)
Eucalyptus thamnoides subsp *megista* Brooker & Hopper (LWS1507a)
Eucalyptus uncinata Turcz (FO71/02)
Eucalyptus wandoo Blakely subsp *wandoo* (LWS1510)
Hypocalymma angustifolium (Endl) Schauer (LWS1200)
Kunzea micromera Schauer (FO305/99)
Kunzea preissiana Schauer (LWS1201)
Leptospermum erubescens Schauer (FO244/98)
Melaleuca aff uncinata (FO266/98)
Melaleuca lecanantha Barlow (FO212/98)
Melaleuca subtrigona Schauer (LWS1211)
Melaleuca tuberculata Schauer var *tuberculata* (LWS1210)
Melaleuca viminea Lindl subsp *viminea* (FO13/02)
Rinzia fumana Schauer (LWS1226)
Verticordia densiflora Lindl var *densiflora* (LWS1436)
Verticordia grandiflora Endl (LWS1092)
Verticordia huegelii var *stylosa* (Turcz) AS George (FO75/02)
Verticordia insignis subsp *compta* (Endl) AS George (LWS1213)

Olacaceae

- Olax benthamiana* Miq (FO19/01)

Orchidaceae

- Caladenia aff marginata* (FO26/99)
Caladenia exilis Hopper & AP Br subsp *exilis* (FO45/01)
Caladenia falcata (Nicholls) MA Clem & Hopper (LWS1084)
Caladenia flava R Br subsp *flava* (FO328/99)
Caladenia flava x reptans (FO31/01)
Caladenia longicauda subsp *eminens* (Domin) Hopper & AP Br (FO338/99)
Caladenia reptans Lindl subsp *reptans* (FO16/01)
Caladenia saccharata Rchb f (FO36/01)
Caladenia xantha Hopper & AP Br (FO14/01)
Cyanicula deformis (R Br) Hopper & AP Br (FO17/01)
Cyanicula sericea (Lindl) Hopper & AP Br (FO33/01)
 * *Disa bracteata* Sw (LWS1413)
Diuris corymbosa Lindl (FO337/99)
Diuris setacea R Br (FO278/98)
Elythranthera brunonis (Endl) AS George (LWS1239)
Eriochilus dilatatus subsp *multiflorus* (Lindl) Hopper & AP Br (FO27/99)
Eriochilus sp (LWS1520)
Leporella fimbriata (Lindl) AS George (LWS1506)
Oligochaetochilus sanguineus (DL Jones & MA Clem) Szlach (LWS1492)
Oligochaetochilus vittatus (Lindl) Szlach (FO335/99)
Prasophyllum gracile Lindl (FO336/99)
Prasophyllum parvifolium Lindl (LWS1505)
Pterostylis aff nana (LWS1500)
Pterostylis recurva Benth (FO9/01)
Thelymitra antennifera (Lindl) Hook f (FO15/01)
Thelymitra crinita Lindl (FO82/02)

Oxalidaceae

- * *Oxalis corniculata* L (FO211/98)

Papilionaceae

- Bossiaea eriocarpa* Benth (FO208/98)

- Chorizema aciculare* (DC) CA Gardner subsp *aciculare* (FO327/99)
Daviesia articulata Crisp (FO91/02)
Daviesia cardiophylla F Muell (FO22/01)
Daviesia decipiens (E Pritz) Crisp (LWS1502)
Daviesia hakeoides subsp *subnuda* (Benth) Crisp (FO246/98)
Daviesia longifolia Benth (FO84/02)
Dillwynia sp A Perth Flora (R Coveny 8036) (FO25/01)
Gastrolobium calycinum Benth (LWS1069)
Gastrolobium parviflorum (Benth) Crisp (FO240/98)
Gastrolobium stowardii S Moore (FO271/98)
Gastrolobium trilobum Benth (FO269/98)
Gompholobium marginatum R Br (FO248/98)
Gompholobium tomentosum Labill (FO56/02)
Hovea pungens Benth (FO18/01)
Isotropis cuneifolia (Sm) Heynh (FO330/99)
Isotropis drummondii Meisn (LWS1063)
Jacksonia alata Benth (LWS1067)
Jacksonia racemosa Meisn (LWS1421)
Jacksonia sternbergiana Huegel (LWS1241)
Mirbelia dilatata R Br (LWS1068)
Nemcia aspera Crisp ms (LWS1415)
Nemcia obovata (Benth) Crisp (LWS1070)
Pultenaea aff *ericifolia* (FO26/01)
* *Trifolium arvense* L var *arvense* (FO77/02)
* *Trifolium campestre* Schreb var *campestre* (FO60/02)
- Phormiaceae**
Dianella revoluta var *divaricata* (R Br) RJF Hend (LWS1498)
Stypantra glauca R Br (LWS1214)
- Pittosporaceae**
Billardiera sericea (Turcz) EM Benn (FO54/02)
Marianthus bicolor (Putt) F Muell (FO24/99)
Marianthus erubescens Putt (LWS1418)
Sollya fusiformis (Labill) Payer (FO256/98)
- Poaceae**
* *Aira cupaniana* Guss (FO226/98)
Amphipogon strictus R Br (FO231/98)
Amphipogon turbinatus R Br (FO232/98)
Austroanthonia caespitosa (Gaudich) HP Linder (LWS1231)
Austroanthonia setacea (R Br) HP Linder (LWS1425)
Austrostipa elegantissima (Labill) SWL Jacobs & J Everett (FO242/98)
Austrostipa hemipogon (Benth) SWL Jacobs & J Everett (LWS1230)
Austrostipa mollis (R Br) SWL Jacobs & J Everett (FO52/02)
Austrostipa tenuifolia (Steud) SWL Jacobs & J Everett (FO81/02)
Austrostipa variabilis (Hughes) SWL Jacobs & J Everett (LWS1232)
* *Avena barbata* Link (FO238/98)
* *Briza maxima* L (FO223/98)
* *Briza minor* L (LWS1429)
* *Bromus diandrus* Roth (FO236/98)
* *Bromus rubens* L (FO80/02)
* *Ehrharta longiflora* Sm (FO235/98)
* *Lolium rigidum* Gaudin (FO239/98)
Neurachne alopecuroidea R Br (LWS1233)
Poa drummondiana Nees (LWS1433)
* *Vulpia myuros* (L) CC Gmel (FO51/02)
- Polygalaceae**
Comesperma ciliatum Steetz (FO70/02)
Comesperma integerrimum Endl (LWS1235)
Comesperma scoparium Steetz (FO20/01)
- Portulacaceae**
Calandrinia calyprata Hook f (FO74/02)
- Primulaceae**
* *Anagallis arvensis* L (FO217/98)
- Proteaceae**
Adenanthos cygnorum Diels subsp *cygnorum* (FO4/01)
Banksia sphaerocarpa R Br var *sphaerocarpa* (LWS1249)
Conospermum stoechadis subsp *sclerophyllum* (Lindl) EM Benn (LWS1218)
Dryandra armata R Br var *armata* (LWS1221)
Dryandra fraseri R Br var *fraseri* (LWS1222)
Dryandra lindleyana subsp *sylvestris* AS George (LWS1437a)
Dryandra nivea (Labill) R Br subsp *nivea* (LWS1244b)
Dryandra nobilis Lindl subsp *nobilis* (FO18/99)
Dryandra rufistylis AS George (P2) (LWS1437b)
Dryandra sessilis (Knight) Domin (FO268/98)
Hakea brownii Meisn (FO17/99)
Hakea hastata Haegi (LWS1496)
Hakea incrassata R Br (FO201/98)
Hakea lehmanniana Meisn (FO255/98)
Hakea lissocarpha R Br (FO21/99)
Hakea prostrata R Br (LWS1513)
Hakea trifurcata (Sm) R Br (FO284/98)
Hakea undulata R Br (LWS1514)
Isopogon dubius (R Br) Druce (LWS1205)
Isopogon teretifolius R Br subsp *teretifolius* (LWS1244a)
Persoonia quinquenervis Hook (LWS1234)
Petrophile rigida R Br (FO43/01)
Petrophile seminuda Lindl (FO294/98)
Petrophile serruriae R Br (LWS1204)
Petrophile squamata R Br subsp *squamata* (FO307/99)
Petrophile striata R Br (FO42/01)
Stirlingia simplex Lindl (LWS1074)
Synaphea aff *interioris* (pointed leaf variant) (FO41/01)
Synaphea aff *interioris* (rounded leaf variant) (FO30/01)
- Restionaceae**
Desmodcladus asper (Nees) BG Briggs & LAS Johnson (FO292/98)
Desmodcladus fasciculatus (R Br) BG Briggs & LAS Johnson (FO58/02)
Harperia lateriflora W Fitzg (FO87/02)
Hypolaena exsulca R Br (LWS1227)
Lepidobolus preissianus Nees subsp *preissianus* (LWS1223)
Lyginia imberbis R Br (LWS1229)
- Rhamnaceae**
Cryptandra arbutiflora Fenzl (FO308/99)
Cryptandra myriantha Diels (LWS1494)
Cryptandra pungens Steud (FO39/01)
Trymalium ledifolium var *rosmarinifolium* (Steud) Benth (LWS1497)
- Rubiaceae**
Opercularia vaginata Juss (FO227/98)
- Rutaceae**
Boronia crassifolia Bartl (FO65/02)
- Santalaceae**
Choretrum glomeratum var *chrysanthum* (F Muell) Benth (FO12/02)
Santalum acuminatum (R Br) A DC (LWS1512)
- Sapindaceae**
Dodonaea humifusa Miq (FO44/01)
Dodonaea pinifolia Miq (FO247/98)
- Scrophulariaceae**
* *Parentucellia latifolia* (L) Caruel (FO219/98)
- Stackhousiaceae**
Stackhousia monogyna Labill (FO214/98)
Stackhousia scoparia Benth (FO64/02)
- Sterculiaceae**
Thomasia macrocalyx Steud (FO270/98)
- Stylidiaceae**
Levenhookia pusilla R Br (LWS1451)

Levenhookia stipitata (Sond) F Muell (FO224/98)
Stylidium calcaratum R Br (FO334/99)
Stylidium caricifolium Lindl (LWS1081)
Stylidium carnosum Benth (LWS1075)
Stylidium dichotomum DC (FO207/98)
Stylidium eriopodum DC (FO59/02)
Stylidium hirsutum R Br (LWS1082)
Stylidium leptophyllum DC (LWS1079)
Stylidium luteum subsp *clavatum* Carlquist (LWS1077)
Stylidium petiolare Sond (FO325/99)
Stylidium piliferum R Br (LWS1080)
Stylidium pubigerum Sond (LWS1076)

Stylidium repens R Br (FO282/98)
Stylidium rhynchocarpum Sond (FO89/02)
Stylidium squamellosum DC (FO49/02)
Stylidium uniflorum Sond (LWS1078)

Thymelaeaceae

Pimelea suaveolens Meisn subsp *suaveolens* (LWS1091)
Pimelea sulphurea Meisn (FO66/02)

Tremandraceae

Tetratheca virgata Steetz (LWS1064)

Xanthorrhoeaceae

Xanthorrhoea gracilis Endl (FO264/98)