Vegetation, flora and recommendations for conservation management of Jingaring Nature Reserve: A "botanical gem" in the Western Australian wheat-belt.

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Abstract

The significance of larger remnants at retaining local bio-diversity in an essentially cleared and fragmented agricultural landscape is generally accepted, but small intact remnants also contribute significantly to overall bio-diversity. This was highlighted by our comprehensive survey of vascular flora of Jingaring Nature Reserve, which included every season over a two-year period. The exceptionally diverse flora of this relatively undisturbed wheatbelt remnant identified six distinct communities encompassing heaths and woodlands. Over 260 vascular species were recorded, including two rare, five priority and a number of species of special interest from 51 families. Weeds accounted for 27 species, but the extent of invasion is relatively low. The known limit of many species' distributions occur near or at the reserve and this may be an evolutionary artefact of significant importance. Higher species diversity per unit area was recorded compared to other unpublished surveys of larger areas around this district.

Several management issues are of concern for Jingaring Nature Reserve including protection of rare and priority flora, weed invasion, fire management and damage caused by unauthorised access. Eradication of rabbits and localised weed control around rabbit warrens in the reserve should result in regeneration of these areas.

Keywords: vegetation, flora, Jingaring Nature Reserve, wheat-belt, remnant vegetation.

Introduction

Jingaring Nature Reserve is a species-rich remnant (see species list in appendix) of high conservation value (*i.e.* "A" class nature reserve). It is located 155 km directly east-south-east of Perth near Pingelly, Western Australia (Fig 1). The district has a dry Mediterranean-type climate with very warm, dry summers and very cool, wet winters. Average annual rainfall for the reserve is about 400 mm, which places the reserve within the wetter western (inner) margins of the wheatbelt (Fig 1). The landscape surrounding Jingaring Nature Reserve is undulating hills with interspersed plains. Overall height relief is low and there are few large granite outcrops or extensive lateritic ridges as found in western parts of this district (Beard 1980a). The reserve is a small triangular remnant (34 ha) situated in the upper reaches of the Avon River, the river being a few kilometres to the north. Drainage of the immediate area is via Sandplain Creek, that runs through the extreme south-western corner of the reserve heading firstly north west, then to the north, before it drains into the Avon River. Jingaring Nature Reserve is actually a remnant portion of creek floodplain and gently sloping valley side. The reserve is surrounded by expanses of cleared agricultural land that forms an integral feature of the Western Australian wheatbelt region. Beard (1980b) classified the dominant vegetation of the district as a mixture of York gum (*Eucalyptus loxophleba*) and wandoo (*E. wandoo*), with scrub-heath on intervening sandplain areas. This describes the situation in the immediate surrounds of the reserve. Further east (~25 km) the wandoo gives way to the more xeric-adapted salmon gum (*E. salmonophloia*), while 20 km south in the Shire of Cuballing, groves of jam (*Acacia acuminata*) and sheoak (*Allocasuarina huegeliana*) surround significant areas of granite outcropping (Beard 1980b).

Currently, there are few published wheatbelt remnant surveys available, but notable are the pioneering surveys of 24 reserves compiled in the Records of the Western Australian Museum (Muir 1977a). There are several other significant, and unpublished, flora surveys of wheatbelt remnants; however, few of these submitted vouchers to the Western Australian Herbarium (PERTH) so that the specimens would be available and taxonomically relevant into the future. Reasons for the lack of published survey information to date are the costs of extensively surveying remnants and the vastness of the region (*i.e.* 18 million hectares). Larger remnants (*i.e.* >2000 ha) are generally considered as important areas for conserving this wealth of bio-diversity and these areas are also particularly necessary for fauna conservation. The aim of this survey was to highlight the contribution that smaller remnants, (particularly intact remnants) can make towards the overall flora diversity within the wheatbelt region. Additionally, it emphasizes that these small intact remnants should not be overlooked nor precluded from future acquisitions of conservation estate.

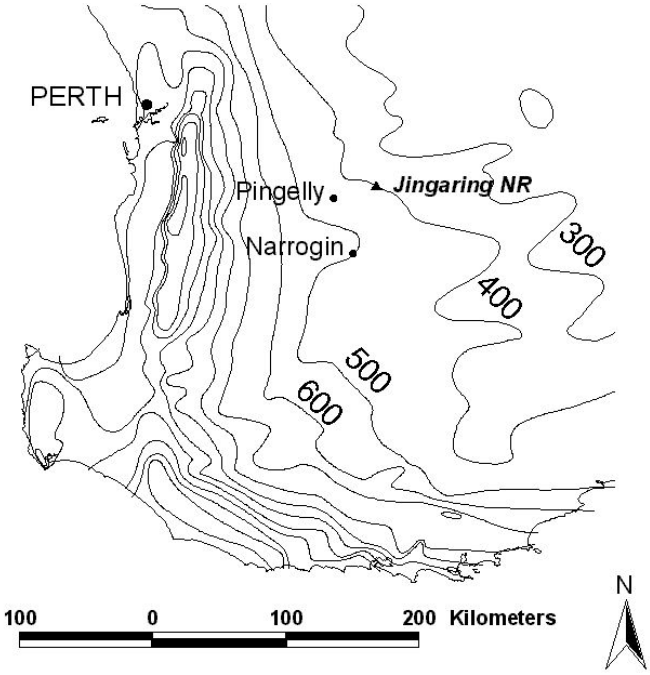

Figure 1. Location of Jingaring Nature Reserve, near Pingelly, in the southwest of Western Australia showing rainfall isohyets.

Methods

The vegetation communities of Jingaring Nature Reserve were interpreted from a 1996 aerial photograph and confirmed in the field during 1999. 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 species compositional differences. Additionally, brief investigations were made of the soils in each vegetation community. This included taking soil samples (~3 cm depth) to nominally assess soil texture and colour.

The flora survey and collections were accomplished by walking along transects (spaced 150 m apart) which spanned the full width of the reserve in a north-south orientation. The first transect began at approximately 50 m in from the reserve's south-west corner, in the vicinity of Sandplain Creek. Every vegetation type was traversed several times using this technique. This transect survey was undertaken during late spring 1998, but various additional surveys were also carried out during mid autumn, early and late winter, early and mid spring, and early summer over 1998 and 1999. On these occasions a technique known as 'randomized stratified walk' (Hopper *et al*. 1997) was employed. As the name suggests, this method involves specimen collections via random walks in each habitat type. The purpose of this intensive surveying was to obtain a good flowering specimen of each species and to compile a more complete vascular flora list (*i.e*. as a benchmark survey).

The authors identified most specimens with some assistance from specialist staff of the WA Herbarium. All specimens were submitted for incorporation at the WA Herbarium. Species names follow WACENSUS (WA Herbarium census of Western Australian vascular plants), while conservation status of species is according to Department of Conservation and Land Management's

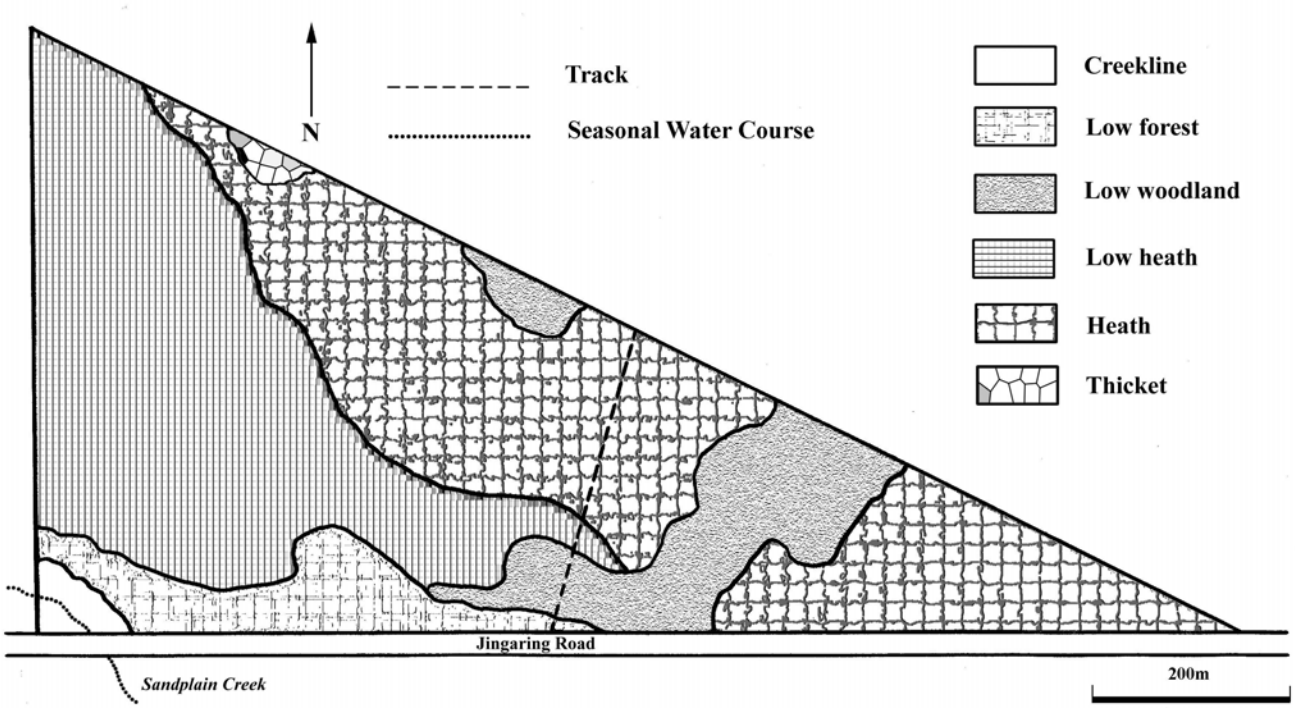

Figure 2. Vegetation communities of Jingaring Nature Reserve.

Table 1. Vegetation communities and their predominant plant species as recognized at Jingaring Nature Reserve.

Community	Plant species
Dense Low Forest	Dense canopy of *Eucalyptus loxophleba*, *E. rudis* and *Allocasuarina huegeliana*. Mid canopy of *Acacia saligna*, *A. acuminata* and *Melaleuca sp*. The understorey is degraded and dominated by weeds.
Low Forest	*Allocasuarina huegeliana*, *Acacia acuminata* and some scattered *Eucalyptus wandoo*, with a mainly herbaceous species understorey occurring on flat plain.
Low Woodland	*Eucalyptus wandoo* with scattered *Acacia acuminata* and sparse, open shrub understorey or sedges.
Low Heath	A very diverse mix of shrubs and sub-shrubs (<1.5 m), abundant sedges, occurring on flat plain.
Heath	A very diverse mix of shrubs and sub-shrubs (most 1-2 m), some sedges, occurring on sloping ground.
Thicket	A mid-dense mix of tall shrubs (most >2 m) occurring on gently sloping ground.

(CALM) Declared Rare Flora and Priority Flora list (Atkins 1999). The authors also received invaluable information from WA Herbarium database records (WAHERB) and (FLORABASE).

Results

Vegetation and habitat

Interpretation of the aerial photograph and site survey indicated six major vegetation types (Table 1 & Fig 2), five quite distinctive, and a sixth being a variant of reasonable species differences and of sufficient area to be considered as separate (*i.e.* 5: Heath from Table 1).

The creekline community covers a small area (~ 3 ha) and has variable soil types, the creek banks being a mixture of gravels bound in fine to coarse sandy clay. *Eucalyptus loxophleba, E. rudis, Acacia saligna* and *Melaleuca sp* are common, while further out *Allocasuarina huegeliana* becomes more dominant on brown sandy loam. Numerous wind-dispersed agricultural grass weeds, such as *Avena barbata, Ehrharta longiflora, Bromus diandrus* and *Lolium rigidum*, are well established here preferring the extra moisture and nutrients.

The low forest community occurs on grey/brown sandy loam in a narrow band east of the creek line (plains country) and parallel to the road. *Allocasuarina huegeliana* and *Acacia acuminata* predominate, interspersed with *Eucalyptus wandoo* and resulting in a mid-dense canopy cover (30-70%), the open patches being more woodland like. There are a few scattered shrubs, but most of the understorey is quite open and rich in annuals and other herbaceous species. The wandoo woodland community slightly intergrades at the boundary with the previous low forest community and again occurs on sandy loams. This vegetation type traverses the slope with the understorey on the lower slopes consisting of scattered low shrubs (mainly Fabaceae) and sedges (predominantly *Lepidobolus preissianus* and *Desmocladus asper*), while on the mid to upper slope there are more frequent bare patches containing wandoo leaf litter. Another pocket of open wandoo woodland also occurs up slope on the reserve's mid northern boundary and extends onto adjacent farmland (Fig 2).

The low heath community covers most of the extensive low-lying plain of the reserve and has a light grey/brown sandy loam appearance. The area is reasonably inundated at times during winter. Low shrubs and sub-shrubs predominate, but there are also scattered patches of taller vegetation including *Allocasuarina campestris*, *Santalum spicatum* and some Acacia species. The heath is species rich with a number of common shrubs such as *Calothamnus brevifolius*, *Melaleuca carrii*, *Beaufortia bracteosa*, *Acacia lasiocarpa*, *Daviesia cardiophylla*, *Comesperma scoparium*, *Hakea lissocarpha*, *Dodonea pinifolia*, *Petrophile ericifolia*, *Laxmannia omnifertilis* and *Allocasuarina humilis* to name but a few. *Mesomelaena preissii* is the most commonly occurring sedge.

Farther up the slope the low heath changes subtly to heath. This community covers a considerable area of the reserve in two large parts separated by wandoo woodland. The soil varies from light grey to light grey/brown sandy loams often with a thin layer of bleached white sand on top. Soil depth also increases farther up slope, which might explain the differences in shrub height for this community. Most of the species mentioned in the previous community occur here also, however, others such as *Banksia sphaerocarpa*, *B. violacea*, *Isopogon buxifolius*, *Pimelea imbricata*, *Leptospermum erubescens* and *Grevillea cagiana* appear to be specifically located within this vegetation type.

The last community is a small patch of thicket dominated by tall *Allocasuarina campestris* and *Dryandra purdieana*, with a mid-dense understorey of *Banksia sphaerocarpa*, *Hakea incrassata* and *Calothamnus brevifolia*. The soils are again a light grey/brown loam and appear to have similar depth to the heath community.

Flora

A total of 264 vascular species (237 natives and 27 introduced weeds) from 51 families were listed for Jingaring Nature Reserve (Appendix). The ten largest families were Proteaceae (28), Myrtaceae (27), Asteraceae (22), Poaceae (18), Papilionaceae (16), Cyperaceae (15), Mimosaceae (13), Orchidaceae (12) Goodeniaceae (11) and total 'Liliaceae' (13). Half of the Poaceae species are weeds. The ten genera with the greatest number of species are *Acacia* (13), *Verticordia* (9), *Hakea* (6), *Caladenia* (6), *Schoenus* (6), *Drosera* (6), *Dryandra* (5), *Daviesia* (5), *Goodenia* (5) and *Stylidium* (5).

Two declared rare species, *Verticordia fimbrilepis* ssp *fimbrilepis*, a variant of *Dryandra ionthocarpa* (currently un-

der review) and five priority species, *Acacia anarthos, Anigozanthos bicolor* ssp *exstans, Calothamnus brevifolius, Calytrix* sp (Jingaring) and *Dryandra lindleyana* ssp *agricola* were recorded for the reserve. There were also several species of special interest (see discussion).

Discussion

Vegetation and habitat

Most of the vegetation communities of the reserve were distinctive, but considered as not particularly unique, there being several other remnants in the area having similar habitat types. The low heath community is not as common locally; however, all habitat types were in relatively good condition.

Flora

Jingaring Nature Reserve, with 264 species located within 34 ha, represents an exceptionally species-rich area. As a comparison, a 'random stratified' flora survey of Yilliminning Rock reserve, just east of Narrogin and about 55 km directly south of Jingaring Nature Reserve, found 238 vascular species in 80 ha (Pigott & Sage 1997). A quadrat-based flora survey near Popanyinning (~30 km south-west of Jingaring Nature Reserve) by Gunness (1998) found 249 vascular species in 60 ha of bushland remnant. Additionally, several surveys over a number of years for the nearby Tutanning Nature Reserve (2310 ha) have so far recognized 628 species for that reserve. Some of the differences found in species richness of these areas might be attributed to the different survey techniques used (*i.e.* not comparable), to different habitats surveyed and to the intensity of surveying (*i.e.* one season or more). Regardless of these factors, Jingaring Nature Reserve has an unusually high concentration of flora species and thus plays a big role for its size in conserving wheatbelt biodiversity. Any future intensive surveys using a similar methodology could act as benchmarks. These benchmark surveys of reserves/remnants spaced equally distant and appropriately throughout the wheatbelt would help to increase our knowledge of the flora in this highly fragmented landscape.

Declared Rare Flora. Two declared rare species are listed for the reserve, *Verticordia fimbrilepis* ssp *fimbrilepis* and a variant of *Dryandra ionthocarpa* (currently under review). The latter record extends that species range by approximately 240 km (former distribution just south of the Stirling Range). Both these species have the IUCN ranking of critically endangered.

Priority species. Five priority species have been identified, and along with the other rare flora this reaffirms the high conservation value of the reserve.

Acacia anarthros. Priority 3. This species is known from more than a dozen small remnants and the Jingaring Nature Reserve find represents one of the larger populations with secure conservation tenure. This population, and another slightly north near Lake Mears, are the only outliers from the known major populations centred around Calingiri, approximately 160 km away.

Anigozanthos bicolor ssp *exstans*. Priority 3. Scattered populations of this species are found from Meckering to south of Pingelly, and appear to be associated with open woodland areas. So far, less than 5 plants have been discovered in the reserve, all in the typical woodland habitat.

Calothamnus brevifolius. Priority 3. Its distribution is a relatively wide area from Marchagee (north) to Tammin and Corrigin (east) and to the Brookton area (south). The large Jingaring population is significant compared to the other smaller roadside remnants.

Calytrix sp (Jingaring). Priority 2. Recently, this taxa has been recognised as distinct from *Calytrix asperula* whose populations are all distributed near the south coast. There are only three populations of *Calytrix* sp (Jingaring) now recognized, on the reserve, at Aldersyde, and over 100 km eastwards near Narembeen. It is doubtful whether this last population still exists as the original collection was made in 1929 prior to significant land clearing there.

Dryandra lindleyana ssp *agricola*. Priority 1. A number of scattered populations are known over a relatively small area from east of Brookton to Kondinin. There are thousands of individual plants in the reserve, making this one of the largest populations.

Species of interest. *Persoonia inconspicua* has a distribution centred around Southern Cross and the Jingaring record represents a significant range extension. A presumed hybrid between *Dryandra pteridifolia* ssp *pteridifolia* (southern sandplains) and *Dryandra pteridifolia* ssp *vernalis* (northern sandplains) occurs on the reserve (taxonomic status to be determined). The reserve locality is also the distribution limit for *Lagenophora huegelii*, *Patersonia occidentalis*, *Hibbertia hypericoides*, *Sowerbaea laxiflora* (most eastern margin); *Adenanthos argyreus*, *Conostylis petrophiloides*, *Grevillea cagiana*, *Logania tortuosa* (most western margin); *Kunzea micromera*, *Banksia violacea* (most northern margin) and *Acacia acuaria, A. anarthros* and *Grevillea eriostachya* (most southern margin). This suggests that Jingaring Nature Reserve was part of a possible refugium where past climatic fluctuations have caused the maximal species interactions *i.e.* a central meeting point for potential speciation (Hopper 1979). In these terms, the reserve is a significant 'evolutionary showcase'.

Introduced weeds. There were 27 weed species (10% of the flora) recorded for Jingaring Nature Reserve compared to 19 weed species (8% of the flora) for Yilliminning Rock and 37 weed species (15% of the flora) for the Popanyinning remnant survey. These weed ratios range from low to moderate with some wheat-belt remnants containing higher numbers of weed species (unpublished personal observations). The number of weed species does not necessarily correspond to the extent of weed invasion. Jingaring Nature Reserve has serious weed infestation throughout the creekline community. Here, grass weeds such as *Avena barbata*, *Briza maxima*, *Bromus diandrus*, *Ehrharta longiflora*, *Hordeum geniculatum* and *Lolium rigidum* dominate the understorey. Broadleaf weeds such as *Arctotheca calendula*, *Brassica tournefortii* and *Hypochaeris glabra* are also locally common. The reserve boundary abutting farm-

land also has dense weed invasion, but by far the larger part of the reserve is relatively weed-free. Some very localized weed incursions also occur around disturbed areas (*i.e.* rabbit warrens, service track edges and an old gravel pit/rubbish site). There are low levels of *Parentucellia latifolia* and *Romulea rosea* scattered in the woodland areas, while *Ursinia anthemoides* is scattered throughout the reserve. These latter weeds appear innocuous, but *Romulea rosea* is a serious woodland weed in the wetter wheat-belt regions (Hussey *et al.* 1997).

Conservation management

Conservation reserves are generally smaller in the inner (*i.e.* western) wheat-belt areas compared to more eastern areas (CALM records). Management of small reserves with large perimeter to area ratios in a fragmented landscape is difficult (Panetta & Hopkins 1991) and has been exacerbated by a long history of disturbance and degradation. This includes more frequent fires, weed invasions due to human intervention and habitat modification, and also rising water-tables leading to increased salinity (Hobbs 1993). In outward appearances, Jingaring Nature Reserve seems relatively undisturbed in comparison to other small remnants in the area. Variable levels of weed incursion were found, but most native vegetation appears relatively healthy. There were no obvious signs of tree or shrub deaths that might indicate increasing salinity, but the reserve may still be at risk due to its low position in the landscape and its proximity to the Avon River. Important management issues include the protection of rare and priority flora, weed abatement, fire management and the protection of vegetation from inappropriate and unauthorised access (*i.e.* trail bikes, horses *etc*).

With two critically endangered and five priority species, the reserve needs a high level of protection from potential threats. The reserve has distinct vegetation communities and its geographical position makes the flora special (as discussed previously). Weeds are a threat to the reserve's integrity because weeds have been shown to displace native species, alter fire regimes, change local hydrology and reduce faunal resources (Hobbs 1991; Humphries *et al.* 1993; Pigott 1994; Adair 1995). Areas of weeds targeted specifically should provide the best management results. For instance, any attempt to eradicate weeds from the degraded creek line or boundary zones is unlikely to produce adequate regeneration of native species. This is because understorey seed-banks are often depleted in long-degraded areas such as these, and/or these areas may require specialised techniques to effect a reasonable germination event (Arnold *et al.*1998; unpublished personal observations). Additionally, these areas easily become weedy again due to wind-transported propagules and this will hinder the growth of any regenerated native seedlings. Ongoing weed control followed by planting out/seeding of local understorey species may be the only option left to rehabilitate these areas. This requires considerable management resources and may not produce equivalent results to the inputs needed. Most rabbit warrens are located in the central portion of the reserve where regular baiting for rabbits and localized weed control should prove more successful at regenerating these areas in the medium term (*i.e.* native seed rain still occurring in the immediate vicinity and weed reinvasion limited). A regular monitoring program must be implemented to determine the effectiveness of management measures and whether or not more control work is required to achieve a better outcome.

Fire is an essential part of most Australian ecosystems, but too-frequent burning of fragmented landscapes can be disastrous leading to weed invasion within small remnants which in turn perpetuates more fire events (Bridgewater & Kaesehagen 1979; Wycherley 1984; Hussey & Wallace 1993; B Muir, Muir Environmental Consultants, personal communication). CALM district records show that the reserve has not had a fire since 1980 and likely many years prior to that date. It appears that the localized weed invasions in the reserve are the results of localized soil disturbance rather than too-frequent fires. Any future fire plans should consider mosaic burns supplemented with post-fire weed control if required. Grading fire-breaks prior to mosaic burns is not recommended due to the increased potential for weed invasion along these breaks (*i.e.* increased soil disturbance) and increased fragmentation of these small reserves. Brush-cutting narrow bands of vegetation may provide the necessary fire-breaks. The potential for fire to adversely impact upon the reserve's rare flora must be considered. These areas should be kept fire-free until recovery plans have been successfully implemented which would include research into the fire response of these species.

There has been some evidence of trail bikes and horses using the area. The open nature of the reserve allows easy access. A management track cuts through the centre of the reserve and another overgrown track leads to the reserve's north-west corner (not shown on Fig 2). At this stage, the damage to vegetation from vehicles and horses has been minor. It would be advisable to erect signs that these activities are not appropriate or authorised, and to more clearly distinguish the area as a nature reserve.

In conclusion, the survey has highlighted aspects that need management attention despite the reserve's relatively pristine appearance. It demonstrates that 'in depth' surveys are especially useful at detecting potential issues prior to these situations becoming real management problems.

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Appendix

The vascular plant species recorded for Jingaring Nature Reserve listed by family. The family sequence is based on Engler's phylogenetic classification of plant families. The collector's number for each specimen is included in parentheses after the species authority name. * symbol represents species which are naturalized weeds.

Poaceae

* *Alopecurus pratensis* L (LWS1308)
Amphipogon strictus R Br (LWS1315)
Amphipogon turbinatus R Br (RD6376)
Austrodanthonia acerosa (Vickery) HP Linder (LWS1346)
Austrodanthonia caespitosa (Gaudich) HP Linder (LWS1300)
Austrostipa elegantissima (Labill) SWL Jacobs & J Everett (LWS1282)
Austrostipa hemipogon (Benth) SWL Jacobs & J Everett (FO236/99)
Austrostipa semibarbata (R Br) SWL Jacobs & J Everett (LWS1352)
Austrostipa sp (LWS1351)
* *Avena barbata* Link (LWS1345)
* *Briza maxima* L (RD6557)
* *Bromus diandrus* Roth (LWS1356)
* *Ehrharta longiflora* Sm (LWS1357)
* *Hordeum geniculatum* All (LWS1314)
* *Lolium rigidum* Gaudin (LWS1306)
Neurachne alopecuroidea R Br (RD6553)
* *Pentaschistis airoides* (Nees) Stapf (LWS1334)
* *Vulpia muralis* (Kunth) Nees (RD6550)

Cyperaceae

Baumea sp (RD6397)
Caustis dioica R Br (LWS1259)
Chorizandra enodis Nees (LWS1321)
* *Cyperus tenellus* L f (LWS1287)
Lepidosperma brunonianum Nees (FO34199)
Lepidosperma costale Nees (LWS1367)
Lepidosperma sp (LWS1382)
Lepidosperma sp A2 Island Flat (GJ Keighery 7000) (LWS1384)
Mesomelaena preissii Nees (RD6543)
Schoenus discifer Tate (LWS1320)
Schoenus sp (LWS1289)
Schoenus sp A2 Kulin (BG Briggs 7939)(LWS1271)
Schoenus sp smooth culms (KR Newbey 7823)(FO41/99)
Schoenus subflavus Kuek subsp long leaves (KL Wilson 2865)(LWS1358)
Schoenus subflavus Kuek subsp *subflavus*(RD6535)

Restionaceae

Anarthria polyphylla Nees (LWS1272)
Desmocladus asper (Nees) LAS Johnson & BG Briggs (RD6384)
Harperia lateriflora W Fitzg. (FO232/99)
Lepidobolus chaetocephalus Benth (RD6379)
Lepidobolus preissianus Nees subsp *preissianus* (LWS1260)

Dasypogonaceae

Calectasia grandiflora Endl (RD6334)
Chamaexeros serra (Endl) Benth (RD6375)
Lomandra effusa (Lindl) Ewart (LWS1251a)
Lomandra sp (LWS1251b)

Xanthorrhoeaceae

Xanthorrhoea drummondii Harv (LWS1307)

Phormiaceae

Dianella revoluta R Br (LWS1309)
Stypandra glauca R Br (RD6532)

Anthericaceae

Chamaescilla corymbosa (R Br) Benth (FO238/99)
Chamaescilla spiralis (Endl) Benth (RD6525)
Dichopogon preissii (Endl) Brittan (LWS1359)
Laxmannia omnifertilis Keighery (RD6451)
Laxmannia squarrosa Lindl (LWS1278)
Sowerbaea laxiflora Lindl (RD6455)
Thysanotus patersonii R Br (FO242/99)
Tricoryne tenella R Br (LWS1303)

Colchicaceae

Wurmbea tenella (Endl) Benth (RD6341)

Boryaceae

Borya laciniata Churchill (RD6448)
Borya sphaerocephala R Br (RD6539)

Haemodoraceae

Anigozanthos bicolor subsp *exstans* Hopper (FO311/99)
Conostylis petrophiloides Benth (LWS1274)
Conostylis villosa Benth (LWS1374)
Haemodorum discolor T Macfarlane (LWS1375)
Tribonanthes longipetala Lindl (RD6527)

Iridaceae

Orthrosanthus laxus var *gramineus* (Endl) Geerinck (RD6456)
Patersonia juncea Lindl (LWS1376)
Patersonia occidentalis R Br (LWS1355)
* *Romulea rosea* var *australis* (Ewart) MP de Vos (RD6447)

Orchidaceae

Caladenia hiemalis Hopper & AP Brown ms (RD6450b)
Caladenia pendens Hopper & AP Brown subsp *pendens* ms (FO245/99)
Caladenia radialis RS Rogers (FO246/99)
Caladenia reptans Lindl (FO243/99)
Caladenia vulgata Hopper & AP Brown ms (FO244/99)
Cyanicula deformis (R Br) Hopper & AP Brown ms (RD6441)
Diuris corymbosa Lindl (RD6416)
Diuris laxiflora Lindl (LWS1311)
Diuris setacea R Br (LWS1310)
Eriochilus helonomos Hopper & AP Brown ms (FO33/99)
Pterostylis recurva Benth (FO235/99)

Casuarinaceae

Allocasuarina campestris (Diels) LAS Johnson (FO6A&B/99)
Allocasuarina huegeliana (Miq) LAS Johnson (RD6328)
Allocasuarina humilis (Otto & F Dietr) LAS Johnson (RD6327)
Allocasuarina microstachya (Miq) LAS Johnson (RD6339)

Proteaceae

Adenanthos argyreus Diels (RD6318)
Banksia sphaerocarpa R Br (RD6316)
Banksia violacea CA Gardner (RD6332)
Dryandra ionthocarpa AS George (LWS1350)
Dryandra lindleyana subsp *agricola* AS George (LWS1383)
Dryandra pteridifolia R Br (RD6337)
Dryandra purdieana Diels (RD6329)
Dryandra vestita Meisn (RD6336)

Grevillea cagiana McGill (LWS1339)
Grevillea eriostachya Lindl (LWS1347)
Grevillea uncinulata Diels subsp *uncinulata* (RD6438)
Hakea brownii Meisn (RD6325)
Hakea cygna Lamont subsp *cygna* (RD6322)
Hakea lissocarpha R Br (RD6439)
Hakea prostrata R Br (LWS1329)
Hakea scoparia Meisn (LWS1349)
Hakea trifurcata (Sm) R Br (RD6369)
Isopogon buxifolius R Br (RD6370)
Isopogon teretifolius R Br subsp *teretifolius* ms (LWS1338)
Persoonia inconspicua PH Weston (FO239/99)
Persoonia sp (LWS1381)
Persoonia striata R Br (FO330/98)
Petrophile brevifolia Lindl (RD6372)
Petrophile ericifolia R Br subsp *ericifolia* (RD6388)
Petrophile seminuda Lindl (RD6380)
Petrophile squamata R Br (RD6377)
Synaphea aff *interioris* (RD6321)
Synaphea spinulosa subsp *major* AS George (RD6340)

Santalaceae
Santalum spicatum (R Br) A DC (RD6454)

Loranthaceae
Nuytsia floribunda (Labill) Fenzl (FO31/99)

Polygonaceae
Muehlenbeckia adpressa (Labill) Meisn (LWS1325)

Amaranthaceae
Ptilotus drummondii (LWS1296)
Ptilotus declinatus Nees (LWS1333)
Ptilotus manglesii (Lindl) F Muell (LWS1254)
Ptilotus polystachyus (Gaudich) F Muell (FO/99)

Caryophyllaceae
* *Spergularia rubra* (L) J Presl & C Presl (FO312/99)
* *Spergularia salina* J Presl & C Presl (LWS1288)

Lauraceae
Cassytha glabella R Br (FO2/99)
Cassytha pomiformis Nees (LWS1316)

Fumariaceae
* *Fumaria muralis* WDJ Koch (RD6446)

Brassicaceae
* *Brassica tournefortii* Gouan (FO240/99)
* *Raphanus raphanistrum* L (LWS1370)

Droseraceae
Drosera bulbosa Hook subsp *bulbosa* (FO30/99)
Drosera erythrorhiza subsp *squamosa* (Benth) Marchant & Lowrie (FO4/99)
Drosera glanduligera Lehm (RD6538)
Drosera macrantha Endl subsp *macrantha* (RD6457)
Drosera menziesii DC subsp *menziesii* (FO310/99)
Drosera subhirtella Planch (RD6554)

Crassulaceae
Crassula colorata (Nees) Ostenf (FO231/99)

Pittosporaceae
Sollya heterophylla Lindl (RD6383)

Mimosaceae
Acacia acuaria W Fitzg (FO159/99)
Acacia acuminata Benth (LWS1283)
Acacia anarthros Maslin (FO15/99)
Acacia lasiocalyx CRP Andrews (RD6324)
Acacia lasiocarpa var *sedifolia* (Meisn) Maslin (RD6381)
Acacia leptospermoides Benth (FO233/99)
Acacia microbotrya Benth (LWS1262)
Acacia multispicata Benth (FO234/99)
Acacia saligna (Labill) HL Wendl (LWS1292)
Acacia sessilispica Maiden & Blakely (RD6533)
Acacia stenoptera Benth (RD6330)
Acacia subflexuosa Maiden subsp *subflexuosa* (RD6338)
Acacia tratmaniana W Fitzg (RD6391)

Papilionaceae
Bossiaea spinescens Meisn (RD6385)
Chorizema aciculare (DC) CA Gardner subsp *aciculare* (RD6536)
Daviesia aff *cardiophylla* (FO40/99)
Daviesia brachyphylla Meisn (FO156/99)
Daviesia cardiophylla F Muell (RD6315)
Daviesia hamata Crisp (RD6333)
Daviesia incrassata subsp *teres* Crisp (LWS1373)
Gastrolobium spinosum var *triangulare* Benth (LWS1275)
Gompholobium marginatum R Br (LWS1270)
Isotropis cuneifolia (Sm) BD Jacks (RD6556)
Isotropis drummondii Meisn (LWS1302)
Jacksonia condensata Crisp & JR Wheeler (LWS1327)
Jacksonia racemosa Meisn (LWS1378)
Mirbelia trichocalyx Domin (LWS1281)
Nemcia sp A Avon (MD Crisp 6183)(RD6530)
* *Trifolium arvense* L (LWS1318)

Geraniaceae
* *Erodium botrys* (Cav) Bertol (LWS1336)
Erodium cygnorum Nees (FO230/99)

Oxalidaceae
* *Oxalis corniculata* L (FO313/99)

Rutaceae
Boronia coerulescens F Muell subsp *coerulescens* (RD6440)
Boronia ramosa subsp *anethifolia* (Bartl) PG Wilson (FO315/99)

Tremandraceae
Tetratheca confertifolia Steetz (LWS1340)

Polygalaceae
Comesperma scoparium Steetz (RD6389)

Euphorbiaceae
Poranthera microphylla Brongn (LWS1313)

Stackhousiaceae
Stackhousia monogyna Labill (LWS1279)

Sapindaceae
Dodonaea pinifolia Miq (RD6367)

Rhamnaceae
Cryptandra leucopogon Reissek (RD6540)
Cryptandra myriantha Diels (RD6319)

Cryptandra pungens Steud (RD6320)
Stenanthemum intricatum Rye (FO36/99)

Dilleniaceae
Hibbertia exasperata (Steud) Briq (RD6531)
Hibbertia hypericoides (DC) Benth (RD6526)

Violaceae
Hybanthus floribundus (Lindl) F Muell subsp *floribundus* (FO42/99)

Thymelaeaceae
Pimelea argentea R Br (RD6445)
Pimelea imbricata var *piligera* (Benth) Diels (LWS1284)

Myrtaceae
Baeckea crispiflora F Muell (LWS1361)
Baeckea preissiana (Schauer) Domin (LWS1360)
Beaufortia bracteosa Diels (RD6335)
Calothamnus brevifolius Hawkeswood (RD6386)
Calothamnus quadrifidus R Br (RD6373)
Calytrix acutifolia (Lindl) Craven (RD6390)
Calytrix leschenaultii (Schauer) Benth (RD6323)
Calytrix sp. Jingaring (F Obbens, R Davis & LW Sage) (LWS1332)
Eremaea pauciflora (Endl) Druce var *pauciflora* (RD6387)
Eucalyptus loxophleba Benth subsp *loxophleba* (LWS1348)
Eucalyptus rudis Endl (FO14/99)
Eucalyptus wandoo Blakely subsp *wandoo* (RD6326)
Kunzea micromera Schauer (RD6442)
Leptospermum aff *nitens* (LWS1319)
Leptospermum erubescens Schauer (RD6534)
Melaleuca carrii Craven ms (LWS1362)
Melaleuca subtrigona Schauer (LWS1331)
Scholtzia sp (FO241/99)
Verticordia acerosa var *preissii* (Schauer) AS George (RD6374)
Verticordia brachypoda Turcz (LWS1263)
Verticordia chrysantha Endl (LWS1341)
Verticordia densiflora Lindl (FO332/98)
Verticordia eriocephala AS George (LWS1343)
Verticordia fimbrilepis Turcz subsp *fimbrilepis* (GD113)
Verticordia grandiflora Endl (LWS1268)
Verticordia picta Endl (RD6437)
Verticordia sp (LWS1342)

Haloragaceae
Glischrocaryon aureum var *angustifolium* (Nees) Orchard (LWS1258)

Apiaceae
Hydrocotyle callicarpa Bunge (RD6549)
Trachymene pilosa Sm (LWS1256)

Epacridaceae
Andersonia lehmanniana subsp *pubescens* (Sond) L Watson (RD6331)
Astroloma compactum R Br (FO38/99)
Astroloma serratifolium (DC) Druce (FO37/99)
Leucopogon conostephioides DC (FO43/99)
Leucopogon dielsianus E Pritz (FO8/99)
Leucopogon fimbriatus Stschegl (RD6372)
Lysinema ciliatum R Br (RD6529)

Primulaceae
* *Anagallis arvensis* L (LWS1330)

Loganiaceae
Logania flaviflora F Muell (LWS1261)
Logania tortuosa DA Herb (LWS1301)

Lamiaceae
Hemiandra incana Bartl (RD6317)
Microcorys sp stellate (A Strid 21885) (LWS1267)

Scrophulariaceae
* *Parentucellia latifolia* (L) Caruel (RD6555)

Rubiaceae
Opercularia spermacocea Juss (RD6371)
Opercularia vaginata Juss (LWS1255)

Goodeniaceae
Anthotium odontophyllum Sage (LWS1335)
Dampiera juncea Benth (RD6444)
Dampiera lavandulacea Lindl (RD6453)
Dampiera lindleyi de Vriese (LWS1299)
Dampiera sacculata Benth (RD6443)
Goodenia berardiana (Gaudich) Carolin (FO316/99)
Goodenia caerulea R Br (LWS1337)
Goodenia glareicola Carolin (FO333/99)
Goodenia helmsii (E Pritz) Carolin (LWS1369)
Goodenia pulchella Benth (LWS1372)
Verreauxia reinwardtii (de Vriese) Benth (LWS1368)

Stylidiaceae
Levenhookia pusilla R Br (RD6547)
Levenhookia stipitata (Sond) F Muell (LWS1312)
Stylidium dichotomum DC (LWS1323)
Stylidium leptophyllum DC (LWS1265)
Stylidium luteum subsp *clavatum* Carlquist (LWS1264)
Stylidium piliferum R Br subsp *piliferum* (LWS1380)
Stylidium repens R Br (LWS1324)

Asteraceae
* *Arctotheca calendula* (L) Levyns (RD6542)
Argentipallium niveum (Steetz) Paul G Wilson (LWS1294)
Blennospora drummondii A Gray (RD6541)
Brachyscome pusilla Steetz (RD6551)
Ceratogyne obionoides Turcz (RD6548)
Cotula coronopifolia L (LWS1298)
Gnephosis tenuissima Cass (LWS1257)
Helichrysum leucopsideum DC (LWS1252)
* *Hypochaeris glabra* L (LWS1377)
Lagenophora huegelii Benth (FO158/99)
Lawrencella rosea Lindl (RD6449)
Millotia tenuifolia Cass var *tenuifolia* (RD6545)
Olearia rudis (Benth) Benth (RD6552)
* *Osteospermum clandestinum* (Less) Norl (FO237/99)
Podolepis capillaris (Steetz) Diels (LWS1297)
Podolepis lessonii (Cass) Benth (RD6558)
Podotheca angustifolia (Labill) Less (RD6544)
Pterochaeta paniculata Steetz (LWS1305)
Rhodanthe manglesii Lindl (RD6559)
* *Sonchus oleraceus* L (LWS1290)
* *Ursinia anthemoides* (L) Poir (RD6546)
Waitzia acuminata Steetz var *acuminata* (LWS1353)