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Impact of agricultural development and changed fire regimes on species composition of the avifauna in the Denmark region of south-west Western Australia, 1889–1999

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SUMMARY

Records of bird species observed by F.L. Whitlock near Wilson Inlet in the period 1905–19 (mostly 1907, 1909 and 1910), hitherto unpublished, were collated from museum specimens and archives. Whitlock noted 94 species comprising 65 landbirds, 10 waterbirds, 7 seabirds, and 12 non-breeding waders. Records of bird species made by other ornithologists from 1889 to 1913 indicate that the original avifauna of this region comprised 81 landbird species. In the past century four of these species (*Burhinus grallarius, Pezoporus wallicus, Atrichornis clamosus* and *Dasyornis longirostris)*, as well as the waterbird *Ixobrychus flavicollis*, appear to have become locally extinct. Deforestation for agricultural development, with the subsequent creation of parkland and pasture, has allowed 10 landbird and 8 waterbird species to colonize the area. Whitlock's records of the seabird species *Eudyptula minor* and *Pterodroma macroptera* nesting on islands in Wilson Inlet are otherwise unreported in the literature.

A comprehensive synthesis of eyewitness accounts of Aboriginal burning practices in the period 1791–1840 indicates that anthropogenic fire was frequent, prevalent in summer, and spatially extensive but in patches varying in area from *c.* 10–2000 ha, with a tendency for riparian vegetation to be burnt less often than uplands. Such fires could be set at the hottest part of the day, with multiple ignitions on the one day, and under windy conditions. Three bird species that are sensitive to frequent fire and now considered to be extinct locally are presumed to have had patchy distributions confined to those limited parts of the landscape naturally protected from frequent burning (vegetation along higher order streams, on steep south-facing slopes, or surrounded by expanses of granite). In addition, some of these sites may have had totemic significance to Aborigines and were thus protected from more intense or frequent fire by periodic burning using low intensity fire in spring, late autumn or early winter. The vulnerability of naturally insularized populations to inappropriate intensity or frequency of fire may explain the early demise of these species following European settlement.

Few other parts of Western Australia have an avifauna so well documented at a time when agricultural development had only recently commenced. The Denmark area would therefore provide an appropriate focal region for documenting ongoing environmental change as indicated by the avifauna.

INTRODUCTION

The English ornithologist F.L. Whitlock (1860–1953) migrated to Western Australia (WA) in 1901 (Whittell 1954), and later settled near Tudor Siding, Wilson Inlet (Fig. 1), 'the house ["Chiltern", Jackson 1912–13 unpublished diary] being within half-a-mile [*c.* 800 m] of the eastern end of the inlet' (Whittell 1940) and 'a little over a mile [1.6 km]' from the siding (Jackson 1912–13, unpublished diary). Whitlock resided there from 1905 to *c.* 1924, though from 1908 he was often in remote parts of Australia collecting eggs for H.L. White and skins for G.M. Mathews. Whittell (1940) drew attention to the absence of a general account of Whitlock's collecting and observations near Wilson Inlet. This omission is difficult to explain, because Whitlock did publish on the bird species encountered on each of his 13 collecting expeditions; perhaps Wilson Inlet was not considered sufficiently remote or the avifauna of the region was regarded as uninteresting. The five papers published on the area treated only six species in varying degrees of detail (Whitlock 1911a, 1912, 1914, 1926, 1936). To my surprise, no remarks about the avifauna of the Denmark region were found in Mathews' 12 volume *Birds of Australia*, published between 1910 and 1927.

With the passage of time, Whitlock's specimens collected near Wilson Inlet have assumed a significance probably not envisaged by him. His specimens were collected following a period of timber getting at Torbay (1884–1896) and Denmark (1896–1905) (Gunzburg and Austin 1997) and the commencement of permanent clearing of vegetation in 1906 for potato farming (Jackson 1912–13, unpublished diary) and dairying (Cullity 1979).

Closer settlement was given impetus when in 1907 the Western Australian government purchased the Elleker-Denmark railway, built by Millar's, and adjacent lands (Gunzburg and Austin 1997). Whitlock's collections provide an important baseline for examining gross changes in species composition of the avifauna during the course of this century.

The aims of this paper are: (1) to collate all available records by Whitlock and make this important baseline historical information more readily accessible; (2) to combine this material with records of bird species observed by other ornithologists in the period 1889–1913 in the Denmark region, resulting in a definitive list of bird species of the Denmark region prior to intensive disturbance by European settlement; and (3) to provide context for evaluating the impact of clearing of native vegetation for farming and of changed fire regimes in native vegetation on bird species. Background information on the habitats present and presumably examined by Whitlock is also given.

METHODS

Sources

Information was collated from three sources, which in the following list of species are indicated as MS, Egg, and Specimen respectively. MS refers to annotations made by Whitlock on his personal copy of R. Hall's 1899 *A Key to the Birds of Australia and Tasmania with their Geographical Distribution in Australia* (held in the Public Records Office of WA). Egg refers to eggs collected for H.L. White and now held in the Museum of Victoria, or eggs lodged in the Australian Museum or Western Australian Museum. Specimen refers to specimens: collected for G.M. Mathews, now held in the collection of the American Museum of Natural History in New York; collected for H.L. White, now held in the Museum of Victoria, Melbourne; or deposited in the Australian Museum, Sydney or Western Australian Museum, Perth. These sources unfortunately contain very little information other than locality and date of collection.

Citation of records

The names and sequence of species follow the current Western Australian Museum list (Johnstone in press). The following convention is adhered to: 'Specimen: 1/11 (1)' signifies that one bird specimen was collected in January 1911 near Wilson Inlet. 'Egg 10/13 (8)' refers to a clutch of 8 eggs collected in October 1913 near Wilson Inlet. Eggs or specimens held in the H.L. White collection are prefixed HLW and those in the Australian Museum and Western Australian Museum are denoted AM and WAM respectively. Specimens without a prefix are lodged at the American Museum of Natural History (AMNH). Locality is cited only for material collected other than at Wilson Inlet. The HLW and AM egg records refer to a clutch.

Habitats visited by Whitlock

According to Churchward *et al.* (1988) three landform/soil units are present between Tudor Siding and Wilson Inlet. The most widely occurring is the Blackwater system, a flat, poorly drained plain vegetated by sedgeland and scattered thickets of *Melaleuca* and *Banksia* species. The Owingup system also consists of poorly drained plains of sedgeland and dense thickets of wattie (*Agonis juniperina*), with lunettes supporting woodland dominated by *Banksia* species and *Allocasuarina fraseriana*. The Collis system comprises low hilly terrain with relief < 20 m vegetated by jarrah (*Eucalyptus marginata*)/marri (*Corymbia calophylla*) forest with a dense shrub layer of *Bossiaea linophylla*.

East of Wilson Inlet the Blackwater system is most extensive. Several large patches of karri forest (Keystone unit) occurred until the 1890s. After clearfelling most of this land was taken up for agriculture, thus destroying the regenerating forest (Bradshaw *et al.* 1997). Smaller patches of jarrah forest (Collis) also occur in this sector. Lake William is surrounded by peppermint (*Agonis flexuosa*) woodland (Meerup dune system).

At and near Denmark, four landform/soil units are present. The Keystone system is characterized by hills and ridges >60 m relief supporting karri forest and jarrah forest/woodland. Most of this system is now on private land and has been cleared for dairying. The Trent system is made up of flat topped hills, < 40 m relief, supporting low jarrah/marri forest. The Fernley system is swampy terrain, with jarrah/bullich (*E. megacarpa*) on rises and kangaroo grass (*Evandra aristata*) sedgeland and tea tree (*Agonis parviceps*) and *A. linearifolia* heath in poorly drained areas. The Denmark River valley is classified as a major valley, with 20 m relief, supporting jarrah/marri forest on slopes and dense thickets of wattie/paperbark (*Melaleuca* spp.) on terraces.

Whitlock makes no mention of the habitats in which he collected, except for six species (Whitlock 1911a, 1912, 1914, 1926, 1936). Jackson (1912–13 unpublished diary) recorded on 9 October 1912 that Whitlock stated his intention of 'collecting up the Hay River in from Wilson's Inlet, not too far from his house at Tudor Siding...'.

Aboriginal burning practices in the period 1791–1840

The Denmark region is adjacent to the Albany region, which was first visited by Europeans in 1791. King George Sound, a commodious and safe harbour with a ready supply of firewood and water onshore, was an attractive landfall after the long sea voyage from Capetown, Sydney or Hobart. As a result the coastal parts of the Albany region were visited several times, before a small penal colony was established at Albany by the Governor of New South Wales in 1826. This was disbanded in 1831 when the area came under the administration of the Swan River colony, resulting in occupation by free settlers.

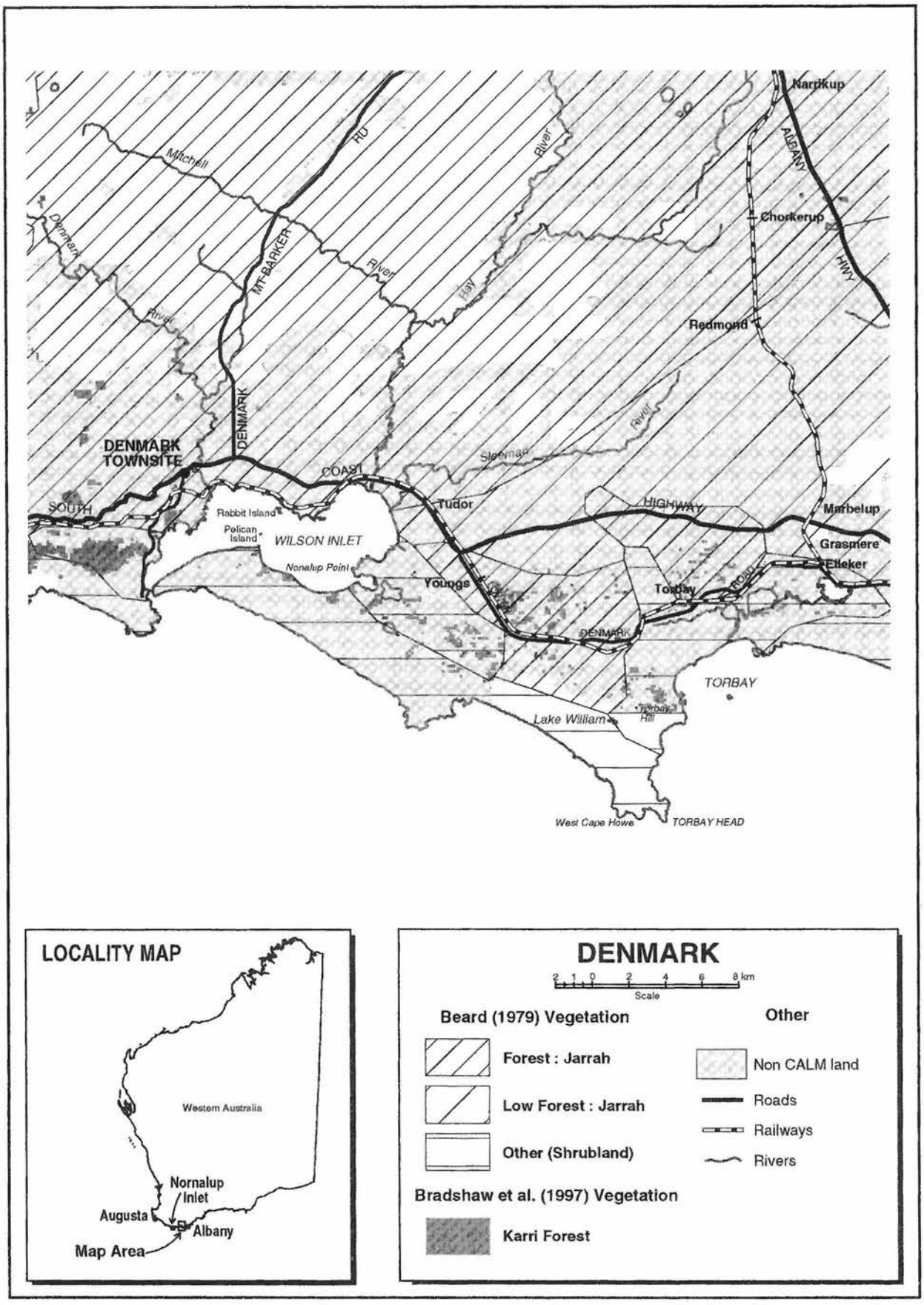

Figure 1. Denmark region, showing localities mentioned in text.

All available published and unpublished records made by naval, army and civilian personnel connected with these visits and later settlement have been searched for statements about fire and the density of vegetation. This information provides one of the most comprehensive accounts of Aboriginal burning practices before and just after European settlement for any locality in southern Australia. I have quoted verbatim all relevant remarks about fire and vegetation structure, taking particular care to avoid selective quotation in support of a particular view. By not paraphrasing these records, I have provided a clear demarcation between my interpretation and what was actually recorded. Scholars can then debate my interpretation, confident that the full background has been provided. All available eyewitness evidence about Aboriginal use of fire in the Denmark and Albany regions is presented in Appendix 1.

The area covered by these observations experiences a west–east rainfall gradient of 1000 mm (Denmark) to 800 mm (Mt Gardner) per annum, and a south–north gradient of 900 mm (Albany) to 750 mm (Mt Barker). Although Hallam (1975) provided quotations relating to this area, they are selective and not comprehensive, having been cited to demonstrate that burning was not an incidental activity of Aborigines. Furthermore, several additional contemporary accounts have become available since 1975.

RESULTS

Annotated list of bird species recorded by Whitlock

Whitlock accumulated 603 records of 103 bird species throughout his period of residence, with the last novel species of landbird, waterbird, and wader being recorded in 1917, 1917 and 1911 respectively (Fig. 2A). He eventually noted 65 landbird species, 10 waterbird species, 7 seabird species, and 12 non-breeding wader species. Most records were made in 1910, 1907, 1909, 1906 and 1911 (Fig. 2B). Whitlock collected 431 specimens (made up as museum skins), observed 55 clutches and made 33 dated annotations of landbirds in his copy of Hall's book. He collected 19 waterbird specimens and 36 wader specimens, recorded 11 clutches of waterbirds and annotated records of 14 waterbirds and 4 waders in his copy of Hall. His cumulative number of species recorded is closely related to his cumulative observation effort (Fig. 2C).

Landbirds

Coturnix novaezelandiae STUBBLE QUAIL
Specimen: 1/11 (1).

Coturnix ypsilophora BROWN QUAIL
MS: 2/06, 2/13.
Egg: HLW 10/13 (8), near Albany.

Accipiter fasciatus BROWN GOSHAWK
Egg: HLW 10/13 (3).
Specimen: 7/11 (1); HLW 10/13 (1).

Accipiter cirrocephalus COLLARED SPARROWHAWK
MS: 9/06
Specimen: WAM 3/07 (1); 12/08 (1), 3/09 (1), 5/10 (2); HLW 2/12 (1).

Haliaeetus leucogaster WHITE-BELLIED SEA-EAGLE
MS: 11/06 (nesting). Nesting in 1905 in a tree close to the beach of Wilson Inlet (Carter 1923).

Circus approximans SWAMP HARRIER
MS: No date given and evidently misidentified as *C. assimilis* (Spotted harrier) based on description supplied ('patch of white on upper tail coverts, wings in flight curved when out spread'). According to Storr (1991), *C. assimilis* did not originally occur west of Two Peoples Bay.
Specimen: HLW 10/16 (2).

Falco berigora BROWN FALCON
Specimen: WAM 3/07 (1); 4/10 (1).

Falco longipennis AUSTRALIAN HOBBY
Specimen: HLW 6/13 (1).

Turnix varia PAINTED BUTTON-QUAIL
Egg: HLW 11/12 (4), near Albany.
Specimen: WAM 3/07 (2); 12/09 (juvenile); HLW 11/12 (1).

Burhinus grallarius BUSH STONE-CURLEW
Egg: HLW 10/12 (2).

Phaps chalcoptera COMMON BRONZEWING
Specimen: 3/05 (1), Denmark.

Phaps elegans BRUSH BRONZEWING
Specimen: 11/11 (1).

Calyptorhynchus banksii RED-TAILED BLACK COCKATOO
Specimen: 10/10 (1), West Cape Howe; HLW 1/16 (1).

Calyptorhynchus baudinii BAUDIN'S COCKATOO
Specimen: HLW 1/16 (1), HLW 4/16 (1), HLW 3/17 (1).

Glossopsitta porphyrocephala PURPLE-CROWNED LORIKEET
Specimen: 2/10 (2), 3/10 (9), 4/10 (6), 5/10 (3), 7/10 (1); 5/10 (1), Denmark. One of Whitlock's specimens collected in 3/10 from Wilson Inlet served Mathews as the type of *G. p. whitlocki* (1912); however, this taxon has not been accepted.

Platycercus zonarius AUSTRALIAN RINGNECK
Specimen: 5/09 (1), 3/10 (2), 1/11 (1); 3/05 (2) and 5/10 (1), Denmark.

Platycercus spurius RED-CAPPED PARROT
MS: 1/06.
Specimen: 4/06 (1); WAM 3/07 (4); 12/08 (2), 4/09 (1), 6/10 (1); HLW 11/10 (1), West Cape Howe.

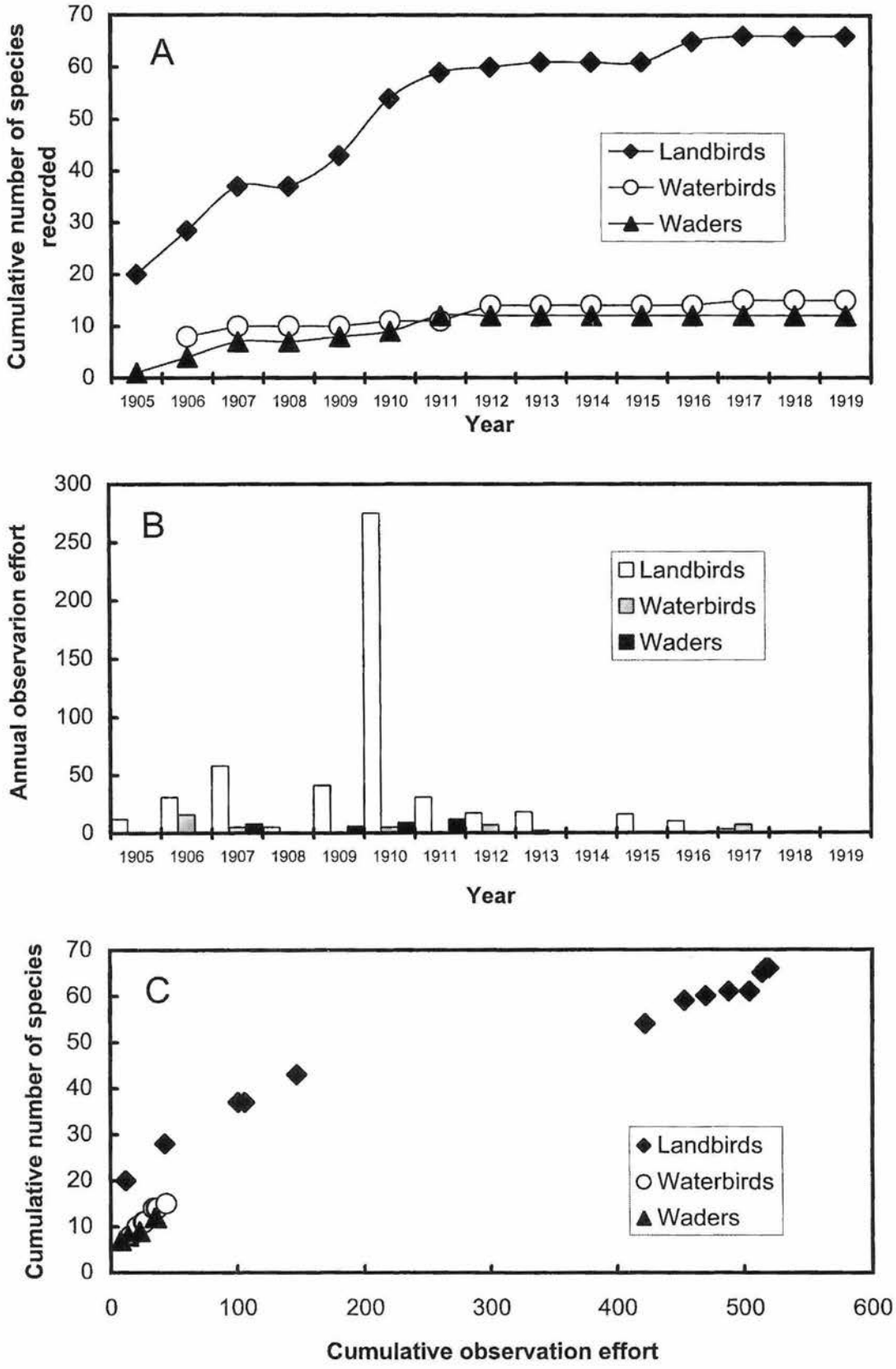

Figure 2A. Year in which each bird species was first recorded by Whitlock in the area shown in Fig. 1.
2B. Whitlock's annual observation effort, shown separately for landbirds, waterbirds and waders. Annual observation effort is the total number of records of annotations, eggs or specimens collected each year.
2C. Cumulative number of species recorded in relation to cumulative observation effort.
Seabird species have been combined with waterbird species in Figures 2A, B & C.

Platycercus icterotis WESTERN ROSELLA
Specimen: WAM 3/07 (1); 3/09 (1), 3/10 (4), 4/10 (2), 5/10 (4); HLW 9/12 (1); HLW 12/12 (1). One of Whitlock's specimens collected in 4/10 from Wilson Inlet served Mathews as the type of *P. i. salvadori* (1912), a taxon not since recognized.

Neophema elegans ELEGANT PARROT
Specimen: HLW 1/16 (5). This record is inconsistent with Storr's (1991) statement that this species colonized the Albany district in the 1960s.

Neophema petrophila ROCK PARROT
Specimen: 12/09 (1).

Pezoporus wallicus GROUND PARROT
Egg: HLW 11/13 (3). Whitlock (1914) also reported nesting 10/12. Serventy (1926, p. 68) mentions a personal communication from Whitlock that this species was seen near Wilson Inlet 7 miles [*c.* 11 km] from the open ocean.
Specimen: HLW 11/11 (2).

Chrysococcyx basalis HORSFIELD'S BRONZE CUCKOO
Egg: HLW 11/16 (1), in nest of *Stipiturus malachurus* (1 egg). This record contradicts Storr's (1991) statement that this species does not occur west of Albany. (Storr 1991 is an otherwise authoritative and comprehensive synthesis of records.)

Chrysococcyx lucidus SHINING BRONZE CUCKOO
MS: 9 and 10/06, egg.
Egg: HLW 10/06 (1) (in *Acanthiza inornata* [1 egg] nest), HLW 11/11 (1) (in *Gerygone fusca* [1 egg] nest), HLW 11/13 (1) (in *Acanthiza chrysorrhoa* [3 eggs] nest).

Podargus strigoides TAWNY FROGMOUTH
Specimen: WAM 3/07 (1); 2/11 (1).

Aegotheles cristatus AUSTRALIAN OWLET-NIGHTJAR
Specimen: 5/10 (1).

Climacteris rufa RUFOUS TREECREEPER
Egg: HLW 12/09 (3).
Specimen: 3/09 (1), 2/10 (2), 3/10 (2), 4/10 (3), 6/10 (1); 5/10 (3), Denmark.

Malurus splendens SPLENDID FAIRY-WREN
Specimen: WAM 3/07 (3); 5/10 (1).

Malurus elegans RED-WINGED FAIRY-WREN
MS: 7/06, 10/06 (eggs).
Egg: HLW 11/12 (3), 'Mingerup, Wilson's Inlet'. The location of Mingerup is now untraceable (R. Properjohn[1] personal communication).
Specimen: WAM 3/07 (10); 12/05 (1), 12/09 (1), 4/10 (1), 6/10 (1); HLW 11/10 (1), Lake William [near Torbay]; HLW 11/12 (1).

Stipiturus malachurus SOUTHERN EMU-WREN
MS: 12/05, Torbay.
Egg: HLW 11/11 (1), HLW 11/12 (3), HLW 10/13 (3), HLW 11/13 (3), HLW 11/15 (2); AM 12/12, AM 10/15 Sphenura Camp [at] Wilson Inlet, AM 11/15, AM 10/16.
Specimen: WAM 3/07 (2), Torbay; WAM 3/07 (7); 11/11 (2); HLW 10/15 (3), HLW 11/13 (3), HLW 11/15 (2); AM no date, Tudor [on] Denmark line.

Pardalotus punctatus SPOTTED PARDALOTE
Specimen: WAM 3/07 (3); 2/10 (1), 3/10 (2); 5/10 (1), Denmark; HLW 11/10 (1), Torbay. One of these specimens from Wilson Inlet served Mathews as the type of *P. p. whitlocki* (1912), a taxon no longer recognized. Details of two unusual nesting sites are provided in Whitlock (1911a).

Pardalotus striatus STRIATED PARDALOTE
Specimen: 1/10 (1), 2/10 (2).

Dasyornis longirostris WESTERN BRISTLEBIRD
MS: 3/07. Whitlock (1936) collected this, a female, which he speculated had been driven from the east by extensive fires at the end of summer 1906/07. He returned to the area in 11/07 and discovered an empty nest in an unburnt patch of vegetation. In 9/08 he found another nest, containing an infertile egg. This species was last recorded in the region in 1912 (caption to photograph in Whitlock 1936). Carter (in Whitley 1971) searched unsuccessfully for this species in 1919 and 1922 in the same area where Whitlock collected it. He noted that 'a good deal' of the coastal vegetation had been 'recently burnt off'.
Specimen: WAM 3/07 (1), -/07 (2).

Sericornis frontalis WHITE-BROWED SCRUBWREN
MS: 11/05, Torbay.
Specimen: WAM 3/07 (1), Torbay; 4/10 (2), 5/10 (2).

Gerygone fusca WESTERN GERYGONE
Specimen: WAM 3/07 (2); 12/09 (1), 3/10 (1), 4/10 (2).

Acanthiza apicalis BROAD-TAILED THORNBILL
MS: 9/06, eggs; 10/06, young.
Egg: HLW 9/12 (2).
Specimen: WAM 3/07 (1); 4/10 (12), 5/10 (3), 3/11 (1); 5/10 (2), Denmark; HLW -/11 (1), HLW 3/11 (5), HLW 4/11 (1).

Acanthiza inornata WESTERN THORNBILL
MS: 9 & 10/06, nesting in jarrah sapling 6 m above ground.
Egg: HLW 11/10 (2), Torbay Hill; HLW 11/11 (3), HLW 10/13 (3); AM 11/13, AM 1/16.
Specimen: 12/08 (1), 11/09 (1), 12/09 (6), 1/10 (1), 3/10 (2), 4/10 (4), 5/10 (5), 6/10 (1); 5/10 (2), Denmark; HLW 5/05 (1), HLW 5/09 (1), HLW 3/11 (2).

[1] Information Management Branch, CALM, Kensington WA.

Acanthiza chrysorrhoa YELLOW-RUMPED THORNBILL
MS: 8/06, building nest, eggs.
Specimen: WAM 3/07 (1); 12/09 (2), 1/10 (1), 3/10 (1), 4/10 (1), 5/10 (2); HLW 3/11 (1), HLW 5/11 (2). One of these specimens from Wilson Inlet served Mathews as the type of *A. c. multi* (1912), a taxon no longer recognized.

Lichmera indistincta BROWN HONEYEATER
Specimen: 5/10 (1), Denmark.

Meliphaga virescens SINGING HONEYEATER
MS: 7/06 (1 male).

Melithreptus chloropsis WESTERN WHITE-NAPED HONEYEATER
MS: 12/05, juvenile male collected and misidentified as *M. brevirostris.*
Specimen: WAM 3/07 (3); 12/08 (1), 12/09 (2), 2/10 (3), 3/10 (5), 4/10 (1), 5/10 (2); 5/10 (3), Denmark. One of Whitlock's specimens from Wilson Inlet served Mathews as the type of *M. lunatus whitlocki* (1909), a taxon no longer recognized.

Phylidonyris novaehollandiae NEW HOLLAND HONEYEATER
MS: 11/05, Torbay.
Egg: HLW 12/05 (3); AM 11/15.
Specimen: WAM 3/07 (1), Torbay; WAM 3/07 (1); 3/10 (3), 4/10 (3); 5/10 (1), Denmark.

Phylidonyris melanops TAWNY-CROWNED HONEYEATER
Egg: WAM 10/11 (4); HLW 12/14 (3); AM 10/15.
Specimen: 12/09 (1), 4/10 (3). One of Whitlock's specimens from Wilson Inlet served Mathews as the type of *P. m. westernensis* (1912), a taxon no longer recognized.

Acanthorhynchus superciliosus WESTERN SPINEBILL
Egg: HLW 11/13 (2); AM 11/16.
Specimen: 3/10 (1), 4/10 (9), 5/10 (4); 5/10 (2), Denmark. One of these specimens from Wilson Inlet served Mathews as the type of *A. s. wilsoni* (1912), a taxon no longer accepted.

Anthochaera lunulata WESTERN LITTLE WATTLEBIRD
MS: 12/05.
Egg: AM 11/12.
Specimen: 1/06 (1); WAM 3/07 (3).

Anthochaera carunculata RED WATTLEBIRD
Egg: AM 7/12.
Specimen: 3/10 (1).

Epthianura albifrons WHITE-FRONTED CHAT
Specimen: 3/10 (2), 4/10 (1). One of these specimens from Wilson Inlet served Mathews as the type of *E. a. westralensis* (1912), a taxon no longer regarded as valid.

Petroica multicolor SCARLET ROBIN
MS: 10/06 (eggs).
Egg: HLW 10/06 (2); AM 11/15.
Specimen: 4/10 (8), 5/10 (2), 6/10 (1).

Eopsaltria australis YELLOW ROBIN
MS: 12/06; 12/06, Torbay.
Specimen: 12/09 (5), 1/10 (2), 2/10 (1), 4/10 (8), 5/10 (2); 5/10 (2), Denmark.

Eopsaltria georgiana WHITE-BREASTED ROBIN
MS: 10/06 young on wing. Nest 5 m above ground; 11/06 (eggs).
Specimen: 3/10 (1).

Daphoenositta chrysoptera VARIED SITTELLA
Specimen: 1/10 (2), 2/10 (2), 3/10 (1), 4/10 (2), 5/10 (1); 5/10 (1) Denmark.

Falcunculus frontatus CRESTED SHRIKE-TIT
MS: no details.
Specimen: WAM 2/06 (1).

Pachycephala pectoralis GOLDEN WHISTLER
MS: 10/06 nest; 11/06 eggs.
Egg: HLW 12/10 (2) Torbay Hill; AM 11/15.
Specimen: WAM 3/07 (1); 2/10 (3), 3/10 (4), 4/10 (9); 3/05 (1) and 5/10 (1), Denmark.

Pachycephala rufiventris RUFOUS WHISTLER
Specimen: 4/10 (3).

Colluricincla harmonica GREY SHRIKE-THRUSH
Specimen: 5/09 (1), 12/09 (5), 1/10 (1), 2/10 (1), 5/10 (4), 6/10 (2).

Myiagra inquieta RESTLESS FLYCATCHER
Specimen: 2/10 (1), 4/10 (3).

Rhipidura fuliginosa GREY FANTAIL
Egg: AM 11/12, AM 12/13.
Specimen: 12/09 (1), 3/10 (1), 4/10 (9), 5/10 (2), 6/10 (1), 10/11 (1).

Coracina novaehollandiae BLACK-FACED CUCKOO-SHRIKE
MS: 11/06, 'carrying twigs'.
Specimen: no details; this specimen from Wilson Inlet served Mathews as the type of *C. n. westralensis* (1912), a taxon no longer recognized.

Artamus cyanopterus DUSKY WOODSWALLOW
MS: 7/06.
Egg: HLW 11/09 (4); WAM 10/18 (2).
Specimen: WAM 3/07 (1); 4/10 (6), 5/10 (2), 6/10 (2).

Strepera versicolor GREY CURRAWONG
Specimen: 3/09 (2), 3/10 (1); HLW 3/12 (1), HLW 4/15 (2).

Anthus australis AUSTRALIAN PIPIT
MS: 10/06 eggs.
Egg: WAM 10/19 (3).
Specimen: 4/10 (2), 5/10 (1), 6/10 (1). One of these specimens from Wilson Inlet served Mathews as the type of *A. n. bilbali* (1912), a taxon no longer recognized as valid.

Stagonopleura oculata RED-EARED FIRETAIL
MS: 2/06.
Egg: AM 10/15 (6); HLW 11/15.
Specimen: WAM 3/07 (3); 4/10 (3); 5/10 (2), Denmark; HLW 11/10 (1) near West Cape Howe; HLW 11/12 (1).

Acrocephalus australis AUSTRALIAN REED WARBLER
Specimen: HLW 2/17 (2).

Megalurus gramineus LITTLE GRASSBIRD
MS: 11/06. Details of habitat and nesting are provided in Whitlock (1912).
Egg: HLW 10/11 (4), HLW 12/11 (4), HLW 12/12 (4), HLW 10/13 (3); AM 11/11, AM 12/11.
Specimen: 1/11 (1); HLW 11/11 (2), HLW 12/11 (1).

Cincloramphus cruralis BROWN SONGLARK
Specimen: WAM 3/07 (1), Torbay.

Zosterops lateralis GREY-BREASTED WHITE-EYE
MS: 12/06 eggs.
Egg: HLW 11/10 (3), Torbay; HLW 11/10 (3), west of Albany; AM 10/10, north of Albany.
Specimen: 12/09 (3), 3/10 (1), 4/10 (7), 5/10 (1), 6/10 (1); HLW 11/10 (1), near Albany; HLW 11/10 (3) Lake William [near Torbay]; HLW 11/10 (1), near West Cape Howe.

Waterbirds

Cygnus atratus BLACK SWAN
Egg: HLW 10/12 (6).

Tadorna tadornoides AUSTRALIAN SHELDUCK
MS: 9/06, Rabbit Island (flock).

Poliocephalus poliocephalus HOARY-HEADED GREBE
MS: 5/06, 9/06.

Phalacrocorax melanoleucos LITTLE PIED CORMORANT
MS: 9/06 (egg). Whitlock (1926) mentions that this species 'breeds in numbers within a quarter of a mile [400 m] of my late home'. Jackson (1912–13 unpublished diary) noted that this swamp was 'below' Whitlock's house.
Egg: HLW 9/13 (5), 'Nornalup Swamp [? = wetland near Nonalup Point], Wilson's Inlet'.

Nycticorax caledonicus RUFOUS NIGHT HERON
Specimen: WAM 3/07 (1).

Ixobrychus flavicollis BLACK BITTERN
Egg: WAM 11/12 (1).

Porzana pusilla BAILLON'S CRAKE
Specimen: HLW 1/17 (1), HLW 2/17 (1).

Porzana tabuensis SPOTLESS CRAKE
Egg: HLW 11/13 (4). Whitlock (1914) records nesting in 3/05 near Torbay Junction [Elleker].
Specimen: HLW 12/10 (1), near Albany; HLW 2/17 (4), HLW 3/17 (1).

Porphyrio porphyrio PURPLE SWAMPHEN
Egg: HLW 10/12 (4), near Albany. See also Whitlock (1914).
Specimen: HLW 2/16 (1).

Charadrius ruficapillus RED-CAPPED PLOVER
MS: 7/06; 10/06 (egg).
Egg: HLW 12/10 (2); WAM 12/10 (2).
Specimen: 3/10 (1).

Seabirds

Eudyptula minor LITTLE PENGUIN
MS: 4/-, breeding on Rabbit Island.

Pterodroma macroptera GREAT-WINGED PETREL
MS: 4/-, breeding on Rabbit Island.

Larus pacificus PACIFIC GULL
MS: 10/06 (immature).

Larus novaehollandiae SILVER GULL
MS: 12/06, Pelican Rock (eggs); 12/06, Murphys Rocks (egg). Neither of these localities is identified on modern maps.
Egg: HLW 12/06 (3), HLW 11/12 (3); AM 12/12.

Sterna caspia CASPIAN TERN
MS: 1/06; 10/06, Rabbit Island (egg); 12/06 Murphys Rocks (egg); 12/06 Rabbit Rock.
Egg: AM 12/10, Pelican Island in Wilson Inlet.
Specimen: HLW 12/06 (2), near Albany; WAM 3/07 (1).

Sterna bergii CRESTED TERN
MS: 1/07 Pelican Rock (addled egg).

Sterna nereis FAIRY TERN
MS: 11/06.
Specimen: WAM 3/07 (2); 1/11 (1); HLW 12/12 (2).

Non-breeding waders

Limosa lapponica BAR-TAILED GODWIT
Specimen: 11/11 (1).

Tringa nebularia COMMON GREENSHANK
MS: 8/06.
Specimen: WAM 3/07 (2); 2/10 (1), 4/10 (1).

Tringa hypoleucos COMMON SANDPIPER
MS: 9/06.

Tringa breviceps GREY-TAILED TATTLER
Specimen: 11/11 (2).

Calidris ruficollis RED-NECKED STINT
Specimen: WAM 3/07 (3); 3/09 (1), 5/09 (3), 1/11 (1).

Calidris acuminata SHARP-TAILED SANDPIPER
Specimen: WAM 3/07 (1); 1/11 (1), 11/11 (2); HLW 11/12 (2).

Calidris ferruginea CURLEW SANDPIPER
Specimen: 5/09 (2), 3/10 (3), 11/11 (1).

Pluvialis squatarola GREY PLOVER
Specimen: 11/11 (1).

Pluvialis fulva PACIFIC GOLDEN PLOVER
Specimen: WAM 7/07 (1), Torbay; 11/11 (1); HLW 3/07 (1), HLW 3/17 (1).

Pluvialis dominica AMERICAN GOLDEN PLOVER
MS: 12/06.

Charadrius bicinctus DOUBLE-BANDED PLOVER
Specimen: 3/10 (2).

Charadrius rubricollis HOODED PLOVER
MS: 12/05.
Specimen: 1/10 (2), Torbay. Another specimen, collected 11/10 at Torbay (Greenway 1978), served Mathews as the type of *C. r. torbayi* (1912), a taxon no longer recognized.

Landbird species considered to be present, though not recorded by Whitlock

With few exceptions, the species listed below were either recorded by others in the period 1889–1913 in or near the Denmark region or were presumably overlooked by Whitlock.

Landbirds

Dromaius novaehollandiae EMU
Noted in 1899 3 miles [*c.* 5 km] east of Denmark (Hall 1902b) and in 1910 in karri forest near Denmark (Carter 1923).

Pandion haliaetus OSPREY
Noted in 1905 at Wilson Inlet (Carter 1923).

Haliastur sphenurus WHISTLING KITE
Noted once by S.W. Jackson in 1912 *c.* 40 km west of Wilson Inlet (Abbott 1998). Presumed to be present in the Denmark area in Whitlock's time.

Aquila morphnoides LITTLE EAGLE
Noted by S.W. Jackson in 1913 *c.* 40 km west of Wilson Inlet (Abbott 1998). Presumed to be present in the Denmark area in Whitlock's time.

Aquila audax WEDGE-TAILED EAGLE
Noted by S.W. Jackson in 1912 *c.* 40 km west of Wilson Inlet (Abbott 1998). Presumed to be present in the Denmark area in Whitlock's time.

Falco peregrinus PEREGRINE FALCON
No records located, but presumed to be present in the Denmark area in Whitlock's time.

Cuculus pallidus PALLID CUCKOO
Noted in 1899 and 1911 near Albany (Hall 1902a; Carter 1920, 1923). Presumed to be present in the Denmark area in Whitlock's time.

Cacomantis flabelliformis FAN-TAILED CUCKOO
Nestling collected in 1899 at Denmark (Hall 1902a).

Ninox novaeseelandiae BOOBOOK OWL
Recorded in 1899 at Denmark (Hall 1902b).

Todiramphus sanctus SACRED KINGFISHER
Recorded by G. C. Shortridge at Chorkerup, 1/05 (Ogilvie-Grant 1909), and by S. W. Jackson at Denmark River and near Whitlock's house at Wilson Inlet, 2/13 (Abbott 1998).

Atrichornis clamosus NOISY SCRUB-BIRD
Collected by A. J. Campbell in 1889 in karri forest near Torbay (Campbell 1890). J.T. Tunney also searched unsuccessfully for this species in his extensive travels in the south-west (letter in WA Museum archives dated 9 August 1900), particularly Denmark (29 June 1904) and Albany (15 December 1904, 29 March 1906). Relevant extracts from these letters are summarized in Appendix 2. E. B. Nicholls (1905) also searched without success for this species between February and June 1905.

Pomatostomus superciliosus WHITE-BROWED BABBLER
Hall (1902a) recorded a flock 'some six miles [c. 10 km] up the [Denmark] river from the town [Denmark]', in karri forest.

Rhipidura leucophrys WILLIE WAGTAIL
Although noted as not seen at Denmark or Albany in 1899 (Hall 1902a), this species was recorded at Albany before 1910 (Carter 1923) and by S. W. Jackson at Denmark, 2/13 (Abbott 1998).

Corvus coronoides AUSTRALIAN RAVEN
Recorded by S. W. Jackson near Whitlock's house at Wilson Inlet, 2/13 (Abbott 1998).

Hirundo neoxena WELCOME SWALLOW
Recorded at Albany (breeding) in 1909 (Carter 1923) and by S. W. Jackson at Denmark, 2/13 (Abbott 1998).

Hirundo nigricans TREE MARTIN
Recorded in 1899 at Denmark (Hall 1902a).

DISCUSSION

Changes in the avifauna since 1889

Parts of the area surveyed by Whitlock were examined by ornithologists in 1889, 1899, 1905, 1980 and 1986–1999 (Table 1). Before these bird lists can be used as a legitimate basis for examining changes in the landbird fauna, it is essential to decide which records represent vagrants, and evaluate whether failure to list any species indicates genuine absence or negligence in recording particular species. This procedure will eliminate any spurious instances of local extinction or local establishment ('pseudoturnover').

Whitlock recorded 65 landbird species and failed to record an additional 16 landbird species, nearly all of which were recorded by other contemporary ornithologists. Thus the landbird fauna in the period 1889–1919 comprised 81 species. Currently, 87 species of landbird occur in the Denmark region. Since 1889 four species appear to have become extinct locally and 10 species have colonized the region. This is similar to the Irwin Inlet–Broke Inlet–Mt Frankland region, *c.* 40 km west of Wilson Inlet, where two (possibly three) landbird species appear to have become extinct locally and 16 species have colonized (Abbott 1998).

The four landbird species that appear to have become locally extinct are *Burhinus grallarius* (Bush stone-curlew), *Pezoporus wallicus* (Ground parrot), *Atrichornis clamosus* (Noisy scrub-bird) and *Dasyornis longirostris* (Western bristlebird). *B. grallarius* is a ground-nesting species susceptible to predation by foxes (Storr 1991; Abbott 1999). *P. wallicus* is also a ground-nesting species and is susceptible to the effects of frequent burning (Burbidge *et al.* 1997). It has not been recorded in the region since 1913 (Serventy and Whittell 1976), though there are unsubstantiated reports in the period 1971–83 from Torbay (Watkins 1985). *A. clamosus* has not been recorded locally since 1889 (Campbell 1890). *D. longirostris* was last recorded in the area in 1912.

Atrichornis clamosus was probably already extinct in the Denmark area by the time Whitlock settled there, as the diligent collector J.T. Tunney searched for it unsuccessfully there. Nicholls (1905) also searched for it between Port Harding and Wilgie Hill in dense tea tree, dwarfed peppermint and other vegetation entangled with dodder, and karri undergrowth near where Campbell had obtained his specimen. This karri regrowth, being 15 years old, would have been about half way through the so-called juvenile phase (Bradshaw and Rayner 1997), thus consisting of *c.* 2000 stems per ha, *c.* 15 m tall, with dense thickets of fireweeds. If not locally extinct, *A. clamosus* may have occurred in only one or two small populations, as Abbott (1999) suggested that probably only five populations of this species occurred between Wilson Inlet and Torbay. These remnants, through bad luck, may have been overlooked by Tunney, Nicholls and Whitlock.

Seven bird species found in open country (woodland, parkland or pasture) appear to have been absent from the region (Fig. 1) in 1905–19, even though settlement was well advanced. These species are *Elanus caeruleus* (Black-shouldered kite), *Hamirostra isura* (Square-tailed kite), *Falco cenchroides* (Australian kestrel), *Tyto alba* (Barn owl), *Grallina cyanoleuca* (Magpie-lark), *Cracticus torquatus* (Grey butcherbird) and *C. tibicen* (Australian magpie).

One species, *Dacelo novaeguineae* (Laughing kookaburra), was introduced to WA and was first recorded in the Denmark area in 1927 (Storr 1991). Two other species, *Ocyphaps lophotes* (Crested pigeon) and *Cacatua roseicapilla* (Galah), did not originally occur in the South West Land Division (Storr 1991). Four other open country species (*Circus assimilis* Spotted harrier, *Polytelis anthopeplus* Regent parrot, *Merops ornatus* Rainbow bee-eater[2] and *Lalage tricolor* White-winged triller), although listed by WA Bird Notes (1985, No. 33, p. 3), WA Group RAOU (1994) or Birds Australia WA Group (1999), have apparently not yet established (L. Broadhurst[3] personal communication). In addition, the population of Galahs in the region may have derived from escaped cagebirds (L. Broadhurst, personal communication). Indeed, a pair observed in 1999 were eastern Australian birds (R. Johnstone[4] personal communication).

Because the status of six species in the Denmark area is unknown, they have not been listed in Table 1. Four of these species (*Tyto novaehollandiae* Masked owl, *Eurostopodus argus* Spotted nightjar, *Psophodes nigrogularis* Western whipbird, and *Rallus pectoralis* Lewin's rail) were not recorded there by Whitlock, contemporary ornithologists or later ornithologists. Although *Ninox connivens* (Barking owl) was heard or seen several times in jarrah forest in 1998 *c.* 8 km west of Redmond, on farmland adjacent to Redmond forest block (R. Walker[5] personal communication), its presence requires confirmation by an experienced ornithologist. The Spotted nightjar was noted once by S. W. Jackson in 1912 *c.* 40 km west of Wilson Inlet (Abbott 1998). The claim that the Western whipbird occurred 'along the coast as far west as Denmark' (Smith 1977) has not been substantiated.

Last century *Cacatua pastinator* (Western Long-billed corella) was distributed extensively throughout south-west WA, excluding the karri and denser jarrah forests. It was recorded near Albany in the 1820s and 1830s (Nind 1831; Clark 1994), and extended north to near Lynton, Morawa and Mt Kenneth, north-west to Bridgetown (and down the Blackwood River to Nannup and Augusta), Lake Muir, Darkan and Toodyay, east to Lake Barlee, Merredin, Broomehill, Mongup, Bremer Bay and Esperance, and on the Swan Coastal Plain from Gingin to Busselton (Roe 1836; Austin 1855; Gregory and Gregory 1884; Curr 1886;

[2] Whitlock (1911b: 316) noted that this species occurred 'almost as far south as Mt. Barker...Though our coastal sand-hills would seem to present an attractive haunt to this species, I have only once met with it there. I refer, of course, to our south coast, east and west of Albany'. My interpretation of these remarks is that this species was only vagrant south of Mt Barker, and that it is unclear if the coastal record came from the area shown in Fig. 1.

[3] Lola Broadhurst, Albany WA.

[4] Ron Johnstone, Western Australian Museum, Perth WA.

[5] Dick Walker, Albany WA.

TABLE 1

Bird species recorded in the Denmark region at various times since 1889

Species	1889 Torbay (1)	1899 Denmark–Torbay (2)	1905 Torbay–Denmark–Wilson Inlet (3)	1905 Chorkerup (4)	1905–19 Denmark–Wilson Inlet–Torbay (5)	1980 Mitchell River area (6)	1986–99 Denmark–Wilson Inlet–Torbay (7)
LANDBIRDS							
Dromaius novaehollandiae		•			#	•	•
Coturnix novaezelandiae					•	•	•
C. ypsilophora			•		•		•
Pandion haliaetus					#		•
Elanus caeruleus							•
Hamirostra isura							•
Haliastur sphenurus						•	•
Accipiter fasciatus					•	•	•
A. cirrocephalus					•		•
Aquila morphnoides							•
A. audax						•	•
Haliaeetus leucogaster					•		•
Circus assimilis							•
C. approximans					•		•
Falco berigora					•	•	•
F. cenchroides						•	•
F. longipennis					•		•
F. peregrinus							•
Turnix varia					•	•	•
Burhinus grallarius					•		
Phaps chalcoptera					•		•
P. elegans					•	•	•
Ocyphaps lophotes							•
Calyptorhynchus banksii		•	•		•	•	•
C. baudinii		•	•		•	•	•
Cacatua roseicapilla							•
Glossopsitta porphyrocephala		•			•	•	•
Polytelis anthopeplus							•
Platycercus zonarius		•	•		•	•	•
P. spurius		•	•		•	•	•
P. icterotis		•	•		•	•	•
Neophema elegans					•	•	•
N. petrophila					•		•
Pezoporus wallicus					•		
Cuculus pallidus		•			#	•	•
Cacomantis flabelliformis		•			#		•
Chrysococcyx basalis					•		•
C. lucidus					•		•
N. novaeseelandiae		•					•
Tyto alba							•
Podargus strigoides					•	•	•
Aegotheles cristatus					•	•	•
Dacelo novaeguineae						•	•
Todiramphus sanctus				•	#		•
Merops ornatus							•
Atrichornis clamosus	•						
Climacteris rufa		•	•		•		•
Malurus splendens					•	•	•
M. elegans		•			•		•
Stipiturus malachurus				•	•		•
Pardalotus punctatus					•	•	•
P. striatus					•		•
Dasyornis longirostris					•		
Sericornis frontalis					•	•	•

TABLE 1 (continued)

Species	1889 Torbay (1)	1899 Denmark–Torbay (2)	1905 Torbay–Denmark–Wilson Inlet (3)	1905 Chorkerup (4)	1905–19 Denmark–Wilson Inlet–Torbay (5)	1980 Mitchell River area (6)	1986–99 Denmark–Wilson Inlet–Torbay (7)
Gerygone fusca		•			•		•
Acanthiza apicalis		•			•	•	•
A. inornata		•			•	•	•
A. chrysorrhoa		•		•	•	•	•
Lichmera indistincta					•	•	•
Meliphaga virescens					•		•
Melithreptus chloropsis		•		•	•	•	•
Phylidonyris novaehollandiae		•			•	•	•
P. melanops	•				•		•
Acanthorhynchus superciliosus	•	•			•	•	•
Anthochaera lunulata					•		•
A. carunculata					•	•	•
Epthianura albifrons					•		•
Petroica multicolor		•			•	•	•
Eopsaltria australis		•			•	•	•
E. georgiana	•				•	•	•
Pomatostomus superciliosus		•					•
Daphoenositta chrysoptera		•			•	•	•
Falcunculus frontatus					•		•
Pachycephala pectoralis		•	•		•	•	•
P. rufiventris					•	•	•
Colluricincla harmonica		•	•	•	•	•	•
Myiagra inquieta		•			•	•	•
Rhipidura fuliginosa		•		•	•	•	•
R. leucophrys					#	•	•
Grallina cyanoleuca						•	•
Coracina novaehollandiae		•			•	•	•
Lalage tricolor							•
Artamus cyanopterus				•	•	•	•
Cracticus torquatus							•
C. tibicen						•	•
Strepera versicolor		•		•	•	•	•
Corvus coronoides					#	•	•
Anthus australis					•	•	•
Stagonopleura oculata		•		•	•	•	•
Acrocephalus australis					•		•
Megalurus gramineus					•		•
Hirundo neoxena					#	•	•
H. nigricans		•			#		•
Cincloramphus cruralis					•		•
Zosterops lateralis		•			•	•	•
WATERBIRDS							
Oxyura australis			•				•
Biziura lobata			•				•
Cygnus atratus			•		•		•
Tadorna tadornoides					•		•
Chenonetta jubata							•
Anas gracilis							•
A. castanea							•
A. superciliosa			•			•	•
A. rhynchotis							•
Malacorhynchus membranaceus							•
Aythya australis							•
Tachybaptus novaehollandiae							•
Poliocephalus poliocephalus					•		•
Podiceps cristatus							•
Anhinga melanogaster							•

TABLE 1 (continued)

Species	1889 Torbay (1)	1899 Denmark–Torbay (2)	1905 Torbay–Denmark–Wilson Inlet (3)	1905 Chorkerup (4)	1905–19 Denmark–Wilson Inlet–Torbay (5)	1980 Mitchell River area (6)	1986–99 Denmark–Wilson Inlet–Torbay (7)
Phalacrocorax carbo			•				•
P. sulcirostris							•
P. melanoleucos					•	•	•
Pelecanus conspicillatus							•
Ardea pacifica							•
A. novaehollandiae						•	•
A. alba						•	•
A. garzetta							•
A. sacra							•
A. ibis							•
Nycticorax caledonicus					•		•
Ixobrychus minutus							•
I. flavicollis					•		
Botaurus poiciloptilus							•
Threskiornis aethiopicus							•
T. spinicollis							•
Platalea regia							•
P. flavipes							•
Gallirallus philippensis							•
Porzana pusilla					•		•
P. fluminea							•
P. tabuensis					•		•
Porphyrio porphyrio					•		•
Gallinula ventralis			•				•
G. tenebrosa							•
Fulica atra							•
Haematopus longirostris							•
H. fuliginosus							•
Himantopus himantopus							•
Cladorhynchus leucocephalus							•
Recurvirostra novaehollandiae							•
Vanellus tricolor							•
Charadrius ruficapillus					•		•
C. melanops							•
C. rubricollis					•		•
Erythrogonys cinctus							•
Sterna hybrida							•
SEABIRDS							
Eudyptula minor					•		•
Pterodroma macroptera					•		•
Puffinus carneipes							•
Phalacrocorax varius							•
Larus pacificus					•		•
L. novaehollandiae			•		•		•
Sterna caspia					•		•
S. bergii					•		•
S. nereis					•		•
WADERS (non-breeding visitors)							
Limosa limosa							•
L. lapponica					•		•
Numenius madagascariensis							•
Tringa stagnatilis							•
T. nebularia					•		•
T. glareola							•

TABLE 1 (continued)

Species	1889 Torbay (1)	1899 Denmark–Torbay (2)	1905 Torbay–Denmark–Wilson Inlet (3)	1905 Chorkerup (4)	1905–19 Denmark–Wilson Inlet–Torbay (5)	1980 Mitchell River area (6)	1986–99 Denmark–Wilson Inlet–Torbay (7)
T. hypoleucos					•		•
T. brevipes					•		•
Arenaria interpres							•
Calidris canutus							•
C. tenuirostris							•
C. alba							•
C. ruficollis					•		•
C. subminuta							•
C. acuminata					•		•
C. ferruginea					•		•
Limicola falcinellus							•
Pluvialis squatarola					•		•
P. fulva					•		•
P. dominica					•		•
Charadrius bicinctus					•		•
C. leschenaultii							•

(1) October 1889, based at Millar's Torbay karri timber mill. Campbell (1890, 1900).
(2) September – November 1899, 3 miles [*c.* 5 km] east of Denmark, Denmark, Denmark River, between Albany and Denmark. Hall (1902a, b).
(3) February–June 1905. Torbay, Denmark and Wilson Inlet. (Nicholls 1905).
(4) January 1905. Chorkerup. Ogilvie-Grant (1909).
(5) This paper. Contemporaneous records of species not collected by Whitlock but recorded in the Denmark region by Jackson and Carter are marked #
(6) Autumn 1980. Mitchell River *c.* 10–20 km inland from Wilson Inlet. Christensen *et al.* (1985).
(7) *Western Australian Bird Notes* No. 38 onwards (1986–99); Jaensch *et al.* (1988) for Grasmere Lake; EPA (1988) for Wilson Inlet; Storr (1991); WA Group RAOU (1994); Birds Australia WA Group (1999) (A. H. Burbidge, personal communication). Non-breeding seabirds have not been listed. The presence of *Hylacola cauta, Calamanthus fuliginosus, Microeca fascinans, Hirundo ariel* and *Cincloramphus mathewsi* requires confirmation before these species should be listed.

Taunton 1903; Bates unpublished[6]; North 1912; Abbott 1999). Outside the breeding season this species visited the coastal plain west of Point D'Entrecasteaux (Abbott 1999). There is no evidence, however, that this species was present near Wilson Inlet. Early observers noted that Western Long-billed corellas were most numerous 'not far from water' and 'on the best lands' (TWH 1833, p. 211) and that 'Where these birds are found, the traveller in the bush may generally rely upon finding water' (Moore 1884, p. 50). West of Albany this species should thus have occurred near the Denmark, Hay and Sleeman Rivers. Neither Wilson in December 1829 nor Barker in February 1830 mention the species there (Wilson 1835, pp. 236–271). Wilson, however, was clearly aware of the species as he provided the King George Sound Aboriginal name for 土,*Maniet* (Wilson 1835, p. 322).

It seems likely that one species of waterbird, *Ixobrychus flavicollis* (Black bittern), is now extinct in the Denmark region. Some waterbird species now present in farm dams or pastures in the Denmark region did not occur or were only vagrant in the south-west in the early days of European settlement. These include *Chenonetta jubata* (Australian wood duck), *Malacorhynchus membranaceus* (Pink-eared duck), *Poliocephalus poliocephalus* (Hoary-headed grebe), *Podiceps cristatus* (Great crested grebe), *Ardea alba* (Great egret), *Threskiornis aethiopicus* (Sacred ibis), *T. spinicollis* (Straw-necked ibis), *Platalea regia* (Royal spoonbill), *P. flaviceps* (Yellow-billed spoonbill), *Gallirallus philippensis* (Buff-breasted rail), and *Gallinula tenebrosa* (Dusky moorhen).

Hall (1902b, p.168) mentions an apparent hearsay report of 'Wedge-tailed Petrels, *Puffinus chlororhynchus*' [now known as *P. pacificus*] nesting in November on 'a small island at the entrance to the Denmark River (Lake Wilson)...about 30 miles [48 km] from Denmark and about 20 miles [32 km] from Albany...'. Although the locational information provided is self-contradictory, Hall is evidently referring to a nesting population of *Puffinus carneipes* (Fleshy-footed shearwater) on Shelter [Muttonbird] Island and the adjacent mainland in Torbay (Storr 1991).

The list of visiting (non-breeding) waders should not be regarded as complete. One species, *Limosa limosa* (Black-tailed godwit), was not recorded in the South West Land Division until after Whitlock's era. Storr's (1991) claim that *Limosa lapponica* (Bar-tailed godwit) was not recorded in the South West Land Division until 1931 is incorrect as it overlooks a specimen collected by Whitlock in 1911.

Most of the remaining species not listed by Whitlock were probably simply missed because they were vagrants, irregular visitors, rare or highly localized residents, cryptic, or just too common or uninteresting to merit the trouble of collecting them. Judged by the paucity of museum specimens (see Table 1), Whitlock appears to have put little effort into collecting waterbirds. Perhaps he only collected waterbirds occurring on the wetland within 400 m of his residence.

[6] Aboriginal vocabularies collected under the authority of the Western Australian Government in 1904 for Daisy Bates, now lodged with her papers in the National Library of Australia, Canberra.

Changes in the environment since 1840

The Denmark region has experienced extensive anthropogenic change since 1907–19. The most dramatic has been deforestation in order to promote agricultural development (Fig. 1). Wildfires, caused by increased fuel loads following reduced Aboriginal fire management in the period 1860–90 as well as the clearing burns of the new settlers, should have become more frequent. The last full blood Aborigine in the Torbay and Denmark district died about 1909 (Bates 1985, p. 51), though until the 1920s a group of Aborigines from inland visited the coastal areas and burnt patches of vegetation (D. Wolfe[7] personal communication). The rabbit and red fox arrived from eastern Australia in *c.* 1926 and *c.* 1930 respectively (Long 1988). Logging commenced in State forest (shown in the north-west sector of Fig. 1) in the 1950s and has continued to the 1980s.

Europeans (the Young family) first settled the region in the 1840s, near the eastern edge of Wilson Inlet, apparently because there was no karri forest to clear there (Denmark Historical Society 1995). At first the rate of clearing was slow – a family took one year to deforest 5 acres [2 ha] (Conochie 1989). From the 1840s horses, cattle and sheep were grazed in the region. Graziers from Tenterden used the coastal part of the region (then a commonage but now reserved as national park) for the depasturing of cattle in summer, when the inland pastures dried off. Coastal areas received summer rainfall and thus offered nutritious feed. Graziers adjacent to the coast also grazed their sheep there briefly each summer, until the end of the 1960s (D. Coombe[8] personal communication). Graziers burnt the coastal vegetation after the first rains of autumn or in early spring, in patches of *c.* 50 ha, to provide green pick later in the year (D. Coombe, personal communication).

Although intense fires presumably escaped from the clearing burns as part of the agricultural development of the region, intense fires did occur before settlement, as evidenced by the following eyewitness accounts: 'the loftiest timbers had the topmost of their branches burned' near King George Sound in 1791 (Lamb 1984, p. 355); an extensive forest crownfire driven by a strong easterly wind on 1 February 1818 was visible from sea at night north of West Cape Howe (Hordern 1997, p. 68); and 'the fire spreads with astonishing rapidity, reaching to the highest branches and charring the trees all over, so you return from a walk in the bush completely blackened' (Quoy in October 1826 at King George Sound; see Rosenman 1987, p. 47).

Studies of Aboriginal burning in the period 1750–1829 in jarrah forest well to the west of Wilson Inlet indicate that only *c.* 5 per cent of all fires recurred once in 10 years (Ward and Van Didden 1997). Fires at this relatively low frequency (the lowest recorded) are presumed to have been the most intense. Most burning by Aborigines took place in January and February, whereas fires started by lightning peak in December (Appendix 3).

[7] Des Wolfe, Kronkup WA.
[8] Dennis Coombe, Kronkup WA.

Relevant here is the fact that in southern jarrah forest, the soil dryness index (SDI) first exceeds 1200 in mid December, whereas in karri forest, SDI first exceeds 1200 in February (Burrows 1987). Even above this threshold, however, a great variety of fire intensities is possible, with an 'extreme' fire danger rating (the highest) on 2 per cent of days. On 54 per cent of days the fire danger rating is either 'very low' or 'low' (Burrows 1987). A fire danger rating of 'moderate' occurred on 22 per cent of days and is considered to be ideal for prescribed burning for fuel reduction. Because the purpose of Aboriginal burning was not fuel reduction but capture of game, they may have set fires on days of 'high', 'very high' and 'extreme' fire danger: 24 per cent of days with SDI > 1200.

In October 1912 Jackson (unpublished diary) noted that the country near the Torbay railway line had 'changed considerably owing to settlement all about, and numerous bushfires year after year when selectors were clearing the land for cultivation'. Similar observations about extensive fires were recorded by Whitlock and Carter (see *Dasyornis longirostris* in the species list above). In February 1913 Jackson recorded that black peat swamps had been converted to 'fine crops of potatoes'. Hosking and Burvill (1938) provided detailed information about agricultural utilization west of Denmark; this appears generalizable to the area immediately east of Wilson Inlet. After the Great War agricultural activity increased further following release of land to soldier settlers (CALM 1995).

Figure 1 indicates that *c.* 60 per cent of the area mapped is not under public ownership via CALM. Recent aerial photographs (1:25 000) taken in colour in October 1997 or January 1998 reveal that *c.* 80 per cent of this non-CALM managed land has been cleared for agriculture, with most of the remnants of native vegetation small and widely separated. However, with the large area of State forest to the north-west, West Cape Howe National Park to the south, and the smaller Down and Lake Powell Nature Reserves to the east, the avifauna of the region appears to be secure from further habitat loss.

Given that intense fires occurred in the region before European settlement (as detailed above), how did the fire-sensitive species *Pezoporus wallicus, Atrichornis clamosus* and *Dasyornis longirostris* manage to persist until late last century or early this century? Several explanations appear possible. First, widespread Aboriginal use of fire should have restricted these species to refuges in higher rainfall areas naturally protected from frequent burning, namely vegetation along higher order streams (Abbott 1999, p. 71), vegetation on steep south-facing slopes (Abbott 1999, p. 23), and vegetation surrounded by large expanses of sheet rock (Smith 1977). Second, intense (crown-scorching) fires may have occurred sufficiently infrequently to allow recolonization of burnt habitat from unburnt patches. Third, all three species were known to Aborigines, as evidenced by their Noongar names having been recorded at Albany (Serventy and Whittell 1976). If these species had totemic significance, local Aborigines with custody of totemic sites may have burned around the habitats of these species with frequent, low intensity (early spring, late autumn or early winter) fires, much as Aborigines in Arnhem Land protect rainforest patches from destructive wildfires (Haynes 1991). Hammond (1933) refers to Aborigines in south-western Australia burning breaks around vegetation in order to secure the supply of berries, without specifying the locality.

Contemporary evidence of patch burning by Aborigines near King George Sound was first published by Nind (1831, p. 28), who noted 'The violence of the fire is frequently very great, and extends over many miles of country; but this is generally guarded against by their burning it in consecutive portions'. Patch burning was also recorded in a 274.5 cm x 18 cm hand coloured etching and aquatint of a panorama from Mt Clarence (Dale 1834) and by an eyewitness account in November 1840 (Stokes 1846, p. 228). There is a wealth of published and unpublished information (Appendix 1) describing patch burning at scales of *c.* 10–2000 ha, burning at the hottest time of the day, multiple ignitions on the same day, and burning under windy conditions.

Recent studies of the fire ecology of *Atrichornis clamosus, Dasyornis longirostris* and *Pezoporus wallicus* along the southern coast of WA confirm that frequent burning is detrimental to the long-term persistence of these species. *A. clamosus* requires a period of 4–10 years before vegetation is suitable for successful breeding (Smith 1985a). In wetter gullies this period is 4–6 years, whereas in drier areas up to 10 years is needed before regeneration is suitable (Smith 1985b). Heath may become suitable (*c.* 1–1.5 m tall) for *D. longirostris* 3 years after fire in higher rainfall areas, whereas in drier areas it may take 5–10 years (Smith 1985a; McNee and Newbey 1998). *P. wallicus* appears to be able to utilize heath *c.* 0.5 m tall (in drier areas) 7 years after fire (Burbidge 1998). It needs to be emphasized that these rates of recolonization would be reduced if source populations were distant from recently burnt areas. Clearly, given the widespread use of fire made by Aborigines at the hottest time of the year, the conjunction of suitable vegetation next to a source population is considered unlikely to have been satisfied, except in sites naturally protected from frequent burning.

FURTHER RESEARCH

Because the Denmark region of south-west WA has an historically well documented avifauna, relative to other parts of WA, this baseline information could be used to monitor ongoing environmental change. Current ornithological activity there could be focused on developing a regional atlas showing the location of all records of bird species once every 10 years. A small subset of species selected as indicators of environmental change could be monitored annually.

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APPENDIX 1

Summary of remarks about Aboriginal usage of fire near King George Sound in the period 1791 to 1840.

Note: KGS = King George Sound; PRH = Princess Royal Harbour. Any mis-spellings are as in the original documents. Explanatory interpolations by me are indicated by brackets and omissions of irrelevant material are indicated by the conventional ellipsis dots.

REMARKS	IMPLICATION	REFERENCE
Vancouver **27 September – 11 October 1791**		
'...we could no where perceive any smoke' [between Point Nuyts and Irwin Inlet]	No burning by Aborigines in September or October (frequent rains before or during this period would prevent burning)	Lamb 1984, vol. 1, p. 334
'...the vegetation had recently undergone the action of fire; the largest of the trees had been burnt, though slightly; every shrub had some of its branches completely charred; and the plants lying close to the ground had not escaped without injury' [western shore of KGS].	Burning in previous summer Partial crown scorch indicative of low intensity fire	p. 336
'This spot was intersected with several small streams of water, yet the same marks of fire were evident on all the vegetable kingdom... this general fire was of a less recent date...' [south-west shore of PRH].	Riparian areas burnt, but not in previous summer	p. 339
'...the same effects of fire were evident' [between Oyster Harbour and Mt Gardner]	Extensive burning	p. 341
'...nor were any smokes to be seen over the extensive country we beheld' [Kalgan R]	No burning by Aborigines in September/ October in drier sector of region	p. 353
'The larger trees in the vicinity of both villages had been hollowed out by fire...'	Some past fires intense (e.g. one intense fire preceded or followed by many low intensity fires)	p. 355
'...the very extraordinary devastation by fire, which the vegetable productions had suffered throughout the whole country we had traversed'.	Extensive burning in dry season	p. 355
'...in our excursion on Shore, we did not see a spot that produced any vegetables [plants], which had not visibly felt its [fire's] effects. Where the country was well wooded, the loftiest timbers had the topmost of their branches burned.'	Aboriginal burning extensive and sufficiently intense to scorch crowns of forest trees	p. 355
Menzies **27 September – 11 October 1791**		
'...the place [near Point Possession] had been recently burnt down here & there, particularly about the stems of the Gum Plant *[Xanthorrhoea preissii]* which bore its marks more than any other'	Patch burning in previous summer	Menzies 1791, folio 44
'There were but few places [Flinders Peninsula] I travelled over this day but which bore evident marks of having been set on fire, especially round the stems of the Gum plants over all the low ground but those near the top of the hills had escapd the general conflagration'	Spatially extensive burning; hill tops (?with expanses of granite rock) not recently burnt	Folio 46

'We traced this brook [bay near Gull Rock] some way up the valley from which it issued a task of no little labor on account of the density and luxuriancy of its crop of brush wood & long grass which made it difficult to penetrate'	Riparian habitat not recently burnt (depending on soil and moisture, *perhaps* burnt 3–4 years previously given the presence of thick grass)	Folios 46–47
'...covered with a variety of low and shrubby vegetables [plants] but by no means so thick as made it any ways difficult to travel through. After this...some swampy ground with long grass but interspersed with scrubby trees much weather beat which obligd us to descend to the sea side & pursue our course' [east of Oyster Harbour]	Vegetation recently burnt [indicated by easy walking], except on swampy ground (thickets) [difficult walking]	Folio 47
'...for travelling now appears more difficult if not wholly impracticable for the country along there [coast east of Oyster Harbour] being so thickly covered with underwood & scattered over with trees'	Patch of vegetation not recently burnt	Folio 48
'...the difficulties we encountered in penetrating the woods [*c.* 1 mile east of entrance to Oyster Harbour] in many places on account of their density'	Ditto	Folio 49
'...though trees & bushes were scattered over it, yet they were not apparently so thick as to form any obstruction to our investigation' [north-east shore of Oyster Harbour]	Recently burnt vegetation [indicated by easy walking]	Folio 50
'...entered a very thick wood not easily penetrated' [Kalgan R]	Riparian vegetation not recently burnt	Folio 50
'...we wandered over meadows & pastures whose crop of grass reached up to our middles' [north shore of Oyster Harbour]	Vegetation not burnt previous summer	Folio 50
'...the interior part of it [Mistaken Island, occasionally accessible on foot from mainland] had been lately burnt down but the skirts of it were covered with a luxuriant crop of grass'	Grass an indication of absence of fire in the pevious summer	Folio 51
'Many of the stems of the trees bore evident marks of fire, some were even hollowed out by it' [south side of PRH]	Signs of extensive burning, some intense enough to have caused hollow butts	Folio 53
'...a thick wood chiefly composed of the Eucalyptus obliqua *[E. marginata]*...without any underwood to obstruct our progress...and many of [these trees] had the marks of fire round their bottoms' [Kalgan R]	Recently burnt forest	Folio 54
'...we seldom met these trees or the other gum plants any where about the Sound without observing their stems burnt or scorchd with fire'	Most of the landscape showing evidence of having been burnt	Folio 54
'...it was strewed over with scrubby bushes & small shrubs which however were not so thick as to impede us much in our progress' [south side of PRH]	Vegetation opened up by recent fire, as indicated by easy walking	Folio 56
'Several places about this village [a collection of aboriginal huts] seemd to have been very recently burnt down & destroyd by fire, many of the larger trees had been scorchd by it' [south side PRH]	Recent fire sufficiently intense to have scorched crowns of tall trees	Folio 57

'...the general conflagration of the country'	Widespread use of fire	Folio 61
'...why should we meet so frequently the Gum plant & Eucalyptus obliqua with the appearance of fire round their stems'	Blackened stems frequent, indicating spatially extensive use of fire	Folio 61
'The frequent marks of fire & general burnt state of the country every where around the Sound'	Spatially extensive fire	Folio 61
'...they [Aborigines] make frequent fires round the plants...& when these happen to be kindled any wise among rank grass & bushes in a dry season it is easy to conceive in a climate like this with what rapidity & devastation it spreads over a considerable tract until its progress is interrupted by some intervening cause'	Hypothesis linking Aborigines and climate to the extensive signs seen of fire	Folios 62–63
Flinders **8 December 1801 – 5 January 1802**		
'the first smoke seen upon this coast' [near Point Irwin, travelling east from Cape Leeuwin]	Burning in early summer	Flinders 1814, vol. 1, p. 52
'Marks of the country being inhabited were found everywhere' [eastern shore of PRH]	Extensive recent burning by Aborigines	p. 57
'Some smokes...perceived at the head of the harbour' [north-west shore of PRH]	Burning in summer	p. 57
Good **8 December 1801 – 5 January 1802**		
'...we found it very troublesome walking... in thick brush wood and long grass 5 or 6 feet high' [Kalgan R]	Riparian zone not recently burnt	Edwards 1981, p. 49
'...we traced this River [near Torbay] a considerable time walking among large Trees and excessive brush wood 5 or 6 feet high with frequent Morasses'	Riparian zone not recently burnt (?burnt 3–4 or more years previously)	p. 50
Baudin & Freycinet **13 February – 1 March 1803**		
'From where we were on the hills [near Oyster Harbour] we had seen some very dense smoke, but it was too far away'	Aboriginal burning in late summer	Cornell 1974, p. 486
'Everywhere we went [banks of Kalgan R] we saw traces of fire'	Aboriginal burning extensive; not even riparian vegetation escaping firing	p. 487
'At the foot of a high range of inland mountains running from North to South [Porongurup Range], we saw many separate columns of smoke'	Extensive burning in late summer, with numerous individual fires	p. 487
'During the afternoon we saw several columns of smoke' [mainland north of Eclipse Island]	Burning at hottest part of the day in late summer	p. 495
'...et les végétaux si multipliés sur ses bords [of the Kalgan R], qu'il étoit presque impossible de la remonter plus avant'	Some riparian thickets not recently burnt	Péron & Freycinet 1816, vol. 2, pp. 151–152

Cunningham
20 January – 1 February 1818

'Several new Smokes, issuing from the woods, above the Trees, indicate the presence of natives...'	Burning in summer	Cunningham 1818, folio 235 (26 January)
'The Natives who (from their fires) appear to be all around us...we observed this aftn. their fresh fires, lighted among the Trees, near the Beach...'	Burning in hottest part of the day in late summer	Folio 235 (27 January)
'...the whole Side of the Harbour [PRH] being recently fired by Natives...Ascending to the Highest Point of the Hill, through a considerable tract of Burnt...Brushwood...'	Scale of burning ?50–100 ha	Folio 273 (31 January)
'The Hills overlooking those, of the Immediate Coast [west of KGS] were one grand blaze of Fire; having been kindled by the aborigines. Its running course before the wind, illuminating all around these [?sterile] Elevations, had a brilliant Effect [observation made at night from ship]	Scale of burning ?many hundreds of hectares. Fire at night.	Folio 238 (1 February)

King
23 December 1821 – 6 January 1822

'The stem of the *casuarina*, on which the [HMS] Mermaid's name and date of our visit had been carved, was almost destroyed by fire'	Area burned since February 1818 [i.e. within the previous 3 years]	King 1827, vol. 2, p. 123

Cunningham
23 December 1821 – 6 January 1822

Nine aborigines on rocks of the south point of the entrance to PRH [Point Possession] 'having fired the thick brushwood about them on the declivities of the Hill...'	Scale of burning ?tens of hectares	Cunningham 1821, folio 199 (24 December)
'...the smokes of several families of Natives being remark'd at the foot of the Range' [west of Oyster Harbour]	Multiple ignitions	Folio 203 (26 December)

D'Urville, Quoy & Gaimard
7 – 25 October 1826

The aborigines 'carry these burning [Banksia] cones everywhere with them...mak[ing] use of their cones to set fire to the undergrowth and the dry grass as they pass through. In general, this is what makes these...forests so open and easy of access'. [d'Urville]	Source of ignition always readily available Little undergrowth present as a result of frequent burning	Rosenman 1987, p. 30
[On the left bank of the Kalgan R c. 8 km north of its confluence with Oyster Harbour] 'the ground is thickly covered with undergrowth and especially by tall ferns with interlacing branches that completely obstruct your passage'. 'On the right-hand side of the river the bush is criss-crossed by narrow well-beaten paths'. [d'Urville]	Riparian area not recently burnt	p. 36
They also use [smouldering dry Banksia cones] to quickly set alight to the area through which they are passing and mostly, it seems, for no reason at all; they do this with a nimbleness and speed	Source of ignition always available Fires started casually	pp. 43–44

that we would be hard put to emulate. So this whole stretch of country is so burned that one cannot walk anywhere without getting black all over. The tall trees are charred right up to their tips, while the undergrowth is dead and only straggly stalks are left' [Quoy & Gaimard]	Undergrowth extensively burnt Complete crown scorch (and thus moderate intensity fire) not unusual	
'The forests appear to have only eucalypts, several of which are enormous, but all appear to be suffering to some extent from the native habit of starting fires wherever they pass through. And as nearly all these trees are resinous...the fire spreads with astonishing rapidity, reaching to the highest branches and charring the tree all over, so you return from a walk in the bush completely blackened' [Quoy]	Extensive burning Complete crown scorch not unusual Undergrowth extensively burned	p. 47
[The Aborigines] 'manifested their presence in the usual way, by setting alight to the undergrowth' [Quoy]	Eyewitness evidence of burning in spring	p. 48

Lockyer
25 December 1826 – 3 April 1827

'a large fire was now burning at the head of the Harbour [PRH], and shortly after we saw a very large smoke about ten miles [16 km] on the Hills to the South west' [22 January, near Torbay]	Burning in summer On one day in midsummer, two large fires visible	Lockyer 1827, p. 465
'Yesterday was counted twelve large smokes or fires at the back of the encampment [between Mt Melville and Mt Clarence] about two miles apart, forming a complete semicircle' [22 January]	Spatially extensive burning on one day in midsummer	p. 471
'The Natives keep up a large smoke in the Country round us from Mount Gardner to West Cape Howe, and from the number of Fires, if we may be allowed to judge from that, the Country must be very numerously peopled' [28 January]	Daily burning in midsummer extensive at regional scale	p. 493
'Made a course due North through the Country [near Kalgan R]...walking is not at all difficult through the Country' [13 February]	Burning spatially extensive and recent	p. 495

Nind
25 December 1826 – October 1829

'Every individual of the tribe, when travelling or going to a distance from their encampment, carries a fire-stick, for the purpose of kindling fires'	Ready availability of source of ignition	Nind 1831, p. 26
'...the presence of the owner of the ground is considered necessary when they fire the country for game'	Evidence of tenural basis for use of fire	p. 28
[In summer] '...they procure the greatest abundance of game. It is done by setting fire to the underwood and grass, which being dry, is rapidly burnt'	Summer burning to capture large animal food	p. 28
'The violence of the fire is frequently very great, and extends over many miles of country; but this is generally guarded against by their burning it in consecutive portions'	Fire often intense, and spatially extensive, with scale of patchiness apparently tens to hundreds, possibly one to two thousands, of hectares; indication of a deliberate and planned operation, creating a mosaic of pyric vegetation succession	p. 28

'larger firings for kangaroos, or walloby'	Extensive battues to drive large mammals towards slaughtering points	p. 28
'About Christmas they commence firing the country for game'	Summer burning the norm	p. 36
[Women] 'carry a fire-stick...and, in the burning season, set fire to the ground by themselves'	Capture of small animals (lizards, snakes, small mammals) involving localized patch burns in summer	pp. 36–37

Barker
3 December 1829 – 26 March 1831

'Kangaroo...killed by the fires' (22 January 1830)	Using fire to capture mobile animals	Mulvaney & Green 1992, p. 250
'Bad walking for an hour through unburnt wood' (c. 4 hours' walking west of Albany, north of Torbay Inlet, 3 February 1830)	Existence of sizeable unburnt vegetation patch, not recently burnt, in wetter country	p. 255
'...walking through the thick brush' [east of Wilson Inlet, 4 February 1830]	Ditto	p. 255
'smoke 154°' [SSE from mouth of Sleeman R, no distance stated, 4 February 1830]	One fire, late morning in summer	p. 256
'Very thick brush (Wattle, etc)' [north of junction of Hay R with Wilson Inlet, 4 February 1830]	Karri forest not recently burnt	p. 257
'very good ground burnt' [*c.* 5 km north of Wilson Inlet near Denmark R, 6 February 1830]	Recent fire	p. 260
'Very thick underwood on both banks [of Denmark R, south of Mt Lindesay]' (February 1830)	Riparian zone in karri forest not recently burnt (?burnt 4–15 years previously	p. 260
'Blacks burn for Wallabi' [several km SE of Mt Lindesay, noon, 7 February 1830]	Burning at midday	p. 262
'Brush on the left' [near Hay R, 8 February 1830]	Patch of vegetation not recently burnt	p. 272
'thick brush' [near entrance to Oyster Harbour, 25 February 1830]	Ditto	p. 266
'Wood was so thick near the rivulet it was difficult to get to it [karri forest at Big Grove on south shore of PRH, 10 March 1830]	Riparian vegetation not recently burnt	p. 272
'Examined the wood [karri forest at Big Grove]... but it is very difficult to get through from the thickness of the underwood' (March 1830)	Isolated patch of karri forest not recently burnt	p. 276
Aborigines 'intended firing the bush on the opposite side [of PRH]' (11 April 1830). 'It is their fire we see...near the top of a hill' (14 April)	Autumn burning	p. 280
'Large fires last night & today' (14 April 1830)	Spatially extensive burning at night, in autumn	p. 281
'Steep & difficult from the precipitous rocks and thick bush between them with accumulation of dead wood...Descended by the valley very slowly in consequence of the thick brush' [Michaelmas Island, May 1830, not accessible to Aborigines]	Long unburnt vegetation virtually impenetrable	p. 290
Aborigines 'are unable to kindle [fire] at this time of year [August 1830] & if their fire goes out,	Burning in winter unlikely (or very patchy)	p. 321

must go without till they are lucky enough to meet with it from their friends'		
[Yanungup, an island in the Kalgan R] 'Not being accessable to the natives, it was unburnt... vegetation was luxuriant' (12 November 1830)	Burned country the norm in this district	p. 353
'Their fires seen by me yesterday [southern side of Porongurup Range, 2 January 1831]	Several fires on one day in summer	p. 377
Aborigines set off to the bush to burn for wallaby, 'which they begin on the grand scale tomorrow' (4 January 1831)	Extensive summer burning the norm	p. 378
'Much burning in different parts. One fire on the top of a mount under Mount Gardener' (7 January 1831)	Extensive burning in summer. No position in the landscape exempt from burning	pp. 378–379
'No Wallabi had yet been taken in their burning, only some Paddy melons' [?quokkas, near Undiup, west of Torbay Inlet, 10 January 1831]	Burning to capture game	p. 379
'...men who were burning for Wallabi' [10 January 1831]	Ditto	p. 380
Aborigines planned 'to burn for Wallabi at Bald Head' (13 January 1831)	Summer burning	p. 382
'Large fires...on M.S. hill' [Quarantine Hill on Vancouver Peninsula, 19 January 1831]	Spatially extensive burning	p. 385
'A large fire at Narinyup about noon...afterwards... there appeared a smoke near the sawyer's wood [Big Grove].' 'Fires brilliant at night on hill' (21 & 22 January 1831)	Burning late morning, afternoon, and into the night	p. 386
'Great fires at Bald Head' (23 January 1831)	Spatially extensive burning on Flinders Peninsula	p. 387
'thick bush' [along coast between Pt Nuyts and KGS]'	Extensive tract of vegetation not recently burnt	p. 393
'He pointed out their fires (smoke) at Oongarup & Copongerup, on this side of the Right hand part of the Porongerup range' (13 February 1831)	Several fires visible on one day late in summer	p. 399
'Abundance of smoke in the line of King's river & beyond...some at a very great distance towards Oorangaddak' (17 February 1831)	Several fires visible on one day in summer	p. 401
'Numerous fires near Porrongerup' (27 February 1831)	Extensive burning in late summer	p. 404

Collie
March 1831 – ?November 1832

'I am not aware that any race of savages is so dependent on fire for their existence... as that of this part of New Holland'	Importance of fire in Aboriginal ecology (sustenance)	Collie 1834 (p. 71 of Green 1979)
'In December, but more particularly in January and February, the natives burn large tracts of country to catch wallabee, or bush kangaroo. For this purpose they generally go in considerable numbers and select a fine and warm day, and, having fired a portion of thick	Most burning in mid and late summer Deliberate burning on dry, hot days	Collie 1834 (pp. 85–86 of Green 1979)

scrub or grass where they know these animals live, they watch their being driven out by fire... As the fire when once lighted cannot be extinguished... The fires when thus lighted generally proceed spreading and consuming everything in their progress, and before the coldness and dew of the night repress their fury or intervening barren spots stop their rage, overrun some square miles of surface, and exhibit a splendidly bright spectacle amid the gloom and darkness of the night'	No Aboriginal means of putting fires out, although Aborigines would doubtless have been aware that fires extinguish themselves at night. Therefore fires spatially extensive (?500 ha) until they run into previously burnt country or weather conditions change so as no longer conducive to further spread	
'The native season of *Mondyeunung* is succeeded by *Peerruck* which continues till about the 20th March, and in which the burning of the country is most general'	Less burning in mid and late autumn	Collie 1834, (p. 86 of Green 1979)
Collie **April – May 1831**		
'...fires, with which the natives seem to have repeatedly consumed the vegetable productions' [*c.* 9 km along Kalgan R from its junction with Oyster Harbour]	Summer or autumn burning	Collie 1831, p. 135
'...tall shrubs, now burnt' [Kalgan R near Kamballup]	Summer or autumn burning	p. 140
'...shrubs, in many parts burnt' [wandoo woodland *c.* 4 km from Kalgan R]	Summer or autumn burning	p. 141
'Fire had recently gone over its surface' [wattle scrub, south of Stirling Range]	Summer or autumn burning	p. 144
Dale **January 1832**		
'Towards the sea-coast, the country was mountainous, but the native fires in that quarter materially obstructed our view' [from summit of Toolbrunup, Stirling Range]	Extensive burning close to coast on one day in summer (panoramic overview)	Dale 1832, pp. 164–165
'The fires, which are periodically spread over vast tracts of the country for the purpose of driving objects of chase from their fastnesses'	Spatially extensive burning at landscape scales	Dale 1834, p. 13
'...the natives having at that season [summer] set fire to the country around for many miles'	Areas burnt of at least ?2000 ha	p. 14
Smoke and flames of four fires (and two aboriginal camp fires) depicted	Burning of multiple fires during an easterly wind	Etching and aquatint of panoramic view from Mt Clarence (Dale 1834). Panels 1,2,5,10 and 11 of the black and white reproduction in Hallam 1975
The fire north-east near the Kalgan R has more obvious flames than the fire close to Mt Clarence	Spatial variation in fire intensity, reflecting mosaic of fuel ages	Panel 1
Of the 36 aborigines depicted on the summit of Mt Clarence, one has a firestick	Portable source of ignition available	Panel 8

Individual plants of *Kingia australis*, *Xanthorrhoea preissii* and *Macrozamia riedlei* on summit of Mt Clarence flowering	Vegetation burned previous summer. No part of landscape exempt from burning [Note: Dale has evidently used some artistic licence, as panel 11 shows a Numbat *Myrmecobius fasciatus*, a species that did not occur near KGS. The drawing is clearly from memory as the tail is incorrect. Dale was the first European to discover this species, near present day Beverley in October 1831]	Panels 1–8, 10, 11
Portions of the vegetation are coloured brown, in contrast to adjoining and intervening parts which are tinted green (not recently burnt)	Recent burning in sections, with estimated areas of 70 ha and 200 ha	Panels 10 and 11
Collie **February 1832**		
'I looked in vain for some hill in the vicinity of the Sound [KGS]. The atmosphere not only being very hazy but thickened with the smoke of native fires' [Kalgan R, south-east of Porongurup Range]	Extensive burning in late summer	Collie 1832a, p. 171
Collie **July 1832**		
'...excellent young grass shooting up where that of the former year had been burnt, and in some places, a thick covering of old grass' [Hay R south-west of Mt Barker]	Patchy burning in previous summer	Collie 1832b, p. 205
Stokes **2 – 15 November 1840**		
'On our way [15 miles (24 km) north of Albany, i.e. south of Narrikup] we met a party of natives engaged in burning the bush, which they do in sections every year. The dexterity with which they manage so proverbially a dangerous agent as fire is indeed astonishing. Those to whom this duty is especially entrusted, and who guide or stop the running flame, are armed with large green boughs, with which, if it moves in a wrong direction, they beat it out. Their only object in these periodical conflagrations seems to be the destruction of the various snakes, lizards, and small kangaroos, called wallaby... [Aborigines] engaged in kindling, moderating, and directing the destructive element, which under their care seems almost to change its nature, acquiring, as it were, complete docility, instead of the ungovernable fury we are accustomed to ascribe to it'	Low intensity fire in late spring Deliberate management of low intensity fire [These may have been marri saplings, which were used as late as the 1920s by the Forests Department – D. Ward personal communication1999]	Stokes 1846, vol. 2, p. 228

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APPENDIX 2

Extracts from letters by J.T. Tunney (hitherto unpublished) held in the Western Australian Museum and relating to his search for *Atrichornis clamosus* Noisy Scrub-bird.

9 August 1900 [The Williams]: '...I have not seen...in my travels...A. clamosa, I think [it] must be found near the coast between Fremantle & Bunbury'.

29 June 1904 [written at Kojonup]: 'I went to Denmark to try & get the A. Clamosa but was not successful'.

17 August 1904 [Gracefield]: [George Masters in 1866] 'was staying with my Grandfather at that time so must have got them near the town [Albany]'.

31 August 1904 [Gracefield]: 'I will leave here about end of Sept & try for A. Clamosa in Albany for a week'.

15 December 1904 [Gracefield]: 'I spent a week in Albany looking for A Clamosa but could not find any traces of them. I will spend a couple of weeks later between Mt Barker & Hay River & Torbay looking for them as Mr Masters was out that way collecting in 67 & may have got them there'.

10 February 1906 [Gracefield]: 'I will stay a week in Albany & try for the A. Clamosa as I heard of a bird resembling it being seen about 10 miles from there the other day'.

13 April 1906 [Esperance]: 'I was not fortunate in getting a Clamosa I was told they used to be numerous 11 miles from Albany. I went there but could not find any traces of them the settler said he heard there were still some up towards Tor bay so when I return I will have a look out there'.

APPENDIX 3

Months when fires started by Aborigines or by lightning were recorded.

Month	Number of dated observations of Aboriginal fires recorded in 1791–1840 (APPENDIX 1)	Number of lightning-caused fires recorded in Albany District 1996–99
September	0	0
October	2	1
November	1	0
December	6	6
January	20	3
February	11	2
March	2	4
April	2	2
May	0	0
June	0	0
July	0	0
August	0	0

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Wood density of improved compared with unimproved maritime pine (*Pinus pinaster*)

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SUMMARY

In a preliminary study, wood density was assessed in eleven pairs of seed orchard origin ('pedigreed') and adjacent unimproved ('routine') maritime pine trees (P1973). Although pedigreed trees produced 19 per cent greater volume, basic and air-dry densities of pedigreed and routine maritime pine were similar. The weighted mean basic density for both pedigreed and routine samples was 448 kg m^{-3}, and weighted mean air-dry density was 548 kg m^{-3} and 546 kg m^{-3} respectively.

The trend of decreasing basic and air-dry density with increasing height up the tree, resulting from the increasing proportion of juvenile wood to mature wood with increasing height, was confirmed. The high density observed in growth rings 1–5 was presumably caused by the high concentration of resin-laden heartwood in this area. With resin extracted, the density trend from the pith would presumably increase consistently to the outside of the tree. Shrinkage measurements of the five-ring segments indicated little difference between pedigreed and routine trees.

INTRODUCTION

Maritime pine (*Pinus pinaster*) is a major plantation timber species in Western Australia (WA). Currently there are about 27 000 ha of maritime pine, mainly in coastal regions just north of Perth. CALM's strategic plan is to establish a minimum 150 000 ha of the species over the next 10 years, in 400–600 mm rainfall areas in the Wheatbelt. The plantations would assist in reducing salinity effects while providing a commercial crop.

Since 1972 all maritime pine plantations in WA have been established using genetically-improved trees, and the older plantations are reaching maturity. With the proposal to significantly increase planting, it is important to reassess the wood properties of these improved pines, which were originally selected for vigour, stem straightness, and small branches at right angles to the trunk.

Most sawlogs produced from the genetically-improved maritime pine are expected to be used for structural products. Wood density is generally considered to be the best predictor of strength (Zobel and Talbert 1984), and it is important to know whether the density of improved maritime pine is different from that of the unimproved trees that form the bulk of older plantations. The proposal for a laminated veneer lumber (LVL) plant in WA, which will utilize the current maritime pine plantations as well as future plantations, has increased the need to collect available data on the wood properties of maritime pine.

The aim of this preliminary trial was to assess the basic and air-dry density at different heights in the tree, and distances from the pith, as well as shrinkage rates of improved, seed orchard origin (pedigreed) and adjacent unimproved (routine) maritime pine trees at age 25 years. Tangential and radial shrinkage measurements of improved and unimproved maritime pine were compared.

METHODS

Log Collection

Eleven pairs of trees from Yanchep Compartment 12 (P1973) were selected. One tree of each pair was an improved tree of known pedigree, while the other tree was an unimproved routine tree growing adjacent and having similar dominance status. On average, the pedigreed trees had 19 per cent greater volume, were 35 per cent straighter, and mean branch size was 31 per cent less than the routine trees (Butcher[1], personal communication). All trees selected were at least three rows from the Compartment boundary, and each tree was clearly identified with a number indicating the pair (1 to 11), with a first letter (P or R) indicating pedigreed or routine, and a second random letter.

Prior to felling breast height was marked on each tree (1.3 m above ground, high side). Trees were felled and each was docked into a 10 m butt log and a 4 to 7 m crown log (minimum small end diameter was 100 mm). Each log was clearly marked with its identification number.

[1] Mr T. Butcher, Department of CALM, Kensington WA 6152.

Logs were stored at CALM Timber Technology, with bark on and under water sprays to prevent premature drying.

Disc Sampling

Discs were cut at six or seven heights (1.3, 2.4, 4.8, 7.2, 9.6, 12.0 and 14.4 m above ground). At each sample position a 100 mm thick disc was cut from the logs and clearly labelled with tree identification number and height in the tree. Using the *Wadkin* bandsaw, two vertical cuts were made through the disc at the shortest diameter to produce a 30 mm wide strip with centred pith (the longest diameter was avoided because it generally contains compression wood). The orientation of this cut was changed on occasions to avoid branch stubs.

Wood basic density was to be assessed in five-year age groups, starting from the pith, (i.e., 1–5, 6–10, 11–15, 16–20, 21–25 growth rings). The first two groups represent the juvenile corewood, while mature wood is laid down from age 11 years. Consequently, each five-year group of growth rings was marked on the strip, and specimen sections cut using the radial arm saw. With fewer than four rings in the last group, the specimen was measured with the previous five-year group. Each specimen was labelled with the tree number, height group and cambial age group. The cut specimens were block-stacked and wrapped in plastic to minimize drying.

Density Measurements

Specimens were removed from their plastic wrapping and checked to confirm correct identification and numbering. Green volume for basic density determination was calculated after digital Vernier calipers (accuracy of 0.01 mm) were used to measure the length, width and thickness of each specimen. The data were recorded on an *Excel* spreadsheet.

Specimens were then dried to 12 per cent moisture content (MC) in an environmental moisture content (EMC) controlled room, initially set to obtain an EMC of 10 per cent to provide a drying gradient. When all specimens were around 12 per cent, the EMC setting was adjusted to this figure. After the specimens were air-dried their weight, length, width and thickness were measured and recorded. They were then oven-dried to constant weight at 103 ± 2 °C for 24 to 48 hours, and re-weighed to obtain the oven-dry weight.

From the air-dry and oven-dry weights, the air-dry moisture content of each specimen was calculated. Basic and air-dry density were calculated, and weighted averages were calculated from the cross-sectional area in concentric circles, based on each 35 mm length core section.

Shrinkage Measurements

One radial face (i.e., perpendicular to the growth rings) and one tangential face (i.e., parallel to the growth rings) were marked in the centre of each specimen, for measurement of shrinkage. The centreline along one of the two selected faces was also marked for the measurement of longitudinal shrinkage. The green dimensions at these selected points were also measured using Vernier calipers.

The mass of each specimen was measured to an accuracy of 0.001 g after the shrinkage measurements had been taken. Extra sections were used as sample boards to monitor the moisture content loss. The specimens were placed on strip sticks and allowed to dry in the EMC room, with a circulation fan operating to provide air flow around the samples.

When the sample boards were air-dry (mean 12 per cent MC) the dimensions at the three selected points and the mass of each specimen were re-measured. Specimens were then oven-dried as described above.

RESULTS AND DISCUSSION

The mean weighted basic densities for both pedigreed and routine samples were 448 kg m^{-3}, and the mean weighted air-dry densities were 548 kg m^{-3} and 546 kg m^{-3} respectively. These results indicated that the increased volume production, improved stem straightness, and smaller branches of pedigree maritime pine did not affect either basic or air-dry density. The pedigreed samples obviously had five-ring specimens that were longer than those of the routine samples.

Table 1 shows that mean weighted values of both basic and air-dry density decrease with increasing height up the tree, as expected. Basic density for pedigree and routine maritime pine decreased from 512 kg m^{-3} and 496 kg m^{-3} respectively at the base of the tree to 394 kg m^{-3} and 375 kg m^{-3} respectively at the highest measured point of 14.4 m. Similarly, air-dry density of pedigree and routine maritime pine decreased from 614 kg m^{-3} and 600 kg m^{-3} at the base of the tree to 468 kg m^{-3} and 499 kg m^{-3} respectively at 14.4 m above ground level.

Juvenile wood in conifers has shorter, thinner-walled, larger diameter fibres, with lower percentage latewood and lower density than in the more mature outer wood (AFRDI 1997). Generally the first 10 years of growth is considered to produce juvenile wood, with mature wood produced after that age. The proportion of juvenile wood to mature wood increases with increasing height in the tree, and the mean density at each height therefore decreases with increasing height up the tree as shown in Table 1.

The mean wood density results for samples taken at different cambial ages (1–5, 6–10, 11–15 and 16+ rings) are shown in Table 2. The density of samples is lowest between growth rings 6–10, with basic densities 435–440 kg m^{-3} and air-dry densities 521–536 kg m^{-3}, increasing with age to 524–526 kg m^{-3} and 608–618 kg m^{-3} respectively at 16+ growth rings. The higher densities of growth rings 1–5 can be explained by the higher resin contents close to the heart. Extracting resin would be expected to result in a pattern of uniform increase in density from the pith (rings 1–5) to the circumference (rings 16+).

Wood density of pedigree and routine maritime pine samples at different heights and ages is shown in Figures 1 and 2, and detailed data are given in Appendix 1.

TABLE 1
Weighted wood density of samples from different heights up the tree (kg m^{-3}).

	HEIGHT IN TREE (m)													
	1.3		2.4		4.8		7.2		9.6		12.0		14.4	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Basic density (kg m^{-3})														
Pedigreed	512	31	482	25	470	22	453	25	438	23	409	19	394	23
Routine	496	45	473	32	464	19	445	16	432	27	396	12	375	25
Air-dry density (kg m^{-3})														
Pedigreed	61	438	585	30	565	25	575	102	550	96	487	24	468	29
Routine	600	44	575	31	560	47	533	18	512	28	503	77	508	100

TABLE 2
Wood density (kg m^{-3}) of pedigreed and routine maritime pine at different cambial ages.

	GROWTH RINGS							
	1–5		6–10		11–15		16+	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Basic density (kg m^{-3})								
Pedigreed	458	51	440	44	464	44	524	51
Routine	452	53	435	43	463	51	526	74
Air-dry density (kg m^{-3})								
Pedigreed	567	81	536	78	556	68	618	56
Routine	559	59	521	50	549	50	608	86

The Figures show there was little difference in density between pedigree and routine maritime pine, but that both basic and air-dry density decreased with increasing height in the tree. The increasing density with increasing cambial age from growth rings 6–10 through to 16+ and the high density of the resin-laden growth rings 1–5 are shown. The extraneous high density figure for the 16+ samples at 4.8 m in both basic and air-dry density for the routine maritime pine is owing to a single sample, with obvious localized high resin content.

Regression analysis (including calculating coefficients of determination) was used to determine the linear relationship between the density at breast height and overall density, and whether the former measure could be used as an accurate predictor of overall density. A weak relationship ($R^2 = 0.43$) was found between air-dry density at breast height and the air-dry density of the whole tree. A much stronger relationship ($R^2 = 0.86$) was found between basic density at breast height and the basic density of the whole tree, suggesting that the former is a satisfactory predictor of whole tree density.

The mean tangential, radial and longitudinal shrinkages at 12 per cent MC for pedigreed maritime pine were 7.0 per cent, 4.3 per cent and 0.1 per cent respectively. For routine maritime pine the mean tangential, radial and longitudinal shrinkages were 6.8 per cent, 4.3 per cent and 0.1 per cent respectively. The mean tangential and radial values are greater than standard published figures of 5.0 per cent and 3.0 per cent respectively before reconditioning (Kingston and Risdon 1961), because of the small size of five-ring segments.

The tangential and radial shrinkages of each five-ring segment are given in Table 3 with detailed data in Appendix 2, indicating a trend of increasing shrinkage with increasing distance from the pith. While the five-ring specimens from pedigreed trees were slightly longer than those from routine trees, because of faster growth rates, there is little difference overall. The high standard

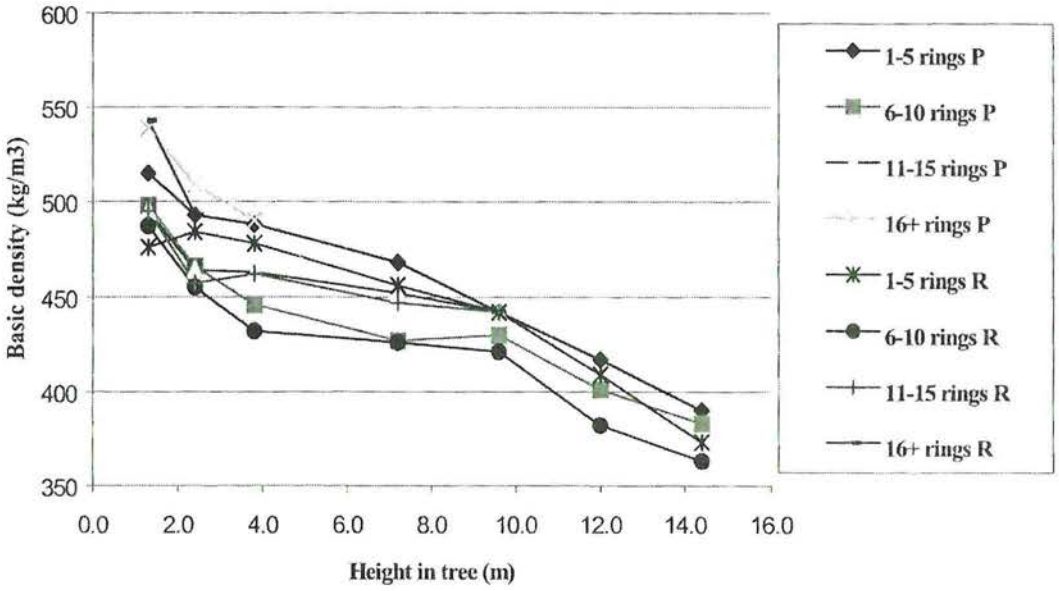

Figure 1. Effect of height in tree on basic density of pedigreed and routine maritime pine (P73).

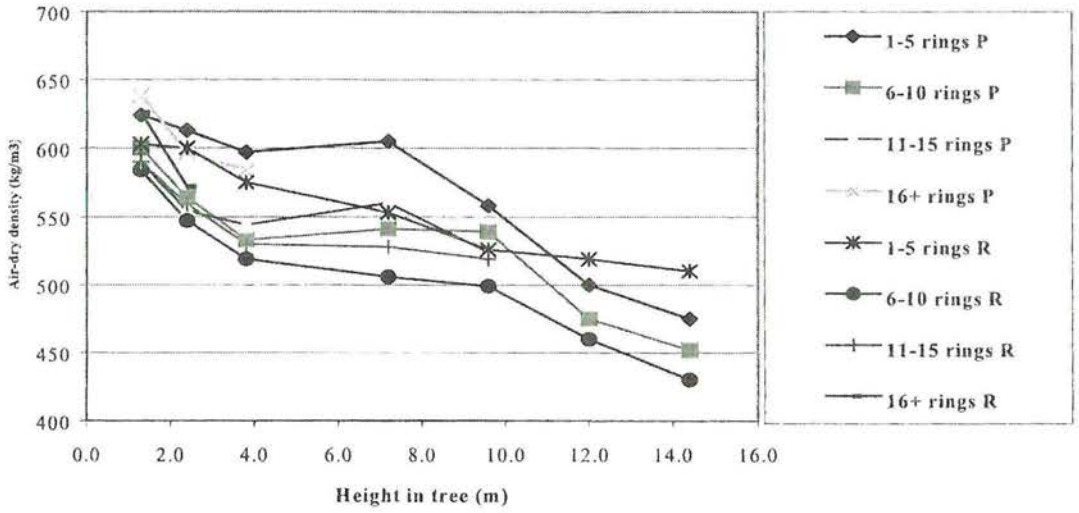

Figure 2. Effect of height in tree on air-dry density of pedigreed and routine maritime pine (P73).

TABLE 3
Shrinkage (%) of pedigreed and routine maritime pine at different cambial ages .

	GROWTH RINGS							
	1–5		6–10		11–15		16+	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Tangential shrinkage (%)								
Pedigreed	5.3	1.4	7.2	1.2	8.5	1.2	8.9	1.3
Routine	5.5	1.2	7.0	1.1	7.7	1.0	7.5	0.8
Radial shrinkage (%)								
Pedigreed	3.9	1.2	4.6	1.3	5.1	2.0	5.4	2.5
Routine	3.8	1.0	4.3	1.3	4.8	2.0	5.5	1.9

deviations indicate that there was considerable variation between trees.

In summary, the wood density and shrinkage assessment of eleven maritime pine trees (P73) of seed orchard origin and eleven adjacent unimproved trees gave similar results, which is encouraging. Although there has been significant improvement in volume production and significant increase in timber volume in pedigreed trees, the basic and air-dry density between pedigreed and unimproved maritime pine has remained the same.

There was the expected trend of decreasing basic and air-dry density with increasing height up the tree, because of the decreasing proportion of mature to juvenile wood with increasing height. The high density observed in growth rings 1–5 was presumably caused by the high concentration of resin-laden heartwood in this area. There was little difference in either tangential or radial shrinkage between pedigreed and routine pine.

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APPENDIX 1

Basic and air-dry densities (kg m^{-3}) of five-ring segments of pedigreed and routine maritime pine at different heights (m) in the tree.

	1.3		2.4		4.8		7.2		9.6		12.0		14.4	
GROWTH RINGS	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
							Basic density (kg m^{-3})							
Pedigree														
1–5	515	46	493	40	488	31	468	28	442	26	417	23	390	24
6–10	498	40	466	34	446	37	427	21	430	24	401	24	383	18
11–15	495	43	464	31	463	38	452	54	442	45				
16+	539	58	509	42	490	50								
Routine														
1–5	476	80	484	39	478	28	456	25	442	26	409	23	373	43
6–10	487	47	455	31	432	24	426	20	421	37	382	10	363	
11–15	495	56	457	61	462	47	447	30	442	47				
16+	543	93	493	52	595									
							Air-dry density (kg m^{-3})							
Pedigree														
1–5	624	61	613	52	597	39	575	37	558	83	500	31	475	35
6–10	600	41	564	51	533	48	512	27	506	28	475	28	452	23
11–15	590	51	554	26	544	42	529	66	524	52				
16+	638	64	597	37	584	63								
Routine														
1–5	603	50	600	40	575	37	553	26	526	32	519	74	510	98
6–10	584	46	547	35	519	32	506	24	499	37	460	17	430	-
11–15	590	53	559	47	530	37	528	34	519	51				
16+	595	74	572	75	686									

APPENDIX 2

Tangential and radial shrinkages (%) of five-ring segments of pedigreed and routine maritime pine at different heights (m) in the tree.

	1.3		2.4		4.8		7.2		9.6		12.0		14.4	
GROWTH RINGS	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
						Tangential shrinkage (%)								
Pedigree														
1–5	5.7	1.5	5.6	1.9	5.0	1.4	5.2	1.6	5.1	1.5	5.4	0.8	5.3	1.1
6–10	7.9	1.2	8.4	1.1	7.6	1.4	7.3	1.3	6.7	1.4	6.8	1.4	6.0	0.9
11–15	9.1	1.1	9.1	0.8	8.2	1.3	8.1	1.2	7.9	1.6				
16+	8.5	1.3	9.0	1.5	9.3	1.2								
Routine														
1–5	5.8	1.6	5.9	1.4	5.6	1.4	5.4	1.0	5.2	1.2	5.3	1.0	5.2	0.7
6–10	7.7	0.9	7.9	1.3	7.3	1.1	6.9	1.1	6.6	1.2	6.3	1.0	6.0	-
11–15	8.4	0.8	8.2	1.0	7.9	0.9	7.7	1.0	6.5	1.4				
16+	8.2	0.8	7.9	0.8	6.6	-								
						Radial shrinkage (%)								
Pedigree														
1–5	3.8	1.7	4.1	0.9	3.4	1.0	3.4	1.0	3.7	1.2	4.4	1.4	4.3	1.1
6–10	4.0	1.3	4.1	0.8	4.0	1.4	3.7	1.3	4.0	1.1	5.4	2.0	6.9	1.3
11–15	4.8	1.9	5.2	1.5	5.0	2.2	5.3	2.9	5.2	1.6				
16+	5.5	2.6	6.3	2.3	4.6	2.6								
Routine														
1–5	3.8	1.3	4.0	0.6	3.6	1.1	3.9	0.8	3.9	0.9	4.1	1.0	3.3	1.2
6–10	4.3	1.5	4.2	1.0	3.9	1.0	3.9	0.8	3.5	1.2	3.6	2.2	6.6	-
11–15	5.3	2.2	5.1	2.4	4.8	1.9	4.5	2.4	4.2	1.0				
16+	5.8	1.9	6.6	1.8	4.0	-								

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Wood properties of southern gidgee (*Acacia pruinocarpa*) from different sites in the Pilbara and goldfields regions of Western Australia

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SUMMARY

The CALM**Science** Division and CALM Timber Technology undertook a joint study to investigate the basic wood properties of initial moisture content, density, fibre saturation point and shrinkage of southern gidgee (*Acacia pruinocarpa* Tindale) trees from three geographic regions within the arid zone of Western Australia.

The low initial moisture contents observed for southern gidgee (24 to 35 per cent) from the three areas is a product of the dry environment in which the species grows, and the high density of its wood. The mean basic density, air-dry density and green density for all sites were 926 kg m^{-3}, 1083 kg m^{-3} and 1203 kg m^{-3} respectively.

The estimated fibre saturation point was 21.2 per cent, lower than that of most other species. The mean tangential, radial and longitudinal shrinkages from green to 12 per cent moisture content for this study were 2.5 per cent, 1.68 per cent and 0.12 per cent respectively. The tangential:radial:longitudinal shrinkage ratio for southern gidgee at 12 per cent moisture content was therefore 21:14:1, compared with the general ratio of 100:50:1. This result could be attributed to the presence of wavy grain and the difficulty in achieving perfectly backsawn or quartersawn samples.

Southern gidgee has an attractive dark ebony colour and very dense wood, giving the species the potential for value-adding into furniture, craftwood and musical instruments.

INTRODUCTION

In its natural environment southern gidgee (*Acacia pruinocarpa* Tindale) grows to a tall dominant tree 12 m high, with a large spreading crown and rough, deep fissured bark which folds into the wood of the trunk and branches (Mitchell and Wilcox 1994). Trees generally occur on rocky hills and on hard mulga (*A. aneura* Muell ex Benth) plains in shallow loamy soils over rock or a hardpan. Larger trees are often found in moisture gaining sites. Southern gidgee has a wide distribution through the central and northern desert areas of Western Australia (WA), beginning about 50 km east of Carnarvon, and extending east into the Northern Territory (Pronk 1997).

The common name of *gidgee* is also applied to a similar looking, but unrelated species (*A. cambagei* R.T. Baker) which grows in the dry inland areas of Queensland and New South Wales. The wood properties of *A. cambagei* are described in Bootle (1983).

Southern gidgee has wide distribution and a large size, considering it grows in an arid environment. Its attractive dark ebony coloured wood with its high density give the species potential for value-adding into furniture and craftwood. This report discusses a joint trial undertaken by the CALM**Science** Division and CALM Timber Technology to investigate the basic wood properties of density, shrinkage, initial moisture content and fibre saturation point of trees from three geographic regions of WA.

METHODS

The southern gidgee trees were sampled from areas ranging from three sites in the Pilbara through to two sites each in the North Eastern and North Western Goldfields (Table 1). The trees were felled, docked to 2.6 m log lengths, and delivered to CALM Timber Technology at Harvey within three to four weeks of harvesting, then stored under water spray. Some were delivered to the Herbarium initially, where they were kept moist until transport to Harvey was available. Generally, the time recommended between felling and stockpiling logs from regrowth jarrah (*Eucalyptus marginata*) and karri (*E. diversicolor*) is less than one week, but the long distances involved in this study resulted in the delay between felling and stockpiling. After stockpiling, the logs were sawn and specimens prepared for assessing the following basic wood properties:

- initial moisture content
- green density, air dry density and basic density
- fibre saturation point (f.s.p.)
- tangential, radial and longitudinal shrinkage

TABLE 1
Site details of southern gidgee logs collected for wood properties assessments.

GEOGRAPHIC REGION	SITE	VOUCHER No.	No. OF TREES SAMPLED	DATE COLLECTED	LATITUDE	LONGITUDE	LOCATION DESCRIPTION
Pilbara	Savory Creek	S. van Leeuwen 3380	1	15 Oct 1997	28° 48' 39" S	120° 24' 40" E	3.2 km SW of Burranbar Pool, 17.3 km E of Mundiwindi, 26 km ENE of Cundlebar, 9.2 km W of Kimberley Well
	Hamersley	S. van Leeuwen 3384	1	15 Oct 1997	23° 12' 44" S	119° 28' 11" E	7.2 km SE of Pamelia Hill, 15.7 km SE of Rhodes Ridge, 32.4 km ENE of Giles Point
	Fortescue Valley	S. van Leeuwen 3386	1	15 Oct 1997	22° 03' 51" S	118° 15' 44" E	Mulga Downs Station, 8.6 km WNW of Windemurra Well, 21 km NNW of Wittenoom, 22.4 km E of Pigeon Camp Well
North Eastern Goldfields	Lake Carnegie	N.A.	3	25 Nov 1997	25° 50' S	122° 33' E	Gunbarrel Highway (south side), about 305 km E of Wiluna
	Yakabindie Station	N.A.	1	30 July 1997	27° 27' S	120° 34' E	Yakabindie Nickel Mine site
North Western Goldfields	Mt Magnet-East	T. McKenzie	1	Sept 1997	28° 06' S	117° 50' E	20 km east of Mt Magnet
	Mt Magnet-North East	T. McKenzie	1	Sept 1997	28° 06' S	117° 50' E	15 km NNE of Mt Magnet

Note: Samples are coded by Site name and Voucher number (when given).

Specimen Preparation

Backsawn specimens (28 x 28 mm) were cut from the outer heartwood of randomly selected log lengths. The logs were broken down on a *Forestor 150* horizontal bandsaw, and the flitches sawn into 28 x 28 mm backsawn lengths, using either a *Jonsereds* vertical bandsaw or a *Wadkin* band resaw. These lengths were then dressed on all sides to 25 x 25 mm cross-section to remove saw marks and produce even surfaces to improve measuring accuracy with vernier calipers. Specimens 200 mm long were then docked. Owing to the twisted log shape, it was difficult to achieve straight grained pieces, which consequently affected longitudinal shrinkage measurements and therefore some specimens were rejected in data analysis.

Initial Moisture Content

The initial moisture content (I.M.C.) of a piece of timber is defined as the mass of water contained in that timber expressed as a percentage of the oven-dry mass.

$$\text{I.M.C. (\%)} \frac{\text{Green mass} - \text{Oven-dry mass}}{\text{Oven-dry mass}} \times 100$$

(AFRDI 1997).

Data on initial moisture content assist in selecting an economical drying schedule for a particular timber species. Previous assessments of specialty timbers from the WA Goldfields have indicated values lower than those for jarrah and karri (Brennan and Newby 1992).

A section was cut from the end of each 25 x 25 mm length and oven-dried to determine moisture content, as described in AS/NZS1080.1:1997 (Standards Australia 1997). If the green mass could not be measured immediately after cutting, then the specimens were block-stacked and wrapped in plastic to reduce moisture loss.

Fibre Saturation Point

Fibre saturation point (f.s.p.) is the moisture content at which the cell cavities have lost their free water while the cell walls are still saturated. It is usually in the range of

25 to 30 per cent moisture content for most species (Campbell 1997). It is important to know f.s.p. because wood properties of a piece of timber change below that moisture content. For example, as water moves out from between the fibrils of the cell wall and the fibrils move closer together and shrinkage of the cell wall occurs, then shrinkage of the whole piece commences. Removing the free water from the cell cavity also allows easier penetration of chemical preservatives, fire retardants and other additives. Thermal, acoustical and electrical properties also change as the moisture content falls below f.s.p. It is critical to know the f.s.p. when drying timber, particularly if drying at temperatures above 100° C, because cell collapse and internal checking can develop if the cells still contain free water.

Kelsey (1956) used the 'shrinkage intersection point' as an estimate of f.s.p. She defined the shrinkage intersection point as the moisture content at which the extended linear portion of the shrinkage-moisture content curve intersects the line of zero shrinkage. Shrinkage curves were produced for southern gidgee specimens from each site by plotting mean moisture content and mean shrinkage (tangential and radial), using the following method.

The mass of each 25 x 25 x 200 mm specimen was then recorded, and the subsequent mass over the assessment period as the timber dried compared with that initial mass (measured at the time of assessing initial moisture content) to estimate moisture content at each measurement time. At the end of the assessment the mean predicted moisture content was below 8 per cent, and the specimens were then oven-dried.

The oven-dry mass and weekly weighing for each southern gidgee specimen allowed the determination of moisture content at each assessment. The oven-dry mass for each specimen was used to calculate initial moisture content and basic density, and to produce shrinkage curves and estimate f.s.p. From shrinkage curves, shrinkage intersection points were estimated for specimens from each site. Using the data between 5 per cent and 25 per cent moisture content, linear regressions were calculated and the intersection point on the y-axis (MC%) used to estimate f.s.p. To construct a shrinkage curve with most species, at least one data point should be above 25 per cent moisture content, i.e. above f.s.p. This generally allows an elbow to develop in the curve and the regression line can be projected onto the y-axis. In some cases the mean moisture content of some specimens was below 25 per cent M.C. and f.s.p. could not be accurately estimated.

Density (green, air-dry and basic density)

The density of a piece of wood (or any substance) is defined as its mass divided by its volume, usually expressed in kilograms per cubic metre (kg m^{-3}). Three methods of estimating density were used in this trial. They were:

Green density (G.D.) is the ratio of the mass of green or unseasoned wood to green volume. This density is useful when determining log transport costs by relating tonnes to cubic metres, the basis of weight-scaling. However, the moisture content of the logs varies during the year, and green density will vary.

Air-dry density (A.D.D.) is the mass of a piece of wood divided by its volume after seasoning (generally to 12 per cent moisture content). This condition relates to wood in use and is the usual figure used when comparing densities of different species in practical situations.

Basic density (B.D.) is the oven-dry mass divided by green volume. This measure has the advantage that moisture content variations during the year are avoided.

Samples for assessing green and basic density were taken from green boards and from dry boards for estimating air-dry density. Air-dried densities were calculated when the specimen moisture contents were approximately 12 per cent. Because measurements were conducted weekly, it was difficult to assess the specimens when their moisture contents were exactly 12 per cent.

Shrinkage

The shrinkage of a piece of wood is expressed as a percentage of its green dimensions (i.e. when the moisture content is above fibre saturation point).

$$\text{Shrinkage (\%)} = \frac{\text{green dimension} - \text{dry dimension}}{\text{green dimension}} \times 100$$

To obtain accurate shrinkage measurements, the 25 x 25 x 200 mm specimens were measured for tangential (parallel to the growth rings), radial (perpendicular to the growth rings) and longitudinal shrinkage before drying in a controlled humidity chamber. The specimens were re-measured weekly at the same position until the moisture content was below 8 per cent. The equilibrium moisture content (e.m.c.) in the humidity chamber was set at 2 per cent lower than the mean moisture content of the specimens to allow them to dry and shrink before the next assessment.

All data collected for moisture content, density and shrinkage for each site were entered onto an *Excel* spreadsheet.

RESULTS AND DISCUSSION

Density

The green density, moisture content, basic density and air-dry density data for each site assessed for this study are given in Table 2. Note the low values for average initial moisture content, some being below the normal fibre saturation point (f.s.p.). The low initial moisture contents measured (ranging from 24.4 to 35.1 per cent) from the seven sites reflect the arid and semi-arid dry environments in which the trees grow, and the high wood density of southern gidgee.

The mean green density, basic density and air-dry density for all sites were 1205 kg m^{-3}, 925 kg m^{-3} and 1085 kg m^{-3} respectively. The high density of southern gidgee is owing to thick cell walls and small cavities that result in less space available for free water. All sites have

TABLE 2

Moisture content, green, basic and air-dry density of southern gidgee specimens from different sites in the Goldfields and Pilbara Regions.

SITE	No. SAMPLES	INITIAL MOISTURE CONTENT (%)		GREEN DENSITY (kg m^{-3})		BASIC DENSITY (kg m^{-3})		AIR-DRY DENSITY (kg m^{-3})	
		MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
Savory Creek	25	24.4	1.5	1175	55	945	50	1095	55
Hamersley Range	19	35.1	3.3	1230	55	910	45	1065	55
Fortescue Valley	23	29.7	4.3	1155	30	890	30	1045	30
Lake Carnegie	18	32.3	4.2	1210	50	915	45	1070	55
Mt. Magnet – East	25	31.6	4.6	1200	55	915	45	1065	50
Mt. Magnet – North East	21	28.4	6.6	1180	30	920	60	1070	70
Yakabindie Station	28	30.2	5.8	1260	60	970	45	1150	55
All Sites	**159**	**30.2**		**1205**		**925**		**1085**	

long term dry conditions with harsh growing conditions. Kalgoorlie has a mean January maximum temperature of 33.6°C and a low mean rainfall of 260 mm per year (Bureau of Meteorology 1988) which are typical of the conditions for sites assessed.

The logs assessed from Savory Creek, Hamersley and Fortescue were from three different trees, producing nine logs. Four logs were assessed from Lake Carnegie, coming from three different trees. The sampling position within these trees will affect the density results for these sites and the comparisons between sites.

The content of cell wall material in wood and thus density varies not only between species but also within species and individual trees. Wood density is affected by factors such as proportions of heartwood and sapwood, rate of growth and the proportion of earlywood to latewood (particularly in conifers). Young trees have a significant volume of juvenile wood in their central core, which is of lower density than mature wood of the same species, and considerable variation in density occurs both between and within trees. Average density increases with cambial age or distance from the pith (Brennan 1997).

Green density is the density of the wood at the time the living tree is felled. It varies considerably with the season, weather conditions, and the age of the tree (Bootle 1983). The seven sites included in this study were sampled at different times of the year under different weather conditions, which affected green density. Yakabindie, which produced different results from all other groups, was sampled in July. All other samples were collected between September and November, and seasonal variation in green density may explain the significant differences in green density. Genetic differences owing to long distances between some sites may contribute some of the variation in green density.

The Yakabindie sample had the highest value for each of the three density measurements, i.e. green, basic and air-dry density. All three density values for Yakabindie were within the range of densities quoted for mulga, a species with similar wood characteristics (Bootle 1983; Brennan and Newby 1992).

Brennan (1997) reported similar densities to the mean results of the present study for raspberry jam (*A. acuminata)* and mulga (*A. aneura*), other *Acacia* species from the Wheatbelt and Goldfields Regions of WA. Bootle (1983) reported green density values of about 1300 kg m^{-3} for two *Acacia* species referred to as gidgee (i.e. *A. cambagei* and *A. georginae*), and air-dry density of about 1250 kg m^{-3} for *A. cambagei*: values slightly higher than those reported in this study.

Special attention is required when milling, drying and processing southern gidgee, as the timber has potential for high value end uses, for example furniture, craftwood and components for musical instruments. High-density timbers normally require high-speed planers and sharp tools with slow feed speeds. Drying of high density timbers with a minimum of degrade is difficult because movement of water through the dense cell structure is slow. High equipment costs, maintenance costs and the slow drying times result in higher processing costs than those of lower density timbers which are softer and faster to dry while equipment requires less maintenance.

Shrinkage

Fibre saturation point estimates were made by generating a regression line from the shrinkage curves of moisture content and shrinkage between 5 and 25 per cent, and taking the 'y' intercept as the f.s.p. prediction: f.s.p. estimates are shown in Table 3.

Fibre saturation point estimates from the longitudinal shrinkage curves were consistently lower than estimates from the tangential and radial shrinkage curves. Estimated f.s.p. for southern gidgee [because changes in dimensions are very small compared with tangential and radial, and less reliable] for reliable data (i.e. excluding longitudinal)

was 21.2 per cent for tangential shrinkage curves and 20.4 per cent for radial shrinkage curves. In comparison, the f.s.p. for most species lies between 25 and 30 per cent (AFRDI 1997), but the estimate in the present study is similar to the 21.7 per cent estimate for gidgee made by Siemon and Kealley (1999).

The mean shrinkage data for tangential, radial and longitudinal shrinkage at a moisture content of 12 per cent and at final moisture content (between 7.5 and 9.0 per cent M.C.) are shown in Table 4.

The mean tangential, radial and longitudinal shrinkage for all sites from green to 12 per cent is 2.5 per cent (SD 0.8), 1.7 per cent (SD 0.4) and 0.1 per cent (SD 0.1) respectively. This gives a tangential:radial:longitudinal shrinkage ratio for southern gidgee of 21:14:1. For all sites from green to final moisture content (Table 4) shrinkages

TABLE 3

Fibre saturation point predicted from tangential (tang), radial and longitudinal (long) shrinkage curves.

	F.S.P. ESTIMATES			INITIAL MC%		
SITE	TANG	RADIAL	LONG	MEAN	STD DEV	RANGE OF MC% FOR F.S.P. ESTIMATES
Yakabindie	21.93	21.53	19	30.21	5.77	21.7–7.5
Savory Creek	21.1	19.7	16.5	24.4	1.45	24.4–8.5
Hamersley	21.2	20.42	15.08	35.1	3.26	20.9–9.0
Fortescue	21.92	21.51	12.04	29.7	4.3	20.3–8.6
Lake Carnegie	21.35	20.24	15.79	32.3	4.24	22.3–8.9
Mt Magnet – East	21.04	20.15	13.35	31.6	4.58	22.2–8.7
Mt Magnet – North East	19.73	19.15	17.78	28.4	6.64	21.1–9.0
Mean all sites	**21.2**	**20.4**	**15.6**	**30.2**	**4.32**	

TABLE 4

Tangential, radial and longitudinal shrinkage measurements of southern gidgee for sites assessed.

SHRINKAGE FROM GREEN TO 12 % MOISTURE CONTENT								
SITE	n	TANGENTIAL (%)		RADIAL (%)		LONGITUDINAL (%)		MEAN MC(%)
		MEAN	STD DEV	MEAN	STD DEV	MEAN	STD DEV	
Savory Creek	24	2.44	0.76	1.57	0.25	0.08	0.05	11.3
Hamersley	19	2.54	0.52	1.63	0.25	0.22	0.09	11.7
Fortescue	23	2.85	0.66	1.76	0.35	0.06	0.06	11.9
Lake Carnegie	18	2.4	0.95	1.57	0.23	0.11	0.07	11.9
Mt. Magnet – East	25	2.42	0.71	1.37	0.46	0.09	0.07	11.8
Mt Magnet – North East	21	1.91	0.48	1.44	0.29	0.12	0.07	11.9
Yakabindie	28	2.83	0.90	2.27	0.37	0.16	0.12	12.5
SHRINKAGE FROM GREEN TO FINAL MOISTURE CONTENT								
SITE	n	TANGENTIAL (%)		RADIAL (%)		LONGITUDINAL (%)		FINAL MC(%)
		MEAN	STD DEV	MEAN	STD DEV	MEAN	STD DEV	
Savory Creek	24	3.56	0.91	2.45	0.32	0.12	0.05	8.5
Hamersley	19	3.38	1.04	2.26	0.33	0.12	0.07	9.0
Fortescue	23	3.94	0.99	2.62	0.38	0.07	0.06	8.6
Lake Carnegie	18	3.26	1.15	2.30	0.37	0.12	0.10	8.9
Mt. Magnet – East	25	3.54	0.90	2.31	0.43	0.12	0.09	8.7
Mt Magnet – North East	21	2.95	0.53	2.23	0.36	1.20	0.13	9.0
Yakabindie	28	4.72	1.28	3.92	0.50	0.31	0.22	7.5

were 3.7 per cent (SD 1.1), 2.6 per cent (SD 0.7) and 0.2 per cent (SD 0.3) respectively, giving a ratio of 20:14:1. Published data on shrinkage is normally given as the shrinkage between green and 12 per cent MC, a figure representative of seasoned timber in dwellings. The mean tangential and radial shrinkage for all sites from green to 12 per cent MC (2.5 per cent and 1.7 per cent respectively) were less than the 2.9 per cent and 2.3 per cent respectively quoted by Siemon and Kealley (1999). The high standard deviations observed in the shrinkage measurements, particularly in longitudinal shrinkage, are owing to wavy grain and/or measuring inaccuracies, with the latter a likely source of variation when measuring the very small changes observed in longitudinal shrinkage.

The tangential:radial:longitudinal ratio of 21:14:1 was significantly different from the generally quoted ratio of 100:50:1. Shrinkage of wood as it dries is caused by the fibrils moving closer together rather than the fibrils actually shrinking. The greatest shrinkage occurs at right angles to the direction in which the fibres lie. Most cells have the fibrils running spirally and close to parallel to the length of the cell. There is little shrinkage in the length of the cell and greater shrinkage at right angles to the length of the cell in the radial and tangential directions, and longitudinal shrinkage is much less than either tangential or radial shrinkage. Radial shrinkage is less than tangential shrinkage because the medullary rays reduce shrinkage in the radial direction.

The amount of shrinkage in a piece of timber is affected by the direction of the grain in that piece. Although we tried to select specimens where the growth rings were parallel to the face, southern gidgee has a very twisted wavy grain making it difficult to select perfect samples. Within a 25 x 25 x 200 mm specimen the grain can change direction, which causes distortion during drying to 12 per cent or final MC and greater than expected longitudinal shrinkage. An increase in the longitudinal shrinkage reduces the ratio of tangential:radial:longitudinal shrinkage.

Southern gidgee's wide distribution and arborescent growth form with large stem diameter for a semi-arid environment, combined with the attractive dark ebony colour and high density of the wood, gives this species the potential for value-adding into furniture, craftwood and in musical instruments. The nature of a scattered resource over vast areas and the difficulty in finding suitable logs from a tree with poor form means that southern gidgee would only have potential for a small scale specialty timber industry.

Considerable interest has been shown in using Goldfields timbers for manufacturing flutes and woodwind instruments (Kealley 1989). The acoustic properties of southern gidgee should be tested for its possible use in the manufacture of musical instruments, because mulga has given satisfactory results in flutes. Desert Timber Products in Kalgoorlie is currently using southern gidgee for guitar components. Future research on southern gidgee may include assessment of sawmilling recoveries, timber drying, processing and an evaluation of its acoustic properties.

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Flora and vegetation of the Byenup-Muir reserve system, south-west Western Australia

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ABSTRACT

This study documents the high conservation values of Byenup-Muir reserve system in terms of both flora and diversity of plant communities recorded. A total of 976 taxa were recorded in 13 reserves; this included three species of Declared Rare Flora and 33 taxa on CALM's priority flora list. Structural vegetation mapping carried out in nine reserves showed a complex mosaic of more than 30 vegetation types. Comparison with oblique aerial photography taken in 1980 allowed qualitative changes in vegetation cover over 19 years to be described.

Eryngium sp. Lake Muir (*E. Wittwer* 2293) and *Tribonanthes* sp. Lake Muir (*GJK & NG* 2387) appear to be endemic taxa to the Byenup-Muir area. The Lake Muir Nature Reserve contains the only known populations of *Euphrasia scabra* and *Lilaeopsis polyantha* in WA. The Byenup-Muir wetland reserve system fulfils at least four criteria for listing as a wetland of international importance under the Ramsar Convention.

The major threats to conservation values of the reserve system identified were (1) increases in salinity resulting from drainage schemes and rising water table and (2) spread of dieback. Major changes in plant communities in many of the wetlands have occurred since 1980. These changes were not just confined to lake margins but also occurred in sumplands and damplands.

INTRODUCTION

The Byenup-Muir wetland complex covers a sequence of basin wetlands, swamps, seasonally wet flats and low sandy and occasionally lateritic rises in the south-west of Western Australia (WA). It is unusual in that this wetland complex is largely undisturbed and contains peat-based wetlands, which are very rare in WA (ANCA 1996; CALM 1998). The wetland complex is reserved in 13 separate nature reserves (Bokarup, Cobertup, Cowerup, Galamup, Kodjinup, Kulunilup, Lake Muir, Noobijup, Pindicup, Pinticup, Quindinup, Unicup and Yarnup) (Fig. 1; Gibson and Keighery 1999).

The broad plain on which most of the wetlands occur has had a complex geological history. The area was subject to several marine incursions while most of the soils are of Tertiary and Quaternary age and represent infilling of blocked paleodrainage systems (Wilde and Walker 1984; Chakravartula and Street 1999). Churchward *et al.* (1988) mapped landforms and soils south of Byenup Lagoon. The wetlands fell into their swampy terrain landform with Cambellup (plains with drainage floors, swamps and low rises) and Morande (lunettes, dunes, hummocks and intervening swamps) being the most common units. Chakravartula and Street (1999) have recently produced a more detailed soil interpretation from airborne radiometric data for the entire Muir and Unicup catchments.

Regional vegetation mapping at 1:250 000 scale was undertaken by Smith (1972) and at 1:1 000 000 scale by Beard (1981). The reserves fall mainly into Beard's Kwornicup vegetation system with the upland areas around Unicup Nature Reserve in the Jingalup vegetation system. The Jingalup uplands have extensive areas of lateritic capping and deeply dissected watercourses. Most of this system is dominated by eucalypt woodland with the creek lines dominated by *Eucalyptus rudis, Melaleuca cuticularis* and *M. viminea*. The more extensive Kwornicup system is characterized by a poorly-drained swampy plain between the headwaters of the Kent, Hay and Gordon Rivers. The vegetation is a mosaic of jarrah (*Eucalyptus marginata*)-marri (*E. calophylla*) forests, paperbark (*Melaleuca* spp.) low forest and reed swamps, with *E. decipiens* occurring on sandy swampy sites as the dominant or understorey species. Clay swamps usually contain stands of yate (*E. cornuta*) with an understorey of *Melaleuca cuticularis* and *M. violacea* while sandy swamps may have dense stands of *Melaleuca cuticularis* grading into reed swamps (Beard 1981).

The broad scale vegetation mapping gives little indication of the degree of patterning or the array of plant communities found in the area. More detailed information is available for three of the nature reserves: Kulunilup, Unicup and Yarnup (Griffin 1984). In his report Griffin described 24 vegetation associations ranging from upland lateritic jarrah communities to shrublands and sedgelands of the wet flats, and commented on the gradational nature of the vegetation with the complex mosaic apparently related to soil type, moisture status and salinity.

The aim of the present work was to compile species lists for all 13 reserves, to map the nine wetland reserves for which detailed vegetation information is lacking, and to provide a qualitative assessment of vegetation change over 19 years using oblique aerial photography taken in 1980.

METHODS

Vegetation and Flora

Structural vegetation mapping was undertaken for Bokarup, Cobertup, Cowerup, Galamup, Kodjinup, Lake Muir, Noobijup, Pindicup, Pinticup Nature Reserves using 1:25 000 stereo colour aerial photographs (WA3619 – 23.x.95) (Fig. 1). Structural units were mapped then field-checked by traverses of external boundaries and internal tracks. The Lake Muir Reserve is over 11 000 ha and much is inaccessible by vehicle: mapping units in this reserve were checked by air. Vegetation units were found to occur in complex mosaics, and broad units similar to those used by Griffin (1984) were adopted.

For each reserve detailed flora lists were compiled. The lists for Lake Muir and Cowerup Nature Reserves are considered preliminary because of the large size in the case of Lake Muir and lack of sampling of annuals in Cowerup. The mapping and flora survey was undertaken during five field trips in spring, summer and autumn from 1997 to 1999. Over 800 voucher collections have been lodged in the Western Australian Herbarium. Nomenclature generally follows Green (1985) and current usage at the Western Australian Herbarium (ms indicates manuscript name, * indicates an introduced taxon).

Current vegetation patterns and aerial photographs were compared with oblique aerial photography of many of the reserves taken by J.A.K. Lane in 1980. This allowed a qualitative assessment of vegetation change within the reserves over the last 19 years.

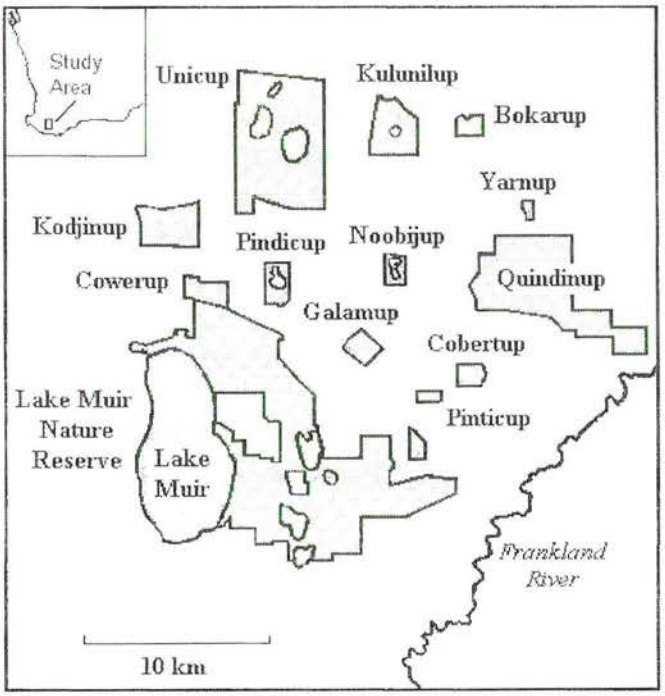

Figure 1. Location map showing the 13 reserves that make up the Byenup-Muir reserve system.

RESULTS AND DISCUSSION

Flora

Reserve summaries, new vegetation mapping and flora lists for the 13 reserves of the Byenup-Muir wetland system are given in Appendix 1. A total of 976 taxa were recorded from the 13 reserves (Appendix 2), of these 862 were native and 114 were introduced. The most species-rich native families were the Orchidaceae (70 taxa), Cyperaceae (65 taxa), Myrtaceae (60 taxa), Proteaceae and Papilionaceae (52 taxa), Asteraceae (50 taxa) and Stylidiaceae (36 taxa). The families with the most introduced taxa were Poaceae (22 taxa), Asteraceae (18 taxa) and the Papilionaceae (12 taxa).

During the survey three taxa listed as Declared Rare Flora (DRF) were recorded from the area, as were 33 taxa listed on CALM's priority flora list (Atkins 1998; Table 1). This is a considerable increase in the number of priority flora previously reported (three DRF and four priority species–CALM 1998).

This is a rich flora for such a small area: it is more than 10 per cent of that recorded for the south-west, about half that recorded for Fitzgerald River National Park (Newbey and McQuoid 1997) and more than that known for Lesueur National Park (Griffin *et al.* 1990). Both the latter areas are major centres of biodiversity in south-west WA (Table 2). The reasons for such diversity in the Byenup-Muir area probably relate to complexes of soil types and hydrological patterns (both local and regional) found over short distances relating to the blockage of major drainage patterns during the Tertiary and subsequent infilling of the plain (Chakravartula and Street 1999). The complex of vegetation patterning is also related to these patterns (particularly period of inundation, and quality of ground water) as well as fire history, although much detailed work would be required to demonstrate these correlations.

TABLE 1

Rare and priority flora recorded from the Byenup-Muir wetland reserves (DRF = Declared Rare Flora, 1–4 = priority flora listing—after Atkins 1998)

TAXON	PRIORITY LISTING
Amphibromus vickeryae	1
Anthotium junciforme	4
Apodasmia ceramophila ms	2
Caladenia christineae ms	DRF
Caladenia harringtoniae ms	DRF
Caladenia starteorum ms	2
Caustis sp. Boyanup (*G.S. McCutcheon* 1706)	1
Diuris drummondii	DRF
Dryandra porrecta	4
Eryngium sp. Lake Muir (*E. Wittwer* 2293)	1
Eucalyptus aspersa	4
Eucalyptus latens	4
Euchiton gymnocephalus	3
Euphrasia scabra	2
Gratiola pedunculata	2
Hibbertia silvestris	4
Hydatella australis	1
Jacksonia sparsa ms	3
Leucopogon lasiophyllus	2
Leucopogon tamariscinus	2
Lilaeopsis polyantha	2
Melaleuca pritzelii	2
Opercularia rubioides	2
Phyllangium palustre	2
Pithocarpa corymbulosa	2
Pterostylis turfosa	1
Rhodanthe pyrethrum	3
Schoenus benthamii	3
Schoenus capillifolius	2
Schoenus loliaceus	2
Schoenus natans	4
Stylidium lepidum	3
Stylidium mimeticum	3
Stylidium rhipidium	1
Synaphea decumbens	1
Tribonanthes sp. Lake Muir (*GJK & NG* 2387)	Recommended P4
Villarsia submersa	4

TABLE 2

Comparison of species richness of the Byenup-Muir wetland reserves with Fitzgerald River National Park and Lesueur National Park.

	AREA (ha)	NUMBER OF TAXA RECORDED
13 Byenup-Muir wetland reserves	19 888	976
Fitzgerald River National Park	329 000	1883
Lesueur National Park	26 978	821

The area was remarkable for the number of threatened or poorly known taxa recorded (Table 1). Of particular note were *Euphrasia scabra, Lilaeopsis polyantha, Schoenus natans, Eryngium* sp. Lake Muir (*E Wittwer* 2293), and *Tribonanthes* sp. Lake Muir (*GJK & NG* 2387).

Euphrasia scabra and *Lilaeopsis polyantha* are known in WA only from the Byenup-Lake Muir area. *E. scabra* was widespread in the eastern States but is now considered extinct in New South Wales and South Australia, many populations in Victoria and Tasmania have disappeared and the remaining ones are declining badly (Thompson 1992; Gilfedder and Kirkpartick 1995; Gilfedder and Kirkpatrick 1997). Two large populations of this taxon were located during the course of this work, both appear in good health.

Schoenus natans is an aquatic sedge that was believed to be extinct until it was rediscovered on the Swan Coastal Plain in the early 1990s when it was listed as Declared Rare Flora (Keighery and Keighery 1996). It was subsequently found in a number of clay-based wetlands on the plain and the adjacent Darling Scarp. During the present survey large populations of this taxon were found in five of the nature reserves. This taxon was subsequently taken off the DRF list.

Two taxa appear to be endemic to the Byenup-Muir wetland reserves: *Eryngium* sp. Lake Muir (*E. Wittwer* 2293), and *Tribonanthes* sp. Lake Muir (*GJK & NG* 2387). Both taxa occur on winter-wet clay flats. While the *Eryngium* has been recognized for some time the *Tribonanthes* appears to be a previously unrecognized taxon. It is recommended that it be listed on CALM's priority flora list as a Priority 4 taxon, given its widespread occurrence in clay wetlands within the reserve system.

Vegetation

More than 30 different structural vegetation units were used to map nine nature reserves. The general pattern found was that of complex mosaics and gradational change as previously reported by Griffin (1984). Initially mapping was undertaken using the same map units as earlier mapping of Unicup, Kulunilup and Yarnup Nature Reserves (Griffin 1984). It was found that some of these units were too heterogenous to map reliably. Final map units chosen are generally comparable with the earlier work and correlations are made in relevant sections of Appendix 1.

Major vegetation patterning appears to be related to soil type, period of inundation, quality and type of ground water, and fire history. The complex hydrology of the area is evident in reserves such as Unicup where saline and freshwater plant communities occur on the same wetland. The occurrence of a patch of *Baumea articulata* on the eastern side of Little Unicup in an otherwise saline lake implies the occurrence of a freshwater spring (Froend and McComb 1991). Similar patterning is seen in other lakes in Unicup and Pindicup Nature Reserves. In both these reserves saline wetlands (presumably in contact with saline ground water) and freshwater wetlands (presumably fed by perched aquifers) can occur within very short distances of each other.

Considerable change in vegetation communities can be noted since J.A.K. Lane took a series of oblique aerial photographs of many of the reserves in 1980. These changes have not been restricted to the margins of the basin wetlands but also affect damplands and sumplands (primarily wet heath communities).

Of the 10 basin wetlands dominated by *Baumea* sedgeland photographed in 1980 five (Cobertup, Kulunilup, Pindicup, Pinticup and Yarnup) show no obvious change when compared with recent aerial photographs. In three wetlands (Galamup, Kodjinup, and Noobijup) the density of the *Baumea* appears to have dropped but the area of open water shows little change. At Bokarup Swamp the cover of *Baumea* sedgeland has decreased by about 50 per cent. Associated with this dramatic change is the almost complete replacement of a *Melaleuca lateritia* wet heath in the eastern wetland by open water. The 1980 photographs show the wet heath beginning to die from the centre of the wetland suggesting that a rise in water table rather than fire has precipitated this change (Fig. 2).

Figure 2. A view looking south across the eastern wetland in Bokarup Nature Reserve taken in 1980. Note the death of the wet heath in the centre of the wetland. By 1999 the wet heath had been relaced by open water except for a narrow band on the eastern boundary. (Photo JAK Lane).

Lane's 1980 photography of Byenup Lagoon shows extensive areas of *Baumea* sedgeland in good condition interspersed by small patches of open water and clumps of *Melaleuca* forming small 'islands'. The October 1995 aerial photography appears to show most of the *Baumea* on the western and north-eastern side to be an orange colour, which is indicative of stress. None of the other *Baumea* sedgelands in the Byenup-Muir wetlands shows this pattern on this series of air photographs. Recent aerial inspections of the wetland (January 1999) indicate the *Baumea* no longer appears stressed but does appear to be less dense in some areas. Salinity levels reached an 8-year peak (and water levels an 8-year low) in Byenup Lagoon in 1995 (J.A.K. Lane[1] personal communication). It would be instructive to compile a time sequence of photographs covering the period 1985–1999 to determine whether the health of the *Baumea* sedgeland of Byenup Lagoon is correlated with salinity levels.

The seasonally inundated clay flats (sumplands) on the west side of Noobijup Nature Reserve also show severe impacts of a rising saline water table dating from 1980. In the 1980 photographs much of the private property on the eastern side of Noobijup had just been cleared and the wet clay flats were in excellent condition. Subsequent hydrological changes have resulted in significant death of both the tree and understorey layers over an extensive area in the reserve. Urgent remedial action is required to stop these impacts in the highly diverse Noobijup clay flats communities.

A salt scald has also developed on the west side of Yarnup Nature Reserve since 1980. Halse *et al.* (1993) report that this was first observed about 1988. Surprisingly, the October 1995 aerial photography shows no obvious change since 1980 in the density of the *Baumea* sedgeland in this reserve.

The observed changes seen in the *Baumea* sedgelands and wet heath communities are consistent with increases in salinity and/or water table depth (Froend and McComb 1991). The comparison of aerial photography is imprecise and subtle changes may not be apparent from these comparisons. What is clear is that there has been significant change to a number of the wetlands since 1980 and in all cases this change has been toward wetland degradation.

Significant degradation has also occurred on the *Banksia ilicifolia* woodlands (damplands) in Kodjinup Nature Reserve since 1993 as the result of installation of an approved drain (CALM 1998; Appendix 2). The drain, constructed through the central part of the reserve, has caused massive deaths of *Banksia ilicifolia* woodland and associated heath species as a result of *Phytophthora* (dieback) spread. This impact is being monitored by a series of photopoints (22 March 1997) laid along a 50-m transect perpendicular to the drain. Changes in inundation owing to drain construction have also resulted in death to small areas of jarrah woodland. The northern (upslope) section of the drain was constructed through what appear to be areas of old dieback infections.

[1] J.A.K.Lane, CALM, Busselton.

The nature conservation values of Kodjinup Nature Reserve have been severely compromised by the construction of this drain. It is clear that detailed biological and dieback assessments should be made in the appropriate season before consideration is given to granting any approval to establish drains into any conservation reserve of the Byenup-Muir system. The dieback hazard of the low-lying areas of the Byenup-Muir reserves system should be considered moderate-to-high. Extensive areas of dead *Banksia ilicifolia* woodland were also observed along the Muir Highway and on the southern boundary of Kodjinup Nature Reserve.

Some degraded vegetation was mapped at the southern end of Lake Muir (Map 5). This was investigated during the aerial survey of the Lake Muir vegetation and appears to be an *Armillaria* infection. This needs to be investigated further.

CONCLUSIONS

The wetlands of the Byenup-Muir reserve system have very high conservation values in terms of total flora diversity, diversity of rare and priority taxa, and diversity of plant communities and their complex mosaic and gradational patterning. This study has shown that the flora of the area is not well known and with further survey work more species will be recorded, especially in Lake Muir Nature Reserve.

The Byenup-Muir wetland system is listed in the Directory of Important Wetlands in Australia (ANCA 1996) under Byenup Lagoon system (including 11 nature reserves) and Lake Muir listings. The flora and vegetation of the Byenup-Muir wetland system would meet at least four Ramsar Convention criteria for listing as Wetlands of International Importance (ANCA 1996). (*Criteria 1a* – it is a particularly good representative example of natural or near natural wetland, characteristic of the appropriate biogeographical region; *Criteria 1d* – it is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region; *Criteria 2a* – it supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species; *Criteria 2d* – it is of special value for one or more endemic plant or animal species or communities.)

There has been significant degradation of some of the wetland areas in the Byenup-Muir system since 1980. The degradation has generally resulted from changes in the hydrological regime or as a result of dieback. Changes in the hydrological regime have resulted from a rising water table, presumably as a consequence of land clearance, or of drainage works. The spread of dieback is correlated with drainage and road works.

The impacts of dieback spread in Kodjinup Nature Reserve since 1993 clearly show how drainage works can have a serious impact on the nature conservation values of a reserve in a short time. Detailed biological survey and dieback mapping are essential before consideration is given to granting approval for any new drainage works in conservation reserves of the Byenup-Muir system.

The designation of the Muir-Unicup catchments as a recovery catchment under the Salinity Action Plan (Government of Western Australia 1996) should provide resources to protect and manage the very significant biodiversity values of this area into the future.

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APPENDIX 1

Descriptions of 13 reserves of the Byenup-Muir reserve system.
(* indicates an introduced taxon, ms indicates a manuscript name)

BOKARUP NATURE RESERVE

Reserve number 14739 **Class** A
Location 34 20 09S 116 49 52E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 146 ha

Biological values

Flora 371 species have been recorded from the reserve (see flora list below). These include four priority taxa (*Jacksonia sparsa* ms (Priority 3), *Schoenus benthamii* (Priority 3), *Schoenus natans* (Priority 4), *Villarsia submersa* (Priority 4)).

Vegetation description Twelve vegetation units have been mapped on the reserve (Map 1).

1. **Jarrah (*Eucalyptus marginata*)-marri (*E. calophylla*) forest and woodlands** on laterites and lateritic gravels cover most of the reserve. The understorey is diverse in shrubs, herbs and grasses. Typical understorey shrubs include *Hibbertia* spp., *Leucopogon* spp. and peas such as *Bossiaea* spp., *Daviesia* spp. and *Gompholobium* spp.

2. **Jarrah-marri open woodlands** occupy the sand dune between the large wetlands. Typical understorey species include *Phyllanthus calycinus* and *Hakea ruscifolia* with *Centrolepis* spp. and *Johnsonia* spp. being the common herbs.

3. ***Melaleuca preissiana-Banksia littoralis* woodland** occurred along the drainage lines on the western side of the reserve. *Pericalymma ellipticum* and *Lepidosperma longitudinale* were the dominant understorey species.

4. ***Melaleuca preissiana-Eucalyptus rudis* woodland** occurred on seasonally wet flats on the transition zones between the drainage lines and wetlands, and the jarrah-marri woodlands on the laterites. Again *Lepidosperma longitudinale* was the common understorey species.

5. ***Melaleuca rhaphiophylla* low forest** surrounds the major wetland on the eastern side of the reserve, at the western end of Bokarup Swamp and a small swamp on the northern boundary. These areas are inundated for long periods in winter and spring and the dense overstorey precludes development of any significant understorey layer.

6. ***Melaleuca rhaphiophylla* open woodland** was found on less inundated areas than the previous unit. *Eucalyptus rudis* was also recorded from this community, while the understorey was generally dominated by *Lepidosperma longitudinale* and/or *Pericalymma ellipticum*.

7. **Wet heath** along the south-western shore of the eastern wetland. This unit was dominated by *Melaleuca lateritia* and once dominated this wetland. A visit in late summer showed the remains of an old post and rail fence line crossing the lake and extending into the upland vegetation on the eastern side of the lake.

8. ***Baumea* sedgeland** covered about half of Bokarup Swamp. This community was very species-poor, with *Baumea articulata* dominating in deeper water and *Baumea vaginalis, B. juncea* and *Villarsia albiflora* co-dominating in shallows near shore.

9. ***Acacia dealbata* thicket** occurs near the northern boundary of Bokarup Swamp on the edge of the cleared area. This introduced species appears to be the result of early rehabilitation efforts. There was little understorey under the dense canopy.

10. **Revegetation** of mostly planted eucalypt occurs in the north-west corner of the reserve.

11. **Cleared area** largely dominated by annual grasses occur in the same area as units 9 and 10. The northern end of the dune between the two major wetlands has also been cleared.

12. **Open water** dominates all of the eastern wetland and approximately half the Bokarup Swamp.

Vegetation change Oblique aerial photographs from April 1980 show the eastern wetland almost totally covered by a *Melaleuca lateritia* wet heath community, this is currently open water (Map 1). The heath appears to be dying from the centre in the 1980 photography. The same series of photographs show Bokarup Swamp itself was fully covered with *Baumea* sedgeland approximately half of which is now open water. The only revegetation work obvious on the 1980 photography was the *Acacia dealbata* thicket.

Disturbance or threats The cause of the major change in the wetland vegetation in this reserve is not clear but appears to have resulted from a rising water table. The occurrence of the *Acacia dealbata* thicket represents a significant potential weed threat and should be removed as soon as possible.

Bokarup Nature Reserve flora list.

Aizoaceae
- Carpobrotus modestus

Amaranthaceae
- Alternanthera nodiflora
- Ptilotus manglesii

Amaryllidaceae
- * Amaryllis belladonna

Anthericaceae
- Agrostocrinum scabrum
- Arthropodium capillipes
- Arthropodium preissii
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Chamaescilla spiralis
- Johnsonia acaulis
- Johnsonia lupulina
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus patersonii
- Thysanotus tenellus
- Thysanotus thyrsoideus
- Thysanotus triandrus
- Tricoryne elatior
- Tricoryne humilis

Apiaceae
- Daucus glochidiatus
- Eryngium pinnatifidum
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle diantha
- Hydrocotyle pilifera
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- Angianthus tomentosus
- * Arctotheca calendula
- * Aster subulatus
- Blennospora drummondii
- Brachyscome iberidifolia
- * Carduus pycnocephalus
- * Cirsium vulgare
- * Conyza albida
- Cotula coronopifolia
- Cotula cotuloides
- Craspedia variabilis
- Euchiton gymnocephalus
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia myosotidifolia
- Podolepis gracilis
- Podotheca angustifolia
- Pterochaeta paniculata
- Quinetia urvillei
- Senecio glomeratus
- Senecio minimus
- Senecio picridioides
- Siloxerus humifusus
- * Sonchus hydrophilus
- * Sonchus oleraceus
- * Tolpis barbata
- * Vellereophyton dealbatum
- Waitzia nitida

Brassicaceae
- * Sisymbrium officinale

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii

Caryophyllaceae
- * Cerastium glomeratum
- * Petrorhagia velutina

Casuarinaceae
- Allocasuarina humilis

Centrolepidaceae
- Aphelia cyperoides
- Brizula drummondii
- Centrolepis aristata
- Centrolepis glabra
- Centrolepis pilosa
- Centrolepis polygyna

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Wurmbea dioica ssp. alba

Convolvulaceae
- Dichondra repens

Crassulaceae
- Crassula colorata
- Crassula exserta
- * Crassula natans

Cyperaceae
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus eragrostis
- * Cyperus tenellus
- Isolepis cernua
- * Isolepis marginata
- Isolepis nodosa
- Isolepis oldfieldiana
- * Isolepis prolifera
- Isolepis stellata
- Lepidosperma aff. angustatum
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma tenue
- Mesomelaena tetragona
- Schoenus benthamii
- Schoenus curvifolius
- Schoenus elegans
- Schoenus natans
- Schoenus tenellus
- Tetraria capillaris
- Tetraria octandra

Dasypogonaceae
- Chamaexeros serra
- Dasypogon bromeliifolius
- Lomandra caespitosa
- Lomandra nigricans
- Lomandra purpurea
- Lomandra sericea
- Lomandra suaveolens

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia acerosa
- Hibbertia commutata
- Hibbertia cunninghamii
- Hibbertia racemosa
- Hibbertia stellaris
- Hibbertia vaginata

Droseraceae
- Drosera erythrorhiza
- Drosera glanduligera
- Drosera macrantha
- Drosera menziesii
- Drosera rosulata
- Drosera stolonifera

Epacridaceae
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum

Leucopogon australis
Leucopogon capitellatus
Leucopogon conostephioides
Euphorbiaceae
Monotaxis occidentalis
Phyllanthus calycinus
Poranthera microphylla
Gentianaceae
* Cicendia filiformis
Geraniaceae
Geranium solanderi
Pelargonium littorale
Goodeniaceae
Anthotium humile
Dampiera alata
Dampiera cuneata
Dampiera linearis
Goodenia micrantha
Goodenia pulchella
Scaevola phlebopetala
Velleia trinervis
Haemodoraceae
Anigozanthos flavidus
Anigozanthos manglesii
Conostylis aculeata
Conostylis laxiflora
Conostylis setigera
Haemodorum laxum
Haemodorum simplex
Haemodorum sparsiflorum
Haemodorum spicatum
Tribonanthes violacea
Haloragaceae
Gonocarpus cordiger
Hydatellaceae
Trithuria bibracteata
Hypoxidaceae
Hypoxis occidentalis
Iridaceae
* Iris germanica
Patersonia juncea
Patersonia occidentalis
Patersonia occidentalis (swamp form)
* Romulea rosea
* Watsonia bulbillifera
Juncaceae
* Juncus bufonius
* Juncus capitatus
Juncus holoschoenus
Juncus pallidus
Juncaginaceae
Triglochin centrocarpum
Triglochin huegelii
Triglochin lineare
Triglochin mucronatum
Lamiaceae
Hemiandra pungens
Lauraceae
Cassytha glabella
Cassytha racemosa
Lentibulariaceae
Polypompholyx multifida
Utricularia inaequalis
Linaceae
Linum marginale
Lindsaeaceae
Lindsaea linearis
Lobeliaceae
Isotoma hypocrateriformis
Lobelia alata
Lobelia tenuior
Loganiaceae
Logania campanulata
Logania serpyllifolia
Phyllangium paradoxum
Lycopodiaceae
Phylloglossum drummondii
Lythraceae
* Lythrum hyssopifolia
Menyanthaceae
Villarsia albiflora
Villarsia submersa
Villarsia ?violifolia
Mimosaceae
* Acacia dealbata
Acacia extensa
Acacia huegelii
Acacia incurva
Acacia myrtifolia
Acacia pulchella
Acacia saligna
Myoporaceae
Myoporum caprarioides
Myrtaceae
Agonis parviceps
Astartea fascicularis
Astartea sp.
Baeckea camphorosmae
Calothamnus lateralis
Eucalyptus calophylla
Eucalyptus decipiens
Eucalyptus marginata
Eucalyptus occidentalis
Eucalyptus rudis
Eucalyptus wandoo
Kunzea micrantha
Kunzea recurva
Melaleuca lateritia
Melaleuca leptoclada
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca viminea
Pericalymma ellipticum
Olacaceae
Olax benthamiana
Onagraceae
Epilobium billardierianum
Orchidaceae
Caladenia flava
Caladenia longicauda
Caladenia marginata
Caladenia radiata
Caladenia reptans
Caladenia varians
Cryptostylis ovata
Cyrtostylis robusta
Diuris laxiflora
Diuris longifolia
Drakonorchis barbarossa ms
Elythranthera brunonis
Elythranthera emarginata
Leporella fimbriata
Leptoceras menziesii
Microtis atrata
Microtis orbicularis
* Monadenia bracteata
Pterostylis barbata
Pterostylis nana
Pterostylis recurva
Pterostylis vittata
Pyrorchis nigricans
Thelymitra crinita
Thelymitra flexuosa
Thelymitra pauciflora
Orobanchaceae
* Orobanche minor
Papilionaceae
Aotus intermedia
Bossiaea eriocarpa
Bossiaea ornata
Bossiaea praetermissa

Brachysema melanopetalum
Callistachys lanceolata
Daviesia cordata
Daviesia physodes
Daviesia preissii
Eutaxia virgata
Gompholobium marginatum
Gompholobium polymorphum
Gompholobium preissii
Gompholobium tomentosum
Hovea chorizemifolia
Hovea trisperma var. grandiflora
Isotropis cuneifolia
Jacksonia sparsa ms
Kennedia coccinea
Kennedia prostrata
* Lotus angustissimus
Oxylobium lineare
Pultenaea ochreata
Sphaerolobium medium
* Trifolium campestre
* Trifolium dubium
* Trifolium repens
* Trifolium subterraneum

Philydraceae
Philydrella pygmaea

Phormiaceae
Dianella brevicaulis
Dianella revoluta
Stypandra glauca

Pittosporaceae
Billardiera variifolia
Marianthus candidus
Sollya heterophylla

Plantaginaceae
Plantago debilis

Poaceae
Agrostis avenacea
* Aira caryophyllea
Amphipogon turbinatus
* Anthoxanthum odoratum
Austrodanthonia occidentalis
Austrostipa pycnostachya
Austrostipa ?trichophylla
* Briza maxima
* Briza minor
* Cynodon dactylon
Deyeuxia quadriseta
Eragrostis elongata
Hemarthria uncinata
* Holcus lanatus
* Hordeum leporinum
* Lolium multiflorum
Microlaena stipoides
Poa poiformis
* Stenotaphrum secundatum
Tetrarrhena laevis
* Vulpia myuros

Polygalaceae
Comesperma calymega
Comesperma flavum
Comesperma virgatum
Comesperma volubile

Polygonaceae
Muehlenbeckia adpressa
Persicaria prostrata
* Rumex acetosella

Primulaceae
* Anagallis arvensis

Proteaceae
Banksia grandis
Banksia littoralis
Dryandra lindleyana
Grevillea fasciculata
Hakea ceratophylla
Hakea lissocarpha
Hakea prostrata
Hakea ruscifolia
Hakea sulcata
Hakea trifurcata
Hakea varia
Persoonia longifolia
Petrophile media
Petrophile serruriae
Synaphea petiolaris

Ranunculaceae
Ranunculus colonorum

Restionaceae
Anarthria laevis
Anarthria prolifera
Harperia lateriflora
Hypolaena exsulca
Lepyrodia muirii
Lyginia barbata
Meeboldina cana ms
Meeboldina tephrina ms

Rhamnaceae
Trymalium ledifolium

Rosaceae
* Acaena echinata

Rubiaceae
* Galium murale
Opercularia apiciflora
Opercularia hispidula

Rutaceae
Boronia megastigma
Boronia ramosa
Boronia spathulata

Santalaceae
Leptomeria squarrulosa

Scrophulariaceae
* Bartsia trixago
* Parentucellia latifolia
* Parentucellia viscosa

Selaginellaceae
Selaginella gracillima

Solanaceae
* Solanum nigrum

Stackhousiaceae
Stackhousia monogyna
Tripterococcus brunonis

Stylidiaceae
Levenhookia pusilla
Levenhookia stipitata
Stylidium affine
Stylidium assimile
Stylidium brunonianum ssp. minor
Stylidium calcaratum
Stylidium ecorne
Stylidium guttatum
Stylidium hispidum
Stylidium junceum
Stylidium repens
Stylidium schoenoides
Stylidium spathulatum

Thymelaeaceae
Pimelea angustifolia
Pimelea argentea
Pimelea sylvestris

Tremandraceae
Platytheca galioides

Typhaceae
* Typha orientalis

Xanthorrhoeaceae
Xanthorrhoea preissii

Zamiaceae
Macrozamia riedlei

COBERTUP NATURE RESERVE

Reserve number 26681 **Class** A
Location 34 27 23S 116 49 50E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 151 ha

Biological values

Flora 370 taxa were recorded from the reserve (see flora list below). These include two priority taxa (*Apodasmia ceramophila* ms (Priority 2) and *Rhodanthe pyrethrum* (Priority 3)).

Vegetation description Ten vegetation units have been mapped on the reserve (Map 2).

1. **Jarrah-marri forest and woodland** on laterite occupies the higher ground in the north-west, north-east and south-west corners of the reserve. The understorey is diverse in shrubs, herbs and grasses. Typical understorey shrubs include *Hibbertia* spp., *Leucopogon* spp. and peas such as *Bossiaea* spp., *Daviesia* spp. and *Gompholobium* spp.

2. **Jarrah-marri open woodland** occupies the dune areas around the major swamps. The understorey is dominated by species such as *Phyllanthus calycinus, Allocasuarina humilis, Desmocladus flexuosus, Hypolaena exsulca,* and *Lyginia barbata,* taxa typical of sandy substrates. Yate (*Eucalyptus occidentalis)* was common on ecotone between this unit and the clay flats (vegetation unit 8).

3. ***Melaleuca preissiana* woodland** occurs in the south-eastern corner of the reserve. In the wettest areas *Banksia littoralis* is a co-dominant. Common understorey species include *Hakea varia, Gonocarpus paniculatus,* and *Hemarthria uncinata.* This area was recently burnt in a hot fire.

4. ***Eucalyptus decipiens* woodland** occurs on the northern boundary of the reserve, common elements in the understorey include *Xanthorrhoea preissii, Hypocalymma angustifolium,* and the sedges *Mesomelaena tetragona* and *Tetraria octandra*

5. ***Melaleuca rhaphiophylla* woodland** occurs as a band around the major *Baumea* swamps and intergrades into *Melaleuca preissiana* woodland in the south-east corner of the reserve. The dominant understorey species is *Lepidosperma longitudinale.*

6. ***Melaleuca rhaphiophylla* woodland over wet heath** has also recently been burnt but appears similar in species composition to vegetation unit 8 (heathland on clay flats) with an open overstorey of *Melaleuca rhaphiophylla.*

7. ***Melaleuca lateritia-Hakea varia* heath** has been recently burnt in a hot fire. Most shrubs were killed and are regenerating from seed. *Lepidosperma longitudinale* has resprouted and is the dominant species at this time.

8. **Heathland** on clay flats are variously dominated by *Melaleuca viminea, Melaleuca densa, Kunzea micrantha* and *Astartea* sp. over a very rich and diverse herb layer including taxa such as *Rhodanthe pyrethrum, Hyalosperma simplex, Caesia micrantha, Burchardia congesta, Wurmbea dioica, Goodenia mimuloides,* and *Tribonanthes* sp. Lake Muir, rushes and annual sedges are also prolific in the understorey.

9. **Open *Baumea* sedgeland** occupies the western swamp, this community is very species-poor being dominated by *Baumea articulata.* Other sedges occurring in this sedgeland include *Baumea arthrophylla* and *B. juncea.*

10. **Closed *Baumea* sedgeland** occupies the eastern swamp with essentially the same species composition as vegetation unit 9, however, *Baumea* spp. cover is denser.

Vegetation change Oblique aerial photographs from April 1980 show that although there has been considerable vegetation clearance in the area around Cobertup Nature Reserve there are no obvious large scale changes to the vegetation.

Disturbance or threats On the northern boundary where run off from a dam is providing extra nutrients on the clay flat there has been considerable weed invasion. Management of this run-off is urgently needed. Further monitoring of the reserve is needed to determine whether vegetation communities are stable given the recent nature clearance of the adjoining lands.

Cobertup Nature Reserve flora list.

Amaranthaceae
- Ptilotus drummondii
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Arthropodium preissii
- Borya sphaerocephala
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Chamaescilla ?spiralis
- Johnsonia lupulina
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus manglesianus
- Thysanotus sparteus
- Thysanotus tenellus
- Tricoryne elatior
- Tricoryne humilis

Apiaceae
- Daucus glochidiatus
- Eryngium pinnatifidum
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle diantha
- Hydrocotyle pilifera var. glabrata
- Hydrocotyle sp.
- Platysace juncea
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- * Arctotheca calendula
- Asteridea athrixioides
- * Cirsium vulgare
- Cotula coronopifolia
- Craspedia variabilis
- Hyalosperma simplex
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia myosotidifolia
- Podolepis gracilis
- Quinetia urvillei
- Rhodanthe pyrethrum
- Rutidosis multiflora
- Senecio glomeratus
- Senecio minimus
- Siloxerus humifusus
- * Sonchus asper
- * Sonchus oleraceus
- Trichocline spathulata
- * Ursinia anthemoides
- * Vellereophyton dealbatum
- Waitzia nitida
- Waitzia suaveolens

Campanulaceae
- Wahlenbergia gracilenta
- Wahlenbergia preissii

Caryophyllaceae
- * Petrorhagia velutina

Casuarinaceae
- Allocasuarina humilis
- Allocasuarina lehmanniana

Centrolepidaceae
- Aphelia cyperoides
- Brizula drummondii
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis glabra

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Burchardia multiflora
- Wurmbea dioica

Crassulaceae
- Crassula colorata
- * Crassula decumbens
- Crassula peduncularis

Cyperaceae
- Baumea arthrophylla
- Baumea articulata
- Baumea juncea
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Gahnia aristata
- Gahnia trifida
- Isolepis cernua
- * Isolepis marginata
- Isolepis nodosa
- Isolepis oldfieldiana
- Isolepis producta
- Lepidosperma angustatum
- Lepidosperma sp.
- Lepidosperma tenue
- Mesomelaena stygia
- Mesomelaena tetragona
- Schoenus bifidus
- Schoenus curvifolius
- Schoenus laevigatus
- Schoenus obtusifolius
- Schoenus sculptus
- Schoenus sp.
- Schoenus ?tenellus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii var. neesii

Dasypogonaceae
- Chamaexeros serra
- Dasypogon bromeliifolius
- Lomandra caespitosa
- Lomandra hermaphrodita
- Lomandra micrantha
- Lomandra purpurea
- Lomandra sericea
- Lomandra suaveolens

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia ?acerosa
- Hibbertia ?commutata
- Hibbertia cunninghamii
- Hibbertia gracilipes
- Hibbertia racemosa
- Hibbertia stellaris

Droseraceae
- Drosera bulbosa
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera macrantha
- Drosera menziesii
- Drosera stolonifera

Epacridaceae
- Astroloma ciliatum
- Astroloma pallidum
- Leucopogon capitellatus
- Leucopogon conostephioides
- Leucopogon propinquus

Euphorbiaceae
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera microphylla

Gentianaceae
- * Centaurium erythraea
- * Cicendia filiformis

Geraniaceae
- Geranium solanderi
- Pelargonium littorale

Goodeniaceae
- Anthotium humile
- Dampiera alata
- Dampiera linearis
- Dampiera trigona
- Goodenia micrantha
- Goodenia mimuloides
- Goodenia pulchella
- Lechenaultia formosa
- Scaevola phlebopetala
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos flavidus
- Anigozanthos manglesii
- Conostylis aculeata
- Conostylis setigera
- Haemodorum laxum
- Haemodorum simplex
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Tribonanthes australis
- Tribonanthes longipetala
- Tribonanthes sp. Lake Muir
- Tribonanthes violacea

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus paniculatus
- Haloragis brownii
- Myriophyllum crispatum
- Myriophyllum limnophilum

Hydatellaceae
- Hydatella sp
- Trithuria submersa

Hypoxidaceae
- Hypoxis occidentalis

Iridaceae
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)

Isoetaceae
- Isoetes drummondii

Juncaceae
- * Juncus articulatus
- * Juncus bufonius
- * Juncus capitatus
- Juncus pallidus
- Juncus planifolius

Juncaginaceae
- Triglochin huegelii
- Triglochin sp.

Lauraceae
- Cassytha glabella
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Utricularia hookeri

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Grammatotheca bergiana
- Isotoma hypocrateriformis
- Lobelia alata
- Lobelia heterophylla
- Lobelia rhombifolia

Loganiaceae
- Logania campanulata
- Logania serpyllifolia
- Phyllangium paradoxum

Lythraceae
- * Lythrum hyssopifolia

Menyanthaceae
- Villarsia albiflora
- Villarsia parnassifolia

Mimosaceae
- Acacia alata
- Acacia extensa
- Acacia huegelii
- Acacia incurva
- Acacia myrtifolia
- Acacia nervosa
- Acacia pulchella
- Acacia saligna
- Acacia stenoptera

Myoporaceae
- Myoporum caprarioides

Myrtaceae
- Astartea fascicularis
- Astartea sp. (pink weeping)
- Baeckea camphorosmae
- Calothamnus lateralis
- Calytrix angulata
- Eucalyptus calophylla
- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus occidentalis
- Eucalyptus patens
- Eucalyptus rudis
- Hypocalymma angustifolium
- Kunzea ericifolia
- Kunzea micrantha
- Melaleuca densa
- Melaleuca lateritia
- Melaleuca leptoclada
- Melaleuca preissiana
- Melaleuca rhaphiophylla
- Melaleuca spathulata
- Melaleuca viminea
- Pericalymma ellipticum
- Verticordia densiflora
- Verticordia habrantha

Olacaceae
- Olax benthamiana

Onagraceae
- Epilobium billardierianum
- Epilobium hirtigerum

Orchidaceae
- Caladenia flava
- Caladenia longicauda
- Caladenia radiata
- Caladenia reptans
- Diuris laxiflora
- Diuris longifolia
- Elythranthera brunonis
- Elythranthera emarginata
- Eriochilus dilatatus
- Microtis atrata
- Microtis media
- Microtis orbicularis
- * Monadenia bracteata
- Prasophyllum macrostachyum
- Pterostylis nana
- Pterostylis recurva
- Pterostylis vittata
- Thelymitra crinita
- Thelymitra flexuosa

Orobanchaceae
- * Orobanche minor

Oxalidaceae
- Oxalis perennans

Papilionaceae
- Bossiaea eriocarpa
- Bossiaea linophylla
- Bossiaea ornata
- Brachysema praemorsum
- Callistachys lanceolata
- Chorizema nanum
- Daviesia ?incrassata
- Daviesia preissii

- Eutaxia virgata
- Gompholobium knightianum
- Gompholobium marginatum
- Gompholobium polymorphum
- Gompholobium preissii
- Gompholobium tomentosum
- Goodia lotifolia
- Hovea chorizemifolia
- Hovea trisperma
- Isotropis cuneifolia
- Jacksonia furcellata
- Kennedia coccinea
- Kennedia prostrata
- * Lotus angustissimus
- Oxylobium lineare
- Sphaerolobium linophyllum
- Sphaerolobium medium
- Sphaerolobium ?vimineum
- Viminaria juncea

Philydraceae
- Philydrella drummondii
- Philydrella pygmaea

Phormiaceae
- Dianella brevicaulis
- Dianella revoluta
- Stypandra glauca

Pittosporaceae
- Sollya heterophylla

Poaceae
- Agrostis avenacea
- Amphibromus nervosus
- Amphipogon ?debilis
- Amphipogon turbinatus
- Austrodanthonia caespitosa
- Austrostipa compressa
- Austrostipa ?pycnostachya
- Austrostipa trichophylla
- * Briza minor
- Deyeuxia quadriseta
- Eragrostis ?brownii
- Hemarthria uncinata
- * Lolium multiflorum
- Microlaena stipoides
- Neurachne alopecuroidea
- * Poa annua
- Poa drummondiana
- Poa poiformis
- * Polypogon monspeliensis
- Tetrarrhena laevis
- * Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma virgatum
- Comesperma volubile

Polygonaceae
- Muehlenbeckia adpressa
- Persicaria prostrata

Portulacaceae
- Calandrinia ?composita
- Calandrinia granulifera

Primulaceae
- * Anagallis arvensis
- Samolus junceus

Proteaceae
- Banksia littoralis
- Dryandra armata
- Dryandra lindleyana
- Grevillea fasciculata
- Hakea ceratophylla
- Hakea lissocarpha
- Hakea prostrata
- Hakea sulcata
- Hakea varia
- Persoonia longifolia
- Synaphea petiolaris

Ranunculaceae
- Clematis pubescens
- Ranunculus colonorum

Restionaceae
- Anarthria prolifera
- Apodasmia ceramophila ms
- Chordifex sp.
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Harperia lateriflora
- Hypolaena exsulca
- Lyginia barbata
- Meeboldina cana ms

Rhamnaceae
- Trymalium ledifolium

Rosaceae
- * Acaena echinata

Rubiaceae
- * Galium divaricatum
- Opercularia hispidula
- Opercularia vaginata

Rutaceae
- Boronia juncea ssp. ?laniflora
- Boronia megastigma
- Boronia spathulata

Santalaceae
- Leptomeria squarrulosa

Scrophulariaceae
- Gratiola peruviana
- Gratiola pedunculata
- * Parentucellia latifolia
- * Parentucellia viscosa

Selaginellaceae
- Selaginella gracillima

Solanaceae
- * Solanum nigrum

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium brunonianum ssp. minor
- Stylidium caespitosum
- Stylidium calcaratum
- Stylidium crassifolium
- Stylidium guttatum
- Stylidium inundatum
- Stylidium perpusillum
- Stylidium pulchellum
- Stylidium sp.
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea ?rosea
- Pimelea suaveolens

Tremandraceae
- Platytheca galioides
- Tetratheca sp.

Typhaceae
- * Typha orientalis

Violaceae
- Hybanthus floribundus

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

COWERUP NATURE RESERVE

Reserve number 33455 **Class** C
Location 34 25 48S 116 25 00E
Land tenure Nature Reserve
Purpose Conservation of flora and fauna
Area 270 ha

Biological values

Flora 185 taxa have been recorded for the reserve (see flora list below). This is likely to seriously underestimate the total flora since only minimal sampling was undertaken when the annuals were conspicuous. Four priority taxa were found (*Rhodanthe pyrethrum* (Priority 3), *Schoenus benthamii* (Priority 3), *Schoenus natans* (Priority 4), and *Villarsia submersa* (Priority 4)).

Vegetation description Cowerup Nature Reserve adjoins the northern boundary of the Lake Muir Nature Reserve. Consequently both reserves were mapped using the same vegetation units. Of the 30 units that occurred in Lake Muir Nature Reserve, eight were found in Cowerup Nature Reserve, one unit was too small to map (Map 5).

1. **Jarrah-marri forest and woodland** on laterite and lateritic gravels occurred as small flat ridges in the sandy jarrah-marri woodlands and could not be distinguished from them on aerial photography. They occurred predominantly on the eastern boundary of the reserve. The understorey is typically diverse in shrubs, herbs and grasses. Typical understorey shrubs include *Hibbertia* spp., *Leucopogon* spp. and peas such as *Bossiaea* spp., *Daviesia* spp. and *Gompholobium* spp.

2. **Jarrah-marri open woodland** on sandy soils occurs widely in the eastern half of the reserve, common understorey species include *Hibbertia racemosa, Astroloma baxteri, Leucopogon* spp., *Phyllanthus calycinus, Acacia pulchella, Jacksonia furcellata*. On wetter sites this community is replaced by jarrah-marri woodland over *Agonis* scrub (unit 3).

3. **Jarrah-marri woodland over *Agonis* scrub** occurs on seasonally wet flats; on slight sandy rises *Banksia ilicifolia* often becomes the dominant canopy species. Understorey development depends on density of the *Agonis* layer.

12. ***Melaleuca cuticularis* woodland over wet heath** forms a distinct unit in the south-western corner of the reserve. The substrate is generally clayey and this unit has a very rich and diverse annual herb layer. The Asteraceae, Centrolepidaceae, Cyperaceae, Orchidaceae, Stylidiaceae are well represented. Common perennial taxa include *Melaleuca* spp., *Kunzea micrantha* and the rushes *Apodasmia ceramophila, Meeboldina coangustata,* and *Meeboldina cana*.

14. ***Melaleuca preissiana* woodland over wet heath** occurs extensively along the wet drainage lines. The understorey is variable in the wettest sites and is generally dominated by *Pericalymma ellipticum.* On drier sites understorey is diverse with peas and Myrtaceae dominating. On the western side of the reserve *Banksia littoralis* takes over as the canopy dominant.

15. ***Melaleuca rhaphiophylla* forest** forms dense stands around the deepest wetland and in the wettest parts of the flats. The understorey is generally dominated by *Lepidosperma* spp. and *Baumea* spp. but where the canopy is more open a variety of shrubs such as *Hypocalymma angustifolium, Pericalymma ellipticum, Callistachys lanceolata, Banksia littoralis, Hakea sulcata* become common.

17. ***Melaleuca densa-M. viminea* heath** occupies drainage lines with sandy clay substrates. These areas are winter-wet and dry slowly in late spring and early summer. In the Lake Muir reserve this type of flat was characterized by aquatic taxa such as *Schoenus natans* and *Villarsia* spp. early in spring giving way to diverse herblands as the wetlands dry.

24. **Closed *Baumea* sedgeland** occupies basin wetlands; *Baumea articulata* is the dominant sedge over most of the wetland, while toward the edge *B. juncea* and *B. vaginalis* co-dominate.

Vegetation change No photographs were taken of this reserve in 1980.

Disturbance or threats The land to the west of the reserve has been cleared for some time. Aerial photography indicates this may have resulted in increased inundation in the wetlands on the western boundary. Recently a new fence and bund has been constructed along this property line. There has been some recent clearance on the south-eastern boundary.

Cowerup Nature Reserve flora list.

Anthericaceae
- Johnsonia acaulis

Apiaceae
- Actinotus omnifertilis
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia huegelii

Asteraceae
- Craspedia sp.
- * Hypochaeris glabra
- Podolepis gracilis
- Rhodanthe pyrethrum
- Senecio glomeratus
- Siloxerus humifusus
- Waitzia suaveolens

Casuarinaceae
- Allocasuarina humilis

Centrolepidaceae
- Brizula drummondii
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis glabra

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Wurmbea dioica

Cupressaceae
- Actinostrobus pyramidalis

Cyperaceae
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Cyathochaeta avenacea
- Gahnia trifida
- Isolepis cernua
- Isolepis stellata
- Lepidosperma angustatum
- Lepidosperma longitudinale
- Mesomelaena tetragona
- Schoenus benthamii
- Schoenus efoliatus
- Schoenus maschalinus
- Schoenus natans
- Schoenus tenellus
- Tetraria octandra
- Tricostularia neesii var. elatior

Dasypogonaceae
- Dasypogon bromeliifolius
- Lomandra purpurea
- Lomandra sericea

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia commutata
- Hibbertia cunninghamii
- Hibbertia racemosa
- Hibbertia stellaris

Epacridaceae
- Astroloma baxteri
- Astroloma ciliatum
- Leucopogon australis
- Leucopogon glabellus
- Leucopogon pendulus
- Leucopogon propinquus
- Lysinema ciliatum

Euphorbiaceae
- Amperea volubilis
- Monotaxis occidentalis

Gentianaceae
- Centaurium spicatum

Goodeniaceae
- Dampiera linearis
- Goodenia claytoniacea
- Goodenia pulchella
- Scaevola phlebopetala

Haemodoraceae
- Conostylis aculeata

Haloragaceae
- Gonocarpus hexandrus ssp.
- Gonocarpus paniculatus
- Myriophyllum ?limnophilum

Iridaceae
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)

Juncaginaceae
- Triglochin huegelii

Lamiaceae
- Hemiandra pungens

Lauraceae
- Cassytha glabella
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Utricularia hookeri
- Utricularia violacea

Lobeliaceae
- Lobelia alata

Loganiaceae
- Phyllangium paradoxum

Loranthaceae
- Nuytsia floribunda

Menyanthaceae
- Villarsia albiflora
- Villarsia submersa

Mimosaceae
- Acacia extensa
- Acacia myrtifolia
- Acacia saligna
- Acacia stenoptera

Myrtaceae
- Actinodium cunninghamii
- Agonis parviceps
- Astartea sp. (pink weeping)
- Astartea sp. (white erect)
- Baeckea camphorosmae
- Calothamnus hirsutus
- Calothamnus lateralis
- Calytrix angulata
- Eucalyptus calophylla
- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus rudis
- Hypocalymma angustifolium
- Kunzea ericifolia
- Kunzea micrantha
- Melaleuca cordata
- Melaleuca cuticularis
- Melaleuca densa
- Melaleuca lateritia
- Melaleuca preissiana
- Melaleuca rhaphiophylla
- Melaleuca spathulata
- Melaleuca thymoides
- Melaleuca viminea
- Melaleuca violacea
- Pericalymma ellipticum
- Verticordia densiflora

Olacaceae
- Olax phyllanthi

Orchidaceae
- Caladenia flava
- Caladenia reptans
- Elythranthera brunonis
- Microtis atrata
- Microtis orbicularis
- Pterostylis nana
- Pterostylis vittata
- Thelymitra pauciflora

Papilionaceae
- Aotus intermedia
- Bossiaea linophylla
- Bossiaea rufa
- Brachysema melanopetalum
- Callistachys lanceolata
- Daviesia physodes
- Gompholobium capitatum
- Jacksonia furcellata
- Kennedia prostrata
- Pultenaea ochreata
- Pultenaea reticulata
- Viminaria juncea

Phormiaceae
- Dianella revoluta

Pittosporaceae
- Marianthus candidus
- Sollya heterophylla

Poaceae
- * Aira caryophyllea
- Amphipogon laguroides
- Austrodanthonia occidentalis
- Austrodanthonia sp.
- Austrostipa compressa
- Austrostipa pycnostachya
- * Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma flavum
- Comesperma volubile

Primulaceae
- Samolus caespitosus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Dryandra lindleyana
- Hakea ceratophylla
- Hakea lissocarpha
- Hakea prostrata
- Hakea ruscifolia
- Hakea sulcata
- Hakea trifurcata
- Hakea undulata
- Hakea varia
- Persoonia longifolia
- Synaphea petiolaris

Restionaceae
- Anarthria laevis
- Anarthria prolifera
- Anarthria scabra
- Desmocladus fasciculatus ms
- Hypolaena exsulca
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina cana ms
- Meeboldina coangustata ms
- Meeboldina denmarkica
- Meeboldina scariosa ms
- Tremulina tremula ms

Rubiaceae
- Opercularia hispidula

Rutaceae
- Boronia juncea ssp. laniflora ms
- Boronia megastigma
- Boronia spathulata

Santalaceae
- Leptomeria spinosa
- Leptomeria squarrulosa

Selaginellaceae
- Selaginella gracillima

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium repens
- Stylidium scandens

Tremandraceae
- Platytheca galioides

Xanthorrhoeaceae
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

GALAMUP NATURE RESERVE

Reserve number 6549 **Class** A
Location 34 26 35S 116 46 10E
Land tenure Nature Reserve
Purpose Conservation of flora and fauna
Area 222 ha

Biological values

Flora 291 taxa and one hybrid have been recorded for the reserve (see flora list below). Eight priority taxa were found (*Caladenia starteorum* ms (Priority 2), *Cryptandra arbutiflora* ssp. *minor* (Priority 1), *Leucopogon lasiophyllus* (Priority 2), *Leucopogon tamariscinus* (Priority 2), *Pterostylis turfosa* (Priority 1), *Schoenus benthamii* (Priority 3), *Schoenus loliaceus* (Priority 2), *Stylidium mimeticum* (Priority 3)). While the hybrid *Caladenia starteorum* x *splendens* was recorded only one of the presumed parents was seen.

Vegetation description Fourteen vegetation units were mapped on the reserve (Map 3).

1. **Jarrah-marri forest and woodland** is the dominant vegetation unit of the reserve, on a mixture of both sandy and lateritic substrates. The gentle topography did not allow different substrates to be mapped. The understorey was diverse and predominantly shrubby.

2. **Jarrah-marri open woodland** on sandy soils in the central part of the reserve had understorey species typical of damplands. The most common of these included *Hypocalymma angustifolium, Kunzea micrantha, Pericalymma ellipticum, Viminaria juncea,* sedge and rushes were also common.

3. **Jarrah-marri open woodland over wet heath** occurred along a drainage line on the north-eastern side of the reserve, with an understorey of scattered *Melaleuca preissiana* and a dense ground layer of *Pericalymma ellipticum* and/or *Agonis parviceps* and sedges such as *Lyginia barbata.* It also occurs in the centre of the reserve where the *Agonis* forms a dense thicket.

4. ***Eucalyptus decipiens* woodland** occurs in the south-eastern corner of the reserve and grades into vegetation unit 11 (heathland on clay flats). The woodland is extremely species-rich with high diversity in shrubs and herbs. Seven species of *Stylidium* were recorded.

5. ***Melaleuca rhaphiophylla-Banksia littoralis* woodland** occurs around the edge of Galamup Swamp. This unit is inundated during the winter and early spring.

6. ***Melaleuca lateritia* heath** occurs in a small basin wetland in the centre of the reserve. Taxa such as *Baumea articulata* and *Lepidosperma longitudinale* co-occur with *M. lateritia* and as the wetland dries diverse annual herbland develops.

7. ***Pericalymma elliptica-Lepidosperma longitudinale* heath** dominates another small basin wetland in the centre of the reserve. This wetland has much lower species richness than vegetation unit 6. *Schoenus loliaceus* was recorded from this wetland. A few scattered *Banksia littoralis* were also found but most have been killed by fire.

8. ***Hakea prostrata* heath** occurs as a series of narrow bands within the jarrah-marri woodland (vegetation unit 1) and appears to represent minor drainage features. Shrubs associated with damplands, as well as sedges and annual herbs, are typical of this unit.

9. ***Baumea* sedgeland** dominates most of Galamup Swamp. *Baumea articulata* is dominant while toward the edge of the wetland *B. juncea* and *B. vaginalis* also occur. In the narrow transition zone between the swamp vegetation and the *Melaleuca rhaphiophylla-Banksia littoralis* woodland an unusual herb-sedgeland dominated by *Drosera glanduligera, Poranthera microphylla, B. juncea* and *Villarsia albiflora* was found.

10. ***Agonis* heath and scrub** occurred along a sandy drainage line in the northern part of the reserve. *Melaleuca thymoides* is a common element of this community.

11. **Wet heath** on clay flats occurs in the southern corner of the reserve. In terms of species composition it is very similar to vegetation unit 4 (*Eucalyptus decipiens* woodland) without the overstorey element.

12. **Wet heath** on sandy substrate occurs in the very centre of the reserve. This heath had a similar species composition to vegetation unit 3 (jarrah-marri woodland over wet heath) without the overstorey element.

13. **Disturbed areas** on the south-western and north-western sides have been used for gravel extraction while the area on the north-eastern boundary is a wet flat degrading as a result of nutrient-rich run-off from a dam across the fence line.

14. **Open water** occurs in the centre of Galamup Swamp.

Vegetation change Oblique aerial photographs from February and April 1980 show a denser *Baumea* sedgeland in Galamup Swamp. No obvious cause is apparent for this change.

Disturbance or threats The changes to Galamup Swamp are of concern, as is the wet heath degradation on the north-eastern boundary which is becoming badly weed-invaded as a result of nutrient-rich run-off from a dam on private property. Further degradation of the wet heath can be expected unless this nutrient run-off is controlled.

Galamup Nature Reserve flora list.

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Johnsonia acaulis
- Johnsonia lupulina
- Sowerbaea laxiflora
- Thysanotus manglesianus
- Thysanotus tenellus
- Tricoryne humilis
- Tricoryne tenella

Apiaceae
- Centella cordifolia
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle pilifera var. glabrata
- Platysace ?juncea
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- Brachyscome iberidifolia
- Craspedia variabilis
- Euchiton gymnocephalus
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia tenuifolia
- Podolepis gracilis
- Pterochaeta paniculata
- Quinetia urvillei
- Senecio glomeratus
- Senecio minimus
- Siloxerus humifusus
- * Sonchus asper
- * Sonchus oleraceus
- Waitzia suaveolens

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii

Casuarinaceae
- Allocasuarina humilis
- Allocasuarina microstachya

Centrolepidaceae
- Aphelia cyperoides
- Centrolepis aristata
- Centrolepis glabra

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Burchardia multiflora

Cyperaceae
- Baumea arthrophylla
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Lepidosperma ?gracile
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma tenue
- Mesomelaena stygia
- Mesomelaena tetragona
- Schoenus benthamii
- Schoenus bifidus
- Schoenus curvifolius
- Schoenus ?humilis
- Schoenus ?loliaceus
- Schoenus odontocarpus
- Schoenus sp.
- Schoenus subbulbosus
- Schoenus unispiculatus
- Tetraria capillaris
- Tetraria octandra

Dasypogonaceae
- Chamaexeros serra
- Dasypogon bromeliifolius
- Lomandra collina
- Lomandra sericea
- Lomandra suaveolens

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia acerosa
- Hibbertia ?amplexicaulis
- Hibbertia commutata
- Hibbertia microphylla
- Hibbertia racemosa
- Hibbertia stellaris

Droseraceae
- Drosera bulbosa
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera heterophylla
- Drosera menziesii
- Drosera pallida
- Drosera rosulata
- Drosera stolonifera

Epacridaceae
- Andersonia ?caerulea
- Astroloma microcalyx
- Astroloma pallidum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon lasiophyllus
- Leucopogon parviflorus
- Leucopogon ?pendulus
- Leucopogon propinquus
- Leucopogon tamariscinus
- Leucopogon verticillatus
- Lysinema ciliatum
- Sphenotoma gracile

Euphorbiaceae
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera microphylla

Geraniaceae
- Pelargonium littorale

Goodeniaceae
- Dampiera linearis
- Dampiera trigona
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos manglesii
- Conostylis aculeata
- Conostylis laxiflora
- Conostylis setigera
- Haemodorum simplex
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Phlebocarya ciliata
- Tribonanthes australis
- Tribonanthes longipetala

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus pithyoides

Iridaceae
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)

Juncaceae
- Luzula meridionalis

Juncaginaceae
- Triglochin huegelii

Lamiaceae
- Hemiandra pungens

Linaceae
- Linum marginale

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Isotoma hypocrateriformis
- Lobelia alata
- Lobelia gibbosa
- Lobelia rhombifolia
- Lobelia tenuior

Loganiaceae
- Logania serpyllifolia
- Phyllangium paradoxum

Lycopodiaceae
- Phylloglossum drummondii

Menyanthaceae
- Villarsia albiflora

Mimosaceae
- Acacia extensa
- Acacia huegelii
- * Acacia longifolia ssp. longifolia
- Acacia myrtifolia
- Acacia nervosa
- Acacia pulchella
- Acacia saligna
- Acacia stenoptera

Myrtaceae
- Agonis parviceps
- Astartea sp. (pink weeping)
- Calytrix angulata
- Calytrix leschenaultii
- Darwinia vestita
- Eucalyptus calophylla
- Eucalyptus cornuta
- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus occidentalis
- Hypocalymma angustifolium
- Kunzea micrantha
- Melaleuca lateritia
- Melaleuca preissiana
- Melaleuca spathulata
- Melaleuca thymoides
- Melaleuca viminea
- Pericalymma ellipticum

Orchidaceae
- Caladenia flava
- Caladenia starteorum ms
- Caladenia starteorum x splendens
- Cryptostylis ovata
- Elythranthera brunonis
- Elythranthera emarginata
- Microtis atrata
- Microtis media
- * Monadenia bracteata
- Prasophyllum drummondii
- Prasophyllum elatum
- Prasophyllum macrostachyum
- Pterostylis recurva
- Pterostylis turfosa
- Pterostylis vittata
- Pyrorchis nigricans
- Thelymitra flexuosa
- Thelymitra macrophylla
- Thelymitra pauciflora

Oxalidaceae
- Oxalis perennans

Papilionaceae
- Aotus intermedia
- Bossiaea linophylla
- Bossiaea ornata
- Brachysema praemorsum
- Daviesia sp.
- Gastrolobium bilobum
- Gompholobium capitatum
- Gompholobium confertum
- Gompholobium marginatum
- Gompholobium polymorphum
- Gompholobium preissii
- Gompholobium tomentosum
- Hovea trisperma var. grandiflora
- Isotropis cuneifolia
- Jacksonia ?furcellata
- Kennedia coccinea
- Oxylobium lineare
- Sphaerolobium vimineum
- Viminaria juncea

Philydraceae
- Philydrella pygmaea

Phormiaceae
- Dianella brevicaulis
- Dianella revoluta
- Stypandra glauca

Pittosporaceae
- Sollya heterophylla

Poaceae
- * Aira caryophyllea
- Austrodanthonia caespitosa
- Austrodanthonia setacea
- Austrostipa compressa
- Austrostipa ?pycnostachya
- * Briza maxima
- * Briza minor
- Deyeuxia quadriseta
- Neurachne alopecuroidea
- Tetrarrhena laevis
- * Vulpia myuros

Polygalaceae
- Comesperma volubile

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia littoralis
- Dryandra lindleyana
- Franklandia fucifolia
- Hakea lissocarpha
- Hakea prostrata
- Hakea sulcata
- Hakea varia
- Petrophile acicularis

- Synaphea petiolaris
- Synaphea sp.

Ranunculaceae
- Clematis pubescens

Restionaceae
- Anarthria laevis
- Anarthria prolifera
- Anarthria scabra
- Chordifex sp.
- Cytogonidium leptocarpoides ms
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Harperia lateriflora
- Hypolaena exsulca
- Lyginia barbata
- Meeboldina kraussii ms

Rhamnaceae
- Cryptandra arbutiflora ssp. minor
- Trymalium ledifolium

Rubiaceae
- Opercularia hispidula
- Opercularia vaginata

Rutaceae
- Boronia crenulata
- Boronia spathulata

Santalaceae
- Leptomeria cunninghamii
- Leptomeria scrobiculata
- Leptomeria squarrulosa

Schizaeaceae
- Schizaea dichotoma

Scrophulariaceae
- Gratiola peruviana
- * Parentucellia viscosa

Selaginellaceae
- Selaginella gracillima

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium ?assimile
- Stylidium brunonianum ssp. minor
- Stylidium calcaratum
- Stylidium corymbosum
- Stylidium guttatum
- Stylidium inundatum
- Stylidium mimeticum
- Stylidium periscelianthum
- Stylidium perpusillum
- Stylidium petiolare
- Stylidium pulchellum
- Stylidium repens
- Stylidium roseonanum
- Stylidium schoenoides
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea imbricata
- Pimelea rosea
- Pimelea sulphurea
- Pimelea sylvestris

Tremandraceae
- Tetratheca affinis
- Tetratheca setigera
- Tetratheca virgata

Violaceae
- Hybanthus floribundus

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

KODJINUP NATURE RESERVE

Reserve number 26678 **Class** A
Location 34 23 07S 116 39 30E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 626 ha

Biological values

Flora 341 taxa and one hybrid have been recorded from the reserve (see flora list below). This includes four priority taxa (*Jacksonia sparsa* ms (Priority 3), *Leucopogon tamariscinus* (Priority 2), *Schoenus benthamii* (Priority 3), *Stylidium mimeticum* (Priority 3)). A hybrid swarm of *Kunzea recurva* x *sulphurea* and backcrosses to both parents can be seen in several places along the southern boundary of the reserve.

Vegetation description Thirteen vegetation units were mapped in the reserve (Map 4).

1. **Jarrah-marri forest and woodland** occur on laterites and lateritic gravels on the western side of the reserve. The understorey is diverse in shrubs, herbs and grasses. Typical understorey shrubs include *Hibbertia* spp., *Leucopogon* spp. and peas such as *Bossiaea* spp., *Daviesia* spp. and *Gompholobium* spp.

2. **Jarrah-marri open woodland** on sandy low-lying soils is widespread in the northern and eastern parts of the reserve. The understorey is variable but includes species such as *Hibbertia racemosa, Andersonia caerulea, Astroloma baxteri, Leucopogon propinquus, Calytrix angulata* and *Melaleuca thymoides*. Where it is wettest, *Agonis parviceps* dominates. The herb layer is similarly diverse.

3. ***Banksia ilicifolia*-jarrah woodland** occurs commonly in the southern and western part of the reserve. This vegetation unit is a dampland with dominant understorey species including *Melaleuca thymoides, Kunzea recurva, Aotus intermedia, Pultenaea ochreata* and *Adenanthos obovatus*. In the wettest areas jarrah disappears. This community grades into vegetation unit 6 (*Melaleuca preissiana-Banksia littoralis* woodland) which occupies somewhat wetter sites.

4. **Dieback affected *Banksia ilicifolia*-jarrah woodland** A significant area of *Banksia ilicifolia* woodland has been destroyed by dieback in the south-western corner of the reserve. Some trees are still standing dead, the understorey is dominated by *Pultenaea ochreata*.

5. ***Melaleuca cuticularis* woodland** occurs in the north-eastern corner of the reserve. A well developed but variable herb and sedge layer develops under the *Melaleuca*. Obvious species include *Lepyrodia muirii, Gahnia trifida, Lepidosperma longitudinale, Cotula coronopifolia, Triglochin* spp., *Juncus* spp., *Tribonanthes* spp. and *Burchardia monantha*. Variability in understorey species appears to be correlated with variation in sand and clay content of the soil.

6. ***Melaleuca preissiana-Banksia littoralis* woodland** is a common vegetation unit on low-lying sandy areas, the understorey is quite variable depending on period of inundation. In the wettest areas *Pericalymma ellipticum* and *Lepidosperma longitudinale* form a dense understorey. In slightly drier sites this is replaced by an understorey dominated by *Melaleuca* spp. (often *M. densa, M. spathulata,* and *M. viminea*), *Kunzea recurva*, and *Viminaria juncea*.

7. ***Melaleuca preissiana* woodland over *Agonis* scrub** is a species-poor unit where the understorey is dominated by dense stands of *Agonis parviceps*.

8. ***Melaleuca rhaphiophylla* low forest** occurs around the basin wetlands and drainage lines. This unit is generally species-poor owing to the dense canopy, and the understorey is usually dominated by sedges (*Lepidosperma longitudinale, Baumea* spp.).

9. **Open *Melaleuca rhaphiophylla* low forest** has a more species-rich understorey with sedges, shrubs (such as *Agonis linearifolia,* and *Aotus intermedia*) and herbs (such as *Villarsia albiflora, Samolus junceus*, and *Opercularia hispidula*).

10. **Open *Baumea* sedgeland** occurs over Kodjinup Swamp itself, *Baumea articulata* is the dominant sedge, while toward the edge *B. juncea* and *B. vaginalis* co-dominate.

11. **Closed *Baumea* sedgeland** occurs in the western basin wetland, and has an identical species composition to vegetation unit 10 but has a higher cover of the *Baumea* spp.

12. **Disturbed areas** associated with an old mill occur on the eastern side.

13. **Open water** occurs in small areas but may dry to herbland later in summer.

Vegetation change Oblique aerial photographs from April 1980 show that the *Baumea* in Kodjinup Swamp appears to have become less dense although expanses of open water are not yet apparent.

Disturbance or threats A drain constructed through the central part of the reserve in 1993 (CALM 1998[1]) has caused massive deaths of *Banksia ilicifolia* woodland and associated heath species as a result of dieback (*Phytophthora* sp.) spread. This impact is being monitored by a series of photopoints (22 March 1997) laid along a 50-m transect perpendicular to the drain. At 10-m intervals a photograph has been taken toward the east parallel to the drain. All photopoints were marked with a fence dropper. Changes in inundation owing to drain construction have resulted in death in small areas of jarrah woodland (Map 4). The northern (upslope) section of the drain was constructed through what appear to be areas of old dieback infections. The nature conservation values of this reserve have been severely compromised by the construction of this drain.

A much smaller drain directs water in wetland vegetation on the southern boundary of the reserve, there are no impacts to the vegetation at this time.

Kodjinup Nature Reserve flora list.

Anthericaceae
- Agrostocrinum scabrum
- Chamaescilla corymbosa
- Johnsonia lupulina
- Laxmannia minor
- Laxmannia sessiliflora
- Thysanotus manglesianus
- Thysanotus multiflorus
- Thysanotus patersonii
- Thysanotus tenellus
- Tricoryne elatior
- Tricoryne humilis

Apiaceae
- Actinotus glomeratus
- Centella cordifolia
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia atkinsoniana
- Xanthosia candida
- Xanthosia ciliata
- Xanthosia huegelii

Asteraceae
- Angianthus preissianus
- * Arctotheca calendula
- * Aster subulatus
- * Cirsium vulgare
- Cotula coronopifolia
- Cotula cotuloides
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia myosotidifolia
- Olearia elaeophila
- Pithocarpa pulchella
- Pogonolepis stricta
- * Pseudognaphalium luteoalbum
- Rhodanthe citrina
- Senecio minimus
- Siloxerus humifusus
- * Sonchus asper
- * Sonchus hydrophilus

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii
- Wahlenbergia stricta

Casuarinaceae
- Allocasuarina humilis

Centrolepidaceae
- Aphelia cyperoides
- Brizula drummondii
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis glabra
- Centrolepis polygyna

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Burchardia multiflora

Crassulaceae
- Crassula colorata

Cyperaceae
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Gahnia trifida
- Isolepis cernua
- Isolepis congrua
- Isolepis ?cyperoides
- * Isolepis marginata
- Isolepis oldfieldiana
- Isolepis stellata
- Lepidosperma angustatum
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma tenue
- Mesomelaena graciliceps
- Mesomelaena tetragona
- Schoenus asperocarpus
- Schoenus benthamii
- Schoenus efoliatus
- Schoenus humilis
- Schoenus odontocarpus
- Schoenus plumosus
- Schoenus submicrostachyus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii var. neesii

Dasypogonaceae
- Dasypogon bromeliifolius
- Lomandra hermaphrodita
- Lomandra micrantha
- Lomandra sericea

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia ?amplexicaulis
- Hibbertia commutata
- Hibbertia pulchra
- Hibbertia racemosa
- Hibbertia stellaris
- Hibbertia vaginata

Droseraceae
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera menziesii
- Drosera pallida
- Drosera stolonifera

[1] CALM (1998). Draft management plan, Perup Forest and Lake Muir/Unicup Nature Reserves. Department of Conservation and Land Management, Perth.

Epacridaceae
- Andersonia caerulea
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon glabellus
- Leucopogon oxycedrus
- Leucopogon ?polymorphus
- Leucopogon propinquus
- Leucopogon tamariscinus
- Leucopogon unilateralis
- Leucopogon verticillatus
- Lysinema ciliatum
- Styphelia tenuiflora

Euphorbiaceae
- Monotaxis occidentalis
- Poranthera microphylla

Goodeniaceae
- Anthotium humile
- Dampiera alata
- Dampiera cuneata
- Dampiera ?juncea
- Dampiera linearis
- Dampiera ?pedunculata
- Dampiera aff. triloba
- Goodenia claytoniacea
- Goodenia micrantha
- Goodenia pulchella
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos flavidus
- Conostylis aculeata
- Conostylis laxiflora
- Conostylis setigera
- Haemodorum laxum
- Haemodorum spicatum
- Tribonanthes australis
- Tribonanthes violacea

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus hexandrus ssp. integrifolius
- Gonocarpus paniculatus

Hydatellaceae
- Trithuria bibracteata
- Trithuria submersa

Iridaceae
- * Gladiolus undulatus
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)

Juncaceae
- * Juncus bufonius
- * Juncus capitatus
- Juncus kraussii
- Juncus pallidus

Juncaginaceae
- Triglochin calcitrapum
- Triglochin centrocarpum
- Triglochin huegelii
- Triglochin striatum

Lamiaceae
- Hemiandra pungens

Lauraceae
- Cassytha glabella
- Cassytha micrantha
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Lobelia alata

Loganiaceae
- Logania serpyllifolia
- Phyllangium paradoxum

Loranthaceae
- Nuytsia floribunda

Lythraceae
- * Lythrum hyssopifolia

Menyanthaceae
- Villarsia albiflora
- Villarsia parnassifolia

Mimosaceae
- Acacia extensa
- Acacia incurva
- Acacia myrtifolia
- Acacia pulchella
- Acacia stenoptera

Myrtaceae
- Agonis linearifolia
- Agonis parviceps
- Astartea sp. (pink weeping)
- Astartea sp. (tall white)
- Baeckea camphorosmae
- Baeckea aff. preissiana
- Calothamnus lateralis
- Calytrix angulata
- Eucalyptus calophylla
- Eucalyptus decipiens
- Eucalyptus marginata
- Hypocalymma angustifolium
- Hypocalymma strictum
- Kunzea recurva
- Kunzea recurva x sulphurea hybrid
- Kunzea sulphurea
- Melaleuca cuticularis
- Melaleuca densa
- Melaleuca lateritia
- Melaleuca leptoclada
- Melaleuca preissiana
- Melaleuca rhaphiophylla
- Melaleuca spathulata
- Melaleuca thymoides
- Melaleuca viminea
- Melaleuca violacea
- Pericalymma ellipticum

Onagraceae
- Epilobium billardierianum

Orchidaceae
- Caladenia flava
- Caladenia longicauda
- Caladenia radialis
- Caladenia radiata
- Elythranthera brunonis
- Elythranthera emarginata
- Eriochilus dilatatus
- Leporella fimbriata
- * Monadenia bracteata
- Praecoxanthus aphyllus ms
- Prasophyllum drummondii
- Prasophyllum ?elatum
- Pterostylis barbata
- Pterostylis nana
- Pterostylis vittata
- Pyrorchis nigricans
- Thelymitra crinita
- Thelymitra flexuosa
- Thelymitra ?macrophylla

Orobanchaceae
- * Orobanche minor

Papilionaceae
- Aotus intermedia
- Bossiaea eriocarpa
- Bossiaea linophylla
- Bossiaea ornata
- Bossiaea sp.
- Brachysema melanopetalum

- Brachysema praemorsum
- Chorizema ilicifolium
- Daviesia physodes
- Gompholobium capitatum
- Gompholobium confertum
- Gompholobium knightianum
- Gompholobium polymorphum
- Gompholobium preissii
- Gompholobium tomentosum
- Hovea chorizemifolia
- Hovea trisperma var. grandiflora
- Jacksonia furcellata
- Jacksonia sparsa ms
- Kennedia coccinea
- * Lotus angustissimus
- * Lotus suaveolens
- * Ornithopus compressus
- Oxylobium lineare
- Pultenaea ochreata
- Pultenaea reticulata
- Sphaerolobium macranthum
- Sphaerolobium medium
- Sphaerolobium vimineum
- Viminaria juncea

Philydraceae
- Philydrella pygmaea

Phormiaceae
- Dianella revoluta

Pittosporaceae
- Billardiera variifolia
- Marianthus candidus

Poaceae
- * Aira caryophyllea
- Amphipogon debilis
- Amphipogon turbinatus
- Austrostipa compressa
- Austrostipa juncifolia
- Deyeuxia quadriseta
- Hemarthria uncinata
- * Holcus lanatus
- Neurachne alopecuroidea
- Poa poiformis
- Tetrarrhena laevis
- * Vulpia myuros

Podocarpaceae
- Podocarpus drouynianus

Polygalaceae
- Comesperma calymega
- Comesperma flavum
- Comesperma virgatum
- Comesperma volubile

Polygonaceae
- * Rumex acetosella
- * Rumex crispus
- * Rumex pulcher

Primulaceae
- Samolus junceus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Conospermum flexuosum
- Dryandra armata
- Dryandra lindleyana
- Franklandia fucifolia
- Hakea ceratophylla
- Hakea lissocarpha
- Hakea prostrata
- Hakea ruscifolia
- Hakea sp.
- Hakea sulcata
- Hakea trifurcata
- Hakea varia
- Isopogon sp.
- Persoonia longifolia
- Petrophile media
- Petrophile rigida
- Petrophile serruriae
- Stirlingia anethifolia
- Synaphea sp.

Ranunculaceae
- Clematis pubescens

Restionaceae
- Anarthria laevis
- Anarthria prolifera
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Hypolaena exsulca
- Leptocarpus tenax
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina tephrina ms
- Sporadanthus strictus ms
- Stenopa ramosissima ms
- Tremulina tremula ms

Rhamnaceae
- Trymalium ledifolium

Rubiaceae
- Opercularia hispidula

Rutaceae
- Boronia nematophylla
- Boronia spathulata
- Eriostemon nodiflorus ssp. lasiocalyx

Santalaceae
- Leptomeria pauciflora
- Leptomeria scrobiculata
- Leptomeria squarrulosa

Scrophulariaceae
- Gratiola peruviana

Stackhousiaceae
- Stackhousia monogyna

Sterculiaceae
- Thomasia ?pauciflora

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium calcaratum
- Stylidium guttatum
- Stylidium luteum
- Stylidium mimeticum
- Stylidium perpusillum
- Stylidium repens
- Stylidium scandens
- Stylidium schoenoides
- Stylidium spathulatum
- Stylidium violaceum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea ciliata ssp. ciliata
- Pimelea imbricata var. major
- Pimelea rosea
- Pimelea sulphurea

Tremandraceae
- Tetratheca sp.
- Tremandra diffusa

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

KULUNILUP NATURE RESERVE

Reserve number 26677 **Class** A
Location 34 20 05S 116 47 16E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 612 ha

Biological values

Flora Using Griffin[2] (1984) data as a basis, a flora list of 432 taxa was compiled from the reserve (see flora list below). This included seven priority taxa (*Amphibromus vickeryae* (Priority 1), *Apodasmia ceramophila* ms (Priority 2), *Euchiton gymnocephalus* (Priority 3), *Phyllangium palustre* (Priority 2), *Rhodanthe pyrethrum* (Priority 3), *Schoenus natans* (Priority 4), *Villarsia submersa* (Priority 4)).

Vegetation description Griffin (1984) mapped the reserve and described 11 vegetation units. Brief descriptions of these units are given below.

3(l). ***Eucalyptus marginata* (jarrah) forest (Type 2)** [bottom of lateritic ridges]. Jarrah-marri forest at the base of lateritic ridges, essentially similar to Kodjinup vegetation unit 1.

3/9. ***Eucalyptus marginata* (jarrah) forest (Type 2)/*Agonis parviceps* thicket** Variable unit similar to Kodjinup vegetation unit 2, common on low-lying sandy substrates.

4/6. ***Eucalyptus marginata* (jarrah)-*E. wandoo* forest/*Hakea prostrata* Low Scrub A** A variable unit dominated by jarrah and/or wandoo, occasionally marri, over a *Hakea prostrata-Hypocalymma angustifolia* heath with sedges *Mesomelaena tetragona* and *M. stygia*. This unit occupies old sandy drainage lines.

6. ***Hakea prostrata* low scrub A** Similar to unit 4/6 without the overstorey. Essentially the same as Galamup vegetation unit 8.

10. ***Melaleuca preissiana-Banksia littoralis* open low woodland A** A complex unit essentially similar to Kodjinup vegetation unit 6.

12. ***Melaleuca lateritia* dense low heath** Essentially similar to Galamup vegetation unit 6, these are small basin wetlands on loamy clays.

13. ***Melaleuca rhaphiophylla* dense low forest B** Occurs as circular or ring shaped areas in the centre of some basin wetlands. This unit is equivalent to Muir vegetation unit 15.

19. ***Baumea* sedges** Occupying basin wetlands, essentially the same as Kodjinup vegetation units 10 and 11.

22. ***Melaleuca viminea* heath** Occurring on grey clayey soils, with a variable understorey of *Baumea* sp. and *Leptocarpus aristatus*.

23. ***Melaleuca spathulata* complex** Very variable unit of poorly drained flats. Its composition depends on drainage conditions; in the wettest areas *M. spathulata* forms a dense heath, in the drier peripheral zones it is more similar to vegetation unit 10.

24. ***Leptocarpus* sedges** Clay flats dominated by *Apodasmia ceramophila* ms. Griffin (1984) states that there are few herbs, however, these winter-wet flats have a diverse annual herb flora in spring and early summer as these seasonally inundated wetlands dry.

Disturbed areas Not mapped by Griffin (1984) but used in compiling species lists.

Vegetation change Oblique aerial photographs from April 1980 show little change to the central wetland.

Disturbance or threats Recent aerial photography and on-the-ground inspections show several major drains entering the reserve. Of particular concern is the impact on the *Melaleuca spathulata* heath in the north-eastern corner of the reserve. Presently the community is very open with large areas of bare ground. This may be the result of salinity, and needs to be investigated using a time series of aerial photography to determine whether this is the case and, if so, the rate of spread of this impact.

Other major drains enter the reserve from the west and south. No obvious impacts from these drains are apparent at this time.

[2] Griffin, E.A. (1984). Vegetation survey of three nature reserves in the Lake Unicup complex (Lake Unicup, Kulunilup Lake and Yarnup Lake). A report for Department of Fisheries and Wildlife, Perth.

Kulunilup Nature Reserve flora list.

Aizoaceae
* Carpobrotus edulis
Carpobrotus modestus
Amaranthaceae
Alternanthera nodiflora
Anthericaceae
Agrostocrinum scabrum
Arthropodium preissii
Borya scirpoidea
Borya sphaerocephala
Caesia micrantha
Caesia occidentalis
Chamaescilla corymbosa
Chamaescilla spiralis
Johnsonia lupulina
Laxmannia minor
Sowerbaea laxiflora
Thysanotus manglesianus
Thysanotus tenellus
Tricoryne elatior
Tricoryne humilis
Apiaceae
Centella cordifolia
Daucus glochidiatus
Eryngium pinnatifidum
Homalosciadium homalocarpum
Hydrocotyle alata
Hydrocotyle diantha
Hydrocotyle pilifera
Schoenolaena tenuior
Trachymene pilosa
Xanthosia candida
Xanthosia huegelii
Asteraceae
Angianthus preissianus
Angianthus tomentosus
* Arctotheca calendula
Asteridea athrixioides
Blennospora drummondii
Brachyscome iberidifolia
* Carduus pycnocephalus
Cotula coronopifolia
Craspedia variabilis
* Dittrichia graveolens
Euchiton gymnocephalus
Euchiton sphaericus
Gnephosis tenuissima
Hyalosperma simplex
* Hypochaeris glabra
Lagenifera huegelii
Millotia myosotidifolia
Olearia paucidentata
Podolepis gracilis
Podotheca angustifolia
* Pseudognaphalium luteoalbum
Pterochaeta paniculata
Quinetia urvillei
Rhodanthe citrina
Rhodanthe pyrethrum
Rutidosis multiflora
Senecio minimus
Siloxerus humifusus
* Sonchus asper
* Sonchus hydrophilus
* Sonchus oleraceus
Trichocline sp.
* Vellereophyton dealbatum
Campanulaceae
Wahlenbergia multicaulis
Wahlenbergia preissii
Caryophyllaceae
* Cerastium glomeratum
Casuarinaceae
Allocasuarina humilis
Allocasuarina lehmanniana
Allocasuarina thuyoides
Centrolepidaceae
Aphelia cyperoides
Brizula drummondii
Centrolepis aristata
Centrolepis drummondiana
Centrolepis glabra
Centrolepis pilosa
Centrolepis polygyna
Colchicaceae
Burchardia congesta
Burchardia monantha
Burchardia multiflora
Wurmbea dioica
Crassulaceae
Crassula colorata
Crassula decumbens var. decumbens
* Crassula natans
Crassula pedicellosa
Crassula peduncularis
Cupressaceae
Actinostrobus pyramidalis
Cyperaceae
Baumea articulata
Baumea juncea
Baumea rubiginosa
Baumea ?vaginalis
Chorizandra enodis
Cyathochaeta avenacea
* Cyperus tenellus
Eleocharis sphacelata
Gahnia ancistrophylla
Gahnia trifida
Isolepis cernua
* Isolepis marginata
Isolepis oldfieldiana
Isolepis sp.
Isolepis stellata
Lepidosperma angustatum
Lepidosperma longitudinale
Lepidosperma sp.
Lepidosperma squamatum
Lepidosperma tenue
Mesomelaena stygia
Mesomelaena tetragona
Schoenus bifidus
Schoenus efoliatus
Schoenus elegans
Schoenus natans
Schoenus sp.
Schoenus subbulbosus
Schoenus tenellus
Tetraria capillaris
Tetraria octandra
Dasypogonaceae
Chamaexeros serra
Dasypogon bromeliifolius
Lomandra caespitosa
Lomandra collina
Lomandra micrantha
Lomandra nigricans
Lomandra purpurea
Lomandra sonderi
Lomandra suaveolens
Dennstaedtiaceae
Pteridium esculentum
Dilleniaceae
Hibbertia ?commutata
Hibbertia cunninghamii
Hibbertia gracilipes
Hibbertia racemosa
Hibbertia spicata ssp. spicata

Hibbertia stellaris
Hibbertia subvaginata
Droseraceae
Drosera erythrorhiza
Drosera gigantea
Drosera glanduligera
Drosera macrantha
Drosera menziesii
Drosera neesii
Drosera rosulata
Epacridaceae
Andersonia caerulea
Astroloma baxteri
Astroloma ciliatum
Astroloma pallidum
Leucopogon australis
Leucopogon capitellatus
Leucopogon conostephioides
Leucopogon parviflorus
Leucopogon pendulus
Leucopogon verticillatus
Lysinema ciliatum
Sphenotoma capitatum
Euphorbiaceae
Poranthera microphylla
Gentianaceae
* Centaurium erythraea
* Cicendia filiformis
Geraniaceae
* Erodium cicutarium
Geranium solanderi
Goodeniaceae
Anthotium humile
Dampiera alata
Dampiera linearis
Dampiera pedunculata
Goodenia mimuloides
Goodenia pulchella
Lechenaultia formosa
Scaevola phlebopetala
Velleia trinervis
Haemodoraceae
Anigozanthos bicolor
Anigozanthos manglesii
Conostylis aculeata
Conostylis aurea
Conostylis laxiflora
Conostylis setigera
Haemodorum laxum
Haemodorum simplex
Haemodorum sparsiflorum
Haemodorum spicatum
Tribonanthes australis
Tribonanthes longipetala
Tribonanthes sp Lake Muir
Tribonanthes violacea
Haloragaceae
Glischrocaryon aureum
Myriophyllum crispatum
Myriophyllum limnophilum
Hydatellaceae
Trithuria bibracteata
Trithuria submersa
Hypoxidaceae
Hypoxis occidentalis
Iridaceae
Patersonia juncea
Patersonia occidentalis
* Romulea rosea
Isoetaceae
Isoetes drummondii
Juncaceae
* Juncus articulatus
* Juncus bufonius
* Juncus capitatus
Juncus pallidus
Juncus radula
Juncus sp.
Juncaginaceae
Triglochin centrocarpum
Triglochin huegelii
Triglochin lineare
Lamiaceae
Hemiandra pungens
* Mentha pulegium
Lauraceae
Cassytha racemosa
Lentibulariaceae
Polypompholyx multifida
Polypompholyx tenella
Utricularia inaequalis
Linaceae
Linum marginale
Lindsaeaceae
Lindsaea linearis
Lobeliaceae
Grammatotheca bergiana
Lobelia alata
Lobelia gibbosa
Loganiaceae
Logania campanulata
Logania serpyllifolia
Phyllangium palustre
Phyllangium paradoxum
Loranthaceae
Nuytsia floribunda
Lythraceae
* Lythrum hyssopifolia
Menyanthaceae
Villarsia albiflora
Villarsia submersa
Mimosaceae
Acacia alata
Acacia cyclops
Acacia extensa
Acacia huegelii
Acacia incurva
Acacia laricina var. laricina
Acacia nervosa
Acacia pulchella
Acacia saligna
Acacia stenoptera
Myrtaceae
Actinodium cunninghamii
Agonis juniperina
Astartea sp. (pink weeping)
Astartea sp. (white erect)
Calothamnus lateralis
Calothamnus sanguineus
Calothamnus schaueri
Calytrix flavescens
Eremaea pauciflora
Eucalyptus calophylla
Eucalyptus decipiens
Eucalyptus marginata
Eucalyptus occidentalis
Eucalyptus rudis
Eucalyptus wandoo
Hypocalymma angustifolium
Kunzea micrantha
Melaleuca cuticularis
Melaleuca densa
Melaleuca lateriflora
Melaleuca lateritia
Melaleuca leptoclada
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca spathulata
Melaleuca thymoides
Melaleuca viminea
Pericalymma ellipticum
Verticordia densiflora

Onagraceae
- Epilobium billardierianum
- Epilobium hirtigerum

Orchidaceae
- Caladenia flava
- Caladenia longicauda
- Caladenia marginata
- Caladenia radiata
- Caladenia splendens ms
- Corybas dilatatus
- Cyrtostylis robusta
- Diuris laxiflora
- Diuris longifolia
- Drakonorchis barbarossa ms
- Elythranthera brunonis
- Elythranthera emarginata
- Leporella fimbriata
- Microtis atrata
- Microtis media
- Microtis orbicularis
- * Monadenia bracteata
- Prasophyllum drummondii
- Prasophyllum macrostachyum
- Pterostylis nana
- Pterostylis pyramidalis
- Pterostylis recurva
- Pterostylis vittata
- Pyrorchis nigricans
- Thelymitra crinita
- Thelymitra pauciflora

Orobanchaceae
- * Orobanche minor

Papilionaceae
- Bossiaea eriocarpa
- Bossiaea linophylla
- Bossiaea ornata
- Bossiaea praetermissa
- Brachysema melanopetalum
- Brachysema praemorsum
- Chorizema aciculare
- Daviesia cordata
- Daviesia incrassata
- Daviesia preissii
- Eutaxia virgata
- Gompholobium capitatum
- Gompholobium knightianum
- Gompholobium marginatum
- Gompholobium ovatum
- Gompholobium polymorphum
- Gompholobium preissii
- Gompholobium scabrum
- Gompholobium tomentosum
- Hovea chorizemifolia
- Hovea trisperma var. grandiflora
- Isotropis cuneifolia
- Jacksonia furcellata
- Kennedia coccinea
- Kennedia prostrata
- * Lotus angustissimus
- * Lotus uliginosus
- Oxylobium lineare
- Pultenaea ericifolia
- Sphaerolobium medium
- Sphaerolobium vimineum
- * Trifolium campestre
- * Trifolium dubium
- * Trifolium subterraneum
- Viminaria juncea

Philydraceae
- Philydrella drummondii
- Philydrella pygmaea

Phormiaceae
- Dianella brevicaulis
- Dianella revoluta
- Stypandra glauca

Pittosporaceae
- Billardiera sp.
- Marianthus candidus
- Sollya heterophylla

Poaceae
- Agrostis avenacea
- * Aira caryophyllea
- Amphibromus nervosus
- Amphibromus vickeryae
- Amphipogon debilis
- Austrodanthonia occidentalis
- Austrodanthonia setacea
- Austrostipa compressa
- Austrostipa pycnostachya
- * Briza maxima
- * Briza minor
- Deyeuxia quadriseta
- Hemarthria uncinata
- * Holcus lanatus
- Neurachne alopecuroidea
- Poa drummondiana
- * Polypogon monspeliensis
- Tetrarrhena laevis
- * Vulpia bromoides
- * Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma ciliatum
- Comesperma flavum
- Comesperma virgatum

Polygonaceae
- Persicaria prostrata
- * Polygonum arenastrum
- * Rumex conglomeratus
- * Rumex pulcher

Primulaceae
- Samolus junceus

Proteaceae
- Banksia grandis
- Banksia littoralis
- Dryandra armata
- Dryandra lindleyana
- Grevillea brownii
- Hakea lissocarpha
- Hakea prostrata
- Hakea ruscifolia
- Hakea sulcata
- Hakea varia
- Isopogon polycephalus
- Isopogon teretifolius
- Persoonia longifolia
- Petrophile media
- Petrophile serruriae
- Petrophile squamata
- Synaphea favosa
- Synaphea petiolaris

Ranunculaceae
- Clematis pubescens

Restionaceae
- Anarthria laevis
- Anarthria prolifera
- Apodasmia ceramophila ms
- Desmocladus fasciculatus ms
- Harperia lateriflora
- Hypolaena exsulca
- Leptocarpus tenax
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina cana ms
- Meeboldina coangustata ms
- Meeboldina scariosa ms
- Tremulina tremula ms

Rhamnaceae
- Trymalium ledifolium

Rubiaceae
- Opercularia hispidula
- Opercularia vaginata

Rutaceae
- Boronia ?juncea
- Boronia megastigma
- Boronia ramosa
- Boronia spathulata

Santalaceae
- Santalum acuminatum

Scrophulariaceae
- Gratiola peruviana
- Limosella australis
- * Parentucellia latifolia
- * Parentucellia viscosa

Selaginellaceae
- Selaginella gracillima

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium assimile
- Stylidium brunonianum ssp. minor
- Stylidium calcaratum
- Stylidium carnosum
- Stylidium crassifolium
- Stylidium emarginatum
- Stylidium guttatum
- Stylidium inundatum
- Stylidium miniatum
- Stylidium perpusillum
- Stylidium petiolare
- Stylidium pulchellum
- Stylidium repens
- Stylidium roseonanum
- Stylidium schoenoides
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea ?ciliata
- Pimelea sulphurea

Tremandraceae
- Platytheca galioides
- Tetratheca setigera

Violaceae
- Hybanthus floribundus

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

LAKE MUIR RESERVE

Reserve number 31880 **Class** A
Location 34 29 08S 116 43 24E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 11 311 ha

Biological values

Flora 737 taxa and one hybrid were recorded from the reserve (see flora list below). This list included three Declared Rare Flora (*Caladenia christineae* ms, *Caladenia harringtoniae, Diuris drummondii*) and 19 priority taxa (*Amphibromus vickeryae* (Priority 1), *Anthotium junciforme* (Priority 4), *Apodasmia ceramophila* ms (Priority 2), *Caladenia starteorum* ms (Priority 2), *Eryngium* sp. Lake Muir (E Wittwer 2293) (Priority 1), *Euchiton gymnocephalus* (Priority 3), *Euphrasia scabra* (Priority 2), *Jacksonia sparsa* ms (Priority 3), *Leucopogon tamariscinus* (Priority 2), *Lilaeopsis polyantha* (Priority 2), *Melaleuca pritzelii* (Priority 2), *Phyllangium palustre* (Priority 2), *Rhodanthe pyrethrum* (Priority 3), *Schoenus capillifolius* (Priority 2), *Schoenus natans* (Priority 4), *Stylidium lepidum* (Priority 3), *Stylidium rhipidium* (Priority 1), *Synaphea decumbens* (Priority 1), *Villarsia submersa* (Priority 4)).

Of these taxa *Eryngium* sp. Lake Muir (*E. Wittwer* 2293) appears to be endemic to the Lake Muir area. The two large populations of *Euphrasia scabra* are the only extant locations known for this taxon in WA, it has been recommended for listing as nationally critical based on population declines in the eastern States. The shrublands and forests surrounding Lake Muir contain the only known populations of *Lilaeopsis polyantha* in WA. The aquatic sedge *Schoenus natans* has recently been delisted as Declared Rare Flora based on the large population of this taxon in Lake Muir Nature Reserve and several other nature reserves in the area. It was previously believed to be restricted to the Swan Coastal Plain (Keighery and Keighery 1996).

Vegetation description 31 vegetation units have been mapped in the reserve, wet heaths and scrubs predominate in the northern section of the reserve while eucalypt woodlands are more common in the south (Map 5).

1. **Jarrah-marri forest and woodland** on laterite and lateritic gravels cover a small area in the south-eastern corner of the reserve. The understorey is typically diverse in shrubs, herbs and grasses. Typical understorey shrubs include *Hibbertia* spp., *Leucopogon* spp. and peas such as *Bossiaea* spp., *Daviesia* spp. and *Gompholobium* spp.

2. **Jarrah-marri open woodland** on sandy soils occurs widely in the southern half of the reserve, common understorey species include *Hibbertia racemosa, Hibbertia subvaginata, Astroloma baxteri, Leucopogon* spp., *Phyllanthus calycinus, Acacia pulchella, Jacksonia furcellata.* There is generally a very rich and diverse herb layer and orchids are numerous early in the spring. Toward the northern part of the reserve, this vegetation unit is replaced by jarrah-yate woodlands (unit 4).

3. **Jarrah-marri woodland over *Agonis* scrub** occurs along seasonally-wet drainage lines and in the swales between the dunes to the east of Lake Muir. Typically the *Agonis* scrub is very dense with little or no other understorey.

4. **Jarrah-yate woodland** occurs on the large dune bordering the eastern side of Lake Muir and sandy flats in the northern part of the reserve. Elsewhere on the reserve it is replaced by vegetation unit 3 (jarrah-marri woodlands on sand). Both units have very similar understorey composition. Where the jarrah-yate community has been grazed weed diversity is high.

5. **Jarrah woodland over *Hakea oleifolia* heath** occurs on the red dunes to the east of Poorginup Swamp. This soil unit was not seen elsewhere in the reserve.

6. ***Eucalyptus decipiens* woodland**, similar to those occurring in Gaiamup and Cobertup Nature Reserves, is found in a small area on the wet clayey flats north of the Muir Highway. *Allocasuarina lehmanniana, Allocasuarina microstachya, Leucopogon australis, Darwinia vestita,* and *Aotus intermedia* are common components of the understorey. There is also a rich and diverse herb and sedge layer.

7. ***Eucalyptus rudis* woodland** occurs in small patches on wet flats and small rises. The understorey is typical of seasonally-inundated situations and includes *Anigozanthos flavidus, Agonis parviceps, Kunzea ericifolia, Viminaria juncea, Hakea ceratophylla,* and *Hakea varia.* Orchids were common in this unit in early spring.

8. ***Eucalyptus rudis* woodland on sand dunes** occurs on the eastern side of most of the basin wetlands. These woodlands tended to be quite weedy reflecting a history of past grazing. *E. rudis* woodland is replaced by yate woodland (vegetation unit 31) on the fringing dunes of Lake Muir, understorey composition is essentially similar.

9. ***Banksia ilicifolia* woodland** occurs in small patches along and to the north of the Muir Highway. Extensive areas of dieback are apparent. In dieback-free areas a diverse understorey of peas, epacrids, and Myrtaceae is present. *Schoenus* spp. and *Mesomelaena tetragona* are also common.

10. ***Melaleuca cuticularis* complex** The wet flats in the northern half of the reserve are mostly covered by *Melaleuca* shrublands and/or woodlands in a complex mosaic. One of the most variable is the *Melaleuca cuticularis* complex, which ranges from woodland to very open woodland to wet heath with occasional *M. cuticularis* trees. Understorey is also variable, apparently related to period of inundation, but generally includes *Astartea* spp., *Melaleuca densa, Hypocalymma angustifolium, Hakea varia, Harperia lateriflora* and *Meeboldina cana.* The Lake Muir endemic *Eryngium* sp. Lake Muir is also found in this unit.

11. ***Melaleuca cuticularis* woodland over *Gahnia* sedgeland** is a distinct unit occurring on the flats along the edge of Lake Muir. This unit is quite species poor.

12. ***Melaleuca cuticularis* woodland over wet heath** forms a distinct unit in the south-eastern part of the reserve. The substrate is generally clayey and this unit has a very rich and diverse annual herb layer. The Asteraceae, Centrolepidaceae, Cyperaceae, Orchidaceae, Stylidiaceae are well represented. Common perennial taxa include *Melaleuca* spp., *Kunzea micrantha* and the rushes *Apodasmia ceramophila, Meeboldina coangustata,* and *Meeboldina cana.*

13. ***Melaleuca preissiana-Kunzea sulphurea* woodland** occurs as a small unit on drainage lines on the southern boundary of the reserve.

14. ***Melaleuca preissiana* woodland over wet heath** occurs extensively north of the Muir Highway. The understorey is variable and in the wettest sites is generally dominated by *Pericalymma ellipticum.* On drier sites the understorey is diverse with peas and Myrtaceae dominating.

15. ***Melaleuca rhaphiophylla* forest** forms dense stands around basin wetland and in the wettest parts of the flats. The understorey is generally dominated by *Lepidosperma* spp. and *Baumea* spp. but where the canopy is more open a variety of shrubs such as *Hypocalymma angustifolium, Pericalymma ellipticum, Callistachys lanceolata, Banksia littoralis, Hakea sulcata* become common.

16. ***Melaleuca-Kunzea* scrub** occurs on the clay flats near Wimbalup Swamp, dominant *Melaleuca* spp. include *M. viminalis, M. densa, M. ?spathulata.* The annual herb layer is again very diverse with an aquatic flora (e.g. *Schoenus natans, Villarsia submersa*) giving way to a sequence of annual Asteraceae, Centrolepidaceae, Cyperaceae and Stylidiaceae as the wetlands dry.

17. ***Melaleuca densa-M. viminea* heath** was a widespread unit in the northern area of the reserve occupying both sandy and sandy clay substrates. These areas are winter-wet and dry slowly in late spring and early summer. Aquatic taxa such as *Schoenus natans* and *Villarsia* spp. are widespread in early spring giving way to herbs as the wetlands dry. It was in this community that *Euphrasia scabra* was found. Two large populations were located and more populations may occur.

18. ***Melaleuca densa-M. viminea* thicket** can develop on long-inundated sites, where diversity drops as the canopy closes over.

19. **Mixed *Melaleuca* heath** occurs in low lying flats in the southern half of the reserve. Composition is variable: *Sphaerolobium vimineum, Eutaxia virgata, Hakea ceratophylla, Aotus intermedia,* and *Calothamnus lateralis* are common. On small rises this unit intergrades with the sandy jarrah unit (unit 2). In the wettest areas it gives way to the wet heath unit (unit 21) often dominated by *Pericalymma ellipticum.* Units 17, 18 and 19 occupy similar positions in the landscape and may reflect differences in fire age and/or period of winter inundation.

20. ***Hakea prostrata* heath** is a very small unit in Lake Muir but has essentially the same species composition to that of the same unit in Galamup Nature Reserve.

21. **Wet heath** occupies very wet sandy sites and is generally dominated by *Pericalymma ellipticum* and *Lepidosperma longitudinale.* On more clayey substrates this community grades into the *Melaleuca* shrublands (units 16–19). This unit is most common in the northern part of the reserve.

22. ***Gahnia* sedgeland** occurs in the shallow swales along the edge of Lake Muir. This community is very species-poor, being dominated by *Gahnia trifida.* This unit grades into unit 11.

23. **Open *Baumea* sedgeland** occupies basin wetlands. In the deeper water *Baumea articulata* is the sole dominant, closer to the shore *B. juncea* and *B. arthrophylla* occur. Around the edge of these wetlands taxa such as *Utricularia australis, Cotula coronopifolia, Centrolepis polygyna, Juncus bufonius, Villarsia albiflora* and *Microtis atrata* can also be found.

24. **Closed *Baumea* sedgeland** occupies basin wetlands and is essentially similar to unit 23, however, the *Baumea articulata* tends to be denser.

25. **Dying *Baumea* sedgeland** The *Baumea articulata* in Byenup Lagoon appears to be dying on the aerial photography taken on the 23rd October1995 (WA3619–5051). This photo shows most of the sedgeland to be bright orange in colour, generally indicative of stress. Recent aerial inspection found a recovery of the sedgeland but that the sedgeland now appears more open than in 1995. It is not clear as to the cause of this apparent decline but it does coincide with an 8-year peak in salinity levels in the lagoon (J.A.K. Lane, personal communication).

26. **Riparian vegetation** (not mapped) Incised creek lines had a narrow but distinctive vegetation unit associated with them: this unit was too small to map. The overstorey was *Agonis* or *Callistachys* with a dense shrub layer of *Brachysema melanopetalum.* The poorly collected orchid *Gastrodia lacista* was found in these habitats.

27. **Samphire flats** occur along the shore of Lake Muir between the shore and the *Gahnia* sedgeland. Common species include *Halosarcia indica, Halosarcia leptoclada, Sarcocornia quinqueflora, Suaeda australis* and *Wilsonia backhousei.*

28. **Cleared land** occurs on a portion of the reserve north-west of Byenup Lagoon. This area is largely covered by pasture grasses and weeds, although some revegetation of the shrub and tree layer is occurring. A block of private land west of Poorginup Swamp has previously been cleared, but is also slowly revegetating.

29. ***Armillaria*-affected shrubland** Part of the *Melaleuca preissiana-Kunzea sulphurea* woodland north of Poorginup Swamp appears to be affected by canker, possibly *Armillaria.* This needs further investigation.

30. **Open water** occurs on most of the larger basin wetlands.

31. **Yate woodland** on sand dunes replaces the more widespread fringing *E. rudis* woodland (vegetation unit 8) on the eastern shore of Lake Muir.

Vegetation change Photographs of three wetlands to the east of Lake Muir from April show little change with recent aerial photography. The photo of Byenup shows healthy *Baumea* sedgeland, dense around open water and more interspersed with clumps of *Melaleuca* and small patches of open water away from the major water body. As outlined above (vegetation unit 25) 1995 aerial photography appears to show the *Baumea* in a very stressed condition. Recent aerial survey indicates the *Baumea* sedgeland is in good condition but appears to have become more open.

Disturbance or threats **(1)** Drainage patterns and salinity levels in Byenup Lagoon should be investigated as a matter of priority in an attempt to identify the cause of the apparent collapse of the *Baumea* sedgeland in this wetland. A series of aerial photos over time should be assembled to confirm whether the health of the *Baumea* sedgeland is correlated with salinity levels. If this proves to be the case then management of salt loads in the lagoon would need to be kept well below the 1995 levels. **(2)** A series of illegal drains have been constructed into the eastern side reserve during the course of this study. Significant impacts owing to salinity and changes to inundation period could be expected. **(3)** The block of private land west of Poorginup Swamp should be acquired to protect Tordit-Gurrup Lagoon and Poorginup Swamp. These are two of the wetland systems in the best condition within the Lake Muir reserve. Any attempt to farm this land could put them at serious risk. **(4)** Vegetation unit 29 needs investigation to determine whether it is a result of fungal canker.

Lake Muir Nature Reserve flora list.

Aizoaceae
- Carpobrotus modestus

Amaranthaceae
- Alternanthera nodiflora
- Hemichroa diandra
- Ptilotus drummondii
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Arthropodium capillipes
- Arthropodium preissii
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Chamaescilla spiralis
- Johnsonia acaulis
- Johnsonia lupulina
- Laxmannia minor
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus multiflorus
- Thysanotus patersonii
- Thysanotus tenellus
- Thysanotus thyrsoideus
- Tricoryne elatior
- Tricoryne humilis
- Tricoryne tenella

Apiaceae
- Actinotus glomeratus
- Actinotus omnifertilis
- Apium annuum
- Apium prostratum
- Centella cordifolia
- Daucus glochidiatus
- Eryngium pinnatifidum
- Eryngium sp. Lake Muir (*E. Wittwer* 1193)
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle diantha
- Hydrocotyle pilifera
- Lilaeopsis polyantha
- Platysace haplosciadia
- Platysace filiformis
- Schoenolaena juncea
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- Angianthus preissianus
- Angianthus sp.

* Arctotheca calendula
* Aster subulatus
Asteridea pulverulenta
Blennospora drummondii
Blennospora sp.
Brachyscome bellidioides
Brachyscome iberidifolia
Calotis erinacea
* Carduus pycnocephalus
* Centaurea melitensis
* Cirsium vulgare
* Conyza albida
Cotula australis
Cotula coronopifolia
Cotula cotuloides
* Cotula turbinata
Craspedia variabilis
* Dittrichia graveolens
Euchiton gymnocephalus
Euchiton sphaericus
Gnephosis sp.
* Hedypnois rhagadioloides
Hyalosperma cotula
* Hypochaeris glabra
Ixiolaena viscosa
* Lactuca serriola
Lagenifera huegelii
Millotia myosotidifolia
Millotia tenuifolia
Olearia axillaris
Olearia elaeophila
Podolepis gracilis
Podolepis lessonii
Podotheca angustifolia
Pogonolepis stricta
* Pseudognaphalium luteoalbum
Pterochaeta paniculata
Quinetia urvillei
Rhodanthe pyrethrum
Rutidosis multiflora
Senecio glomeratus
Senecio lautus
Senecio minimus
Senecio picridioides
Senecio quadridentatus
Siloxerus humifusus
* Sonchus asper
* Sonchus hydrophilus
* Sonchus oleraceus
Trichocline sp.
Trichocline spathulata
* Ursinia anthemoides
* Vellereophyton dealbatum
Vittadinia australasica var. australasica
Waitzia nitida
Waitzia suaveolens

Brassicaceae
* Cardamine paucijuga
* Lepidium africanum

Callitrichaceae
* Callitriche stagnalis

Campanulaceae
Wahlenbergia multicaulis
Wahlenbergia preissii

Caryophyllaceae
* Cerastium glomeratum
* Corrigiola litoralis
* Petrorhagia velutina
* Spergularia salina

Casuarinaceae
Allocasuarina humilis
Allocasuarina lehmanniana
Allocasuarina microstachya

Centrolepidaceae
Aphelia cyperoides
Brizula drummondii
Centrolepis aristata
Centrolepis drummondiana
Centrolepis glabra
Centrolepis humillima
Centrolepis mutica
Centrolepis pilosa
Centrolepis polygyna

Chenopodiaceae
* Atriplex prostrata
* Chenopodium murale
Halosarcia indica
Halosarcia leptoclada
Rhagodia baccata
Sarcocornia quinqueflora
Suaeda australis

Clusiaceae
Hypericum gramineum

Colchicaceae
Burchardia congesta
Burchardia monantha
Burchardia multiflora
Wurmbea dioica

Convolvulaceae
Dichondra repens
Wilsonia backhousei

Crassulaceae
Crassula colorata
* Crassula natans
Crassula pedicellosa
Crassula peduncularis

Cupressaceae
Actinostrobus acuminatus
Actinostrobus pyramidalis

Cyperaceae
Baumea arthrophylla
Baumea articulata
Baumea juncea
Baumea vaginalis
Carex appressa
Carex preissii
Chorizandra enodis
Cyathochaeta avenacea
Cyathochaeta clandestina
* Cyperus tenellus
Gahnia ancistrophylla
Gahnia trifida
Isolepis cernua
Isolepis cyperoides
Isolepis fluitans
* Isolepis marginata
Isolepis nodosa
Isolepis oldfieldiana
Isolepis producta
* Isolepis prolifera
Isolepis stellata
Lepidosperma angustatum
Lepidosperma gladiatum
Lepidosperma longitudinale
Lepidosperma squamatum
Lepidosperma tenue
Mesomelaena stygia
Mesomelaena tetragona
Schoenus bifidus
Schoenus capillifolius
Schoenus curvifolius
Schoenus efoliatus
Schoenus humilis
Schoenus laevigatus
Schoenus maschalinus
Schoenus nanus
Schoenus natans
Schoenus plumosus
Schoenus rigens
Schoenus sp.
Schoenus subbulbosus
Schoenus submicrostachyus

- Schoenus tenellus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii var. elatior

Dasypogonaceae
- Dasypogon bromeliifolius
- Lomandra caespitosa
- Lomandra nigricans
- Lomandra purpurea
- Lomandra sericea
- Lomandra sonderi
- Lomandra suaveolens

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia acerosa
- Hibbertia amplexicaulis
- Hibbertia commutata
- Hibbertia cunninghamii
- Hibbertia racemosa
- Hibbertia spicata
- Hibbertia stellaris
- Hibbertia subvaginata
- Hibbertia vaginata

Droseraceae
- Drosera bulbosa
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera macrantha
- Drosera menziesii
- Drosera neesii
- Drosera pallida
- Drosera pulchella
- Drosera stolonifera

Epacridaceae
- Andersonia caerulea
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon conostephioides
- Leucopogon glabellus
- Leucopogon parviflorus
- Leucopogon pendulus
- Leucopogon propinquus
- Leucopogon pulchellus
- Leucopogon sprengelioides
- Leucopogon tamariscinus
- Leucopogon unilateralis
- Leucopogon verticillatus
- Lysinema ciliatum
- Needhamiella pumilio
- Sphenotoma gracile
- Styphelia tenuiflora

Euphorbiaceae
- Amperea simulans
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera huegelii
- Poranthera microphylla

Fumariaceae
- * Fumaria capreolata

Gentianaceae
- * Centaurium erythraea
- Centaurium spicatum
- * Cicendia filiformis

Geraniaceae
- * Erodium botrys
- * Erodium cicutarium
- * Erodium moschatum
- Geranium solanderi
- Pelargonium littorale

Goodeniaceae
- Anthotium humile
- Anthotium junciforme
- Dampiera alata
- Dampiera linearis
- Dampiera pedunculata
- Dampiera trigona
- Goodenia claytoniacea
- Goodenia micrantha
- Goodenia mimuloides
- Goodenia pulchella
- Lechenaultia expansa
- Scaevola globulifera
- Scaevola lanceolata
- Scaevola phlebopetala
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos flavidus
- Anigozanthos manglesii
- Anigozanthos viridis
- Anigozanthos bicolor x manglesii
- Conostylis aculeata
- Conostylis laxiflora
- Conostylis setigera
- Haemodorum laxum
- Haemodorum simplex
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Tribonanthes australis
- Tribonanthes brachypetala
- Tribonanthes longipetala
- Tribonanthes violacea

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus cordiger
- Gonocarpus paniculatus
- Haloragis brownii
- Myriophyllum crispatum
- Myriophyllum drummondii
- Myriophyllum tillaeoides

Hydatellaceae
- Trithuria bibracteata
- Trithuria submersa

Hypoxidaceae
- Hypoxis occidentalis

Iridaceae
- * Homeria flaccida
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)
- Patersonia umbrosa
- * Romulea rosea

Isoetaceae
- Isoetes drummondii

Juncaceae
- * Juncus bufonius
- * Juncus capitatus
- Juncus kraussii
- Juncus pallidus
- Luzula meridionalis

Juncaginaceae
- Triglochin calcitrapum
- Triglochin centrocarpum
- Triglochin huegelii
- Triglochin lineare
- Triglochin minutissimum
- Triglochin mucronatum
- Triglochin striatum

Lamiaceae
- Hemiandra pungens

Lauraceae
- Cassytha flava
- Cassytha glabella
- Cassytha micrantha
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Polypompholyx tenella
- Utricularia australis
- Utricularia inaequalis
- Utricularia simplex
- Utricularia sp.
- Utricularia violacea
- Utricularia volubilis

Linaceae
- Linum marginale

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Isotoma hypocrateriformis
- Isotoma scapigera
- Lobelia alata
- Lobelia gibbosa
- Lobelia rhombifolia

Loganiaceae
- Logania campanulata
- Logania serpyllifolia
- Phyllangium palustre
- Phyllangium paradoxum

Loranthaceae
- Amyema miquelii
- Nuytsia floribunda

Lycopodiaceae
- Phylloglossum drummondii

Lythraceae
- * Lythrum hyssopifolia

Malvaceae
- Lawrencia spicata
- * Malva parviflora
- Sida hookeriana

Marsileaceae
- Pilularia novae-hollandiae

Menyanthaceae
- Villarsia albiflora
- Villarsia capitata
- Villarsia parnassifolia
- Villarsia submersa
- Villarsia violifolia

Mimosaceae
- Acacia alata
- Acacia cochlearis
- Acacia cyclops
- Acacia extensa
- Acacia huegelii
- Acacia incurva
- Acacia latipes ssp. latipes ms
- Acacia myrtifolia
- Acacia nervosa
- Acacia pentadenia
- Acacia pulchella
- Acacia pulchella var. goadbyi
- Acacia saligna
- Acacia stenoptera
- Acacia urophylla
- Acacia willdenowiana

Molluginaceae
- Macarthuria apetala

Myoporaceae
- Myoporum caprarioides

Myrtaceae
- Actinodium cunninghamii
- Agonis hypericifolia
- Agonis linearifolia
- Agonis parviceps
- Astartea fascicularis
- Astartea sp. (pink weeping)
- Astartea sp. (white erect)
- Baeckea camphorosmae
- Baeckea pygmaea
- Calothamnus lateralis
- Calothamnus lehmannii
- Calytrix angulata
- Calytrix flavescens
- Calytrix leschenaultii
- Darwinia oederoides
- Darwinia vestita
- Eucalyptus calophylla
- Eucalyptus cornuta
- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus megacarpa
- Eucalyptus occidentalis
- Eucalyptus patens
- Eucalyptus rudis
- Hypocalymma angustifolium
- Kunzea ericifolia
- Kunzea micrantha
- Kunzea recurva
- Kunzea sulphurea
- Melaleuca cordata
- Melaleuca cuticularis
- Melaleuca densa
- Melaleuca lateriflora
- Melaleuca lateritia
- Melaleuca leptoclada
- Melaleuca preissiana
- Melaleuca pritzelii
- Melaleuca rhaphiophylla
- Melaleuca spathulata
- Melaleuca thymoides
- Melaleuca viminea
- Melaleuca violacea
- Pericalymma ellipticum
- Verticordia densiflora
- Verticordia densiflora ssp. caespitosa
- Verticordia habrantha
- Verticordia plumosa

Olacaceae
- Olax phyllanthi

Onagraceae
- Epilobium billardierianum

Ophioglossaceae
- Ophioglossum lusitanicum

Orchidaceae
- Caladenia caesarea
- Caladenia caesarea ssp. caesarea ms
- Caladenia christineae ms
- Caladenia drummondii
- Caladenia ferruginea
- Caladenia flava
- Caladenia harringtoniae
- Caladenia latifolia
- Caladenia longicauda
- Caladenia longiclavata
- Caladenia macrostylis
- Caladenia marginata
- Caladenia nana
- Caladenia radiata
- Caladenia reptans
- Caladenia starteorum ms
- Caladenia varians ssp. varians ms
- Corybas recurvus
- Cryptostylis ovata
- Cyanicula deformis ms
- Cyanicula gemmata ms
- Cyrtostylis huegelii
- Diuris drummondii
- Diuris laxiflora
- Diuris longifolia
- Drakaea glyptodon
- Drakaea livida
- Drakonorchis barbarossa ms
- Elythranthera brunonis
- Elythranthera emarginata
- Eriochilus dilatatus
- Eriochilus dilatatus ssp. undulatus ms
- Gastrodia lacista

Leporella fimbriata
Leptoceras menziesii
Microtis atrata
Microtis media
Microtis orbicularis
* Monadenia bracteata
Paracaleana nigrita
Praecoxanthus aphyllus ms
Prasophyllum drummondii
Prasophyllum elatum
Prasophyllum fimbria
Prasophyllum macrostachyum
Prasophyllum plumiforme
Pterostylis barbata
Pterostylis nana
Pterostylis pyramidalis
Pterostylis recurva
Pterostylis vittata
Pyrorchis nigricans
Thelymitra antennifera
Thelymitra benthamiana
Thelymitra crinita
Thelymitra cucullata
Thelymitra flexuosa
Thelymitra fuscolutea
Thelymitra nuda
Thelymitra pauciflora

Orobanchaceae
* Orobanche minor

Oxalidaceae
Oxalis perennans

Papilionaceae
Aotus intermedia
Bossiaea aquifolium
Bossiaea eriocarpa
Bossiaea linophylla
Bossiaea ornata
Bossiaea rufa
Brachysema melanopetalum
Brachysema praemorsum
Callistachys lanceolata
Chorizema nanum
Daviesia cordata
Daviesia hakeoides
Daviesia physodes
Daviesia preissii
Eutaxia virgata
Gastrolobium bilobum
Gompholobium capitatum
Gompholobium confertum
Gompholobium knightianum
Gompholobium marginatum
Gompholobium ovatum
Gompholobium polymorphum
Gompholobium preissii
Gompholobium scabrum
Gompholobium tomentosum
Hardenbergia comptoniana
Hovea chorizemifolia
Hovea elliptica
Hovea trisperma
Hovea trisperma var. grandiflora
Isotropis cuneifolia
Jacksonia furcellata
Jacksonia sparsa ms
Kennedia coccinea
Kennedia prostrata
Latrobea tenella
* Lotus angustissimus
* Ornithopus compressus
Oxylobium lineare
Pultenaea ericifolia
Pultenaea ochreata
Pultenaea reticulata
Sphaerolobium linophyllum
Sphaerolobium medium
Sphaerolobium vimineum
* Trifolium arvense
* Trifolium campestre
* Trifolium dubium
* Trifolium fragiferum
* Trifolium glomeratum
* Trifolium repens
* Trifolium subterraneum
Viminaria juncea

Philydraceae
Philydrella drummondii
Philydrella pygmaea

Phormiaceae
Dianella brevicaulis
Dianella revoluta
Stypandra glauca

Pinaceae
* Pinus pinaster

Pittosporaceae
Billardiera variifolia
Marianthus candidus
Sollya heterophylla

Plantaginaceae
Plantago exilis

Poaceae
Agrostis avenacea
* Aira caryophyllea
Amphibromus vickeryae
Amphipogon debilis
Amphipogon laguroides
Amphipogon turbinatus
* Anthoxanthum odoratum
* Avena fatua
* Briza maxima
* Briza minor
* Bromus diandrus
Austrodanthonia occidentalis
Austrodanthonia sp.
Austrostipa compressa
Austrostipa juncifolia
Austrostipa pycnostachya
Austrostipa trichophylla
* Cynodon dactylon
* Cynosurus echinatus
Deyeuxia quadriseta
Eragrostis brownii
Eragrostis elongata
Hemarthria uncinata
* Holcus lanatus
* Holcus setiger
* Hordeum geniculatum
* Hordeum leporinum
* Lolium multiflorum
* Lolium rigidum
Microlaena stipoides
Neurachne alopecuroidea
* Parapholis incurva
Poa drummondiana
Poa poiformis
* Polypogon monspeliensis
Sporobolus virginicus
Tetrarrhena laevis
* Vulpia myuros

Podocarpaceae
Podocarpus drouynianus

Polygalaceae
Comesperma calymega
Comesperma ciliatum
Comesperma drummondii
Comesperma flavum
Comesperma virgatum

Polygonaceae
Muehlenbeckia adpressa
Persicaria prostrata
* Rumex acetosella
* Rumex brownii

* Rumex crispus
* Rumex pulcher

Portulacaceae
- Calandrinia composita
- Montia australasica

Potamogetonaceae
- Potamogeton tricarinatus
- Ruppia megacarpa

Primulaceae
* Anagallis arvensis var. arvensis
* Anagallis arvensis var. caerulea
- Samolus caespitosus
- Samolus junceus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Conospermum flexuosum
- Dryandra armata
- Dryandra bipinnatifida
- Dryandra lindleyana
- Franklandia fucifolia
- Grevillea brownii
- Hakea ceratophylla
- Hakea lissocarpha
- Hakea oleifolia
- Hakea prostrata
- Hakea ruscifolia
- Hakea sulcata
- Hakea trifurcata
- Hakea undulata
- Hakea varia
- Isopogon polycephalus
- Isopogon teretifolius
- Persoonia longifolia
- Petrophile media
- Petrophile serruriae
- Petrophile squamata
- Stirlingia tenuifolia
- Synaphea decumbens
- Synaphea petiolaris

Ranunculaceae
- Clematis pubescens
- Ranunculus colonorum
* Ranunculus muricatus

Restionaceae
- Anarthria laevis
- Anarthria prolifera
- Anarthria scabra
- Apodasmia ceramophila ms
- Desmocladus fasciculatus ms
- Harperia lateriflora
- Hypolaena exsulca
- Hypolaena humilis ms
- Lepyrodia macra
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina cana ms
- Meeboldina coangustata ms
- Meeboldina denmarkica
- Meeboldina kraussii ms
- Meeboldina sp.
- Meeboldina tephrina ms
- Stenopa ramosissima ms
- Tremulina tremula ms

Rhamnaceae
- Cryptandra sp.
- Trymalium floribundum
- Trymalium ledifolium

Rosaceae
* Acaena echinata

Rubiaceae
* Galium divaricatum
* Galium murale
- Opercularia apiciflora
- Opercularia hispidula
- Opercularia vaginata
* Sherardia arvensis

Rutaceae
- Boronia capitata
- Boronia crenulata
- Boronia juncea
- Boronia megastigma
- Boronia ramosa
- Boronia sp.
- Boronia spathulata

Santalaceae
- Leptomeria lehmannii
- Leptomeria scrobiculata
- Leptomeria spinosa
- Leptomeria squarrulosa

Schizaeaceae
- Schizaea dichotoma

Scrophulariaceae
* Bartsia trixago
- Euphrasia scabra
- Glossostigma diandrum
- Glossostigma drummondii
- Gratiola peruviana
* Parentucellia latifolia
* Parentucellia viscosa

Selaginellaceae
- Selaginella gracillima

Solanaceae
* Solanum americanum
* Solanum nigrum

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Sterculiaceae
- Guichenotia sp.
- Rulingia corylifolia
- Thomasia foliosa
- Thomasia paniculata
- Thomasia pauciflora

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium adnatum
- Stylidium amoenum
- Stylidium assimile
- Stylidium brunonianum ssp. minor
- Stylidium calcaratum
- Stylidium corymbosum
- Stylidium crassifolium
- Stylidium ecorne
- Stylidium emarginatum
- Stylidium guttatum
- Stylidium hispidum
- Stylidium inundatum
- Stylidium junceum
- Stylidium lepidum
- Stylidium periscelianthum
- Stylidium perpusillum
- Stylidium petiolare
- Stylidium pulchellum
- Stylidium repens
- Stylidium rhipidium
- Stylidium scandens
- Stylidium schoenoides
- Stylidium sp.
- Stylidium spathulatum
- Stylidium spinulosum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea argentea
- Pimelea ciliata
- Pimelea cracens ssp. cracens
- Pimelea imbricata var. gracillima
- Pimelea imbricata var. piligera
- Pimelea rosea

Pimelea suaveolens
Pimelea sylvestris
Tremandraceae
Platytheca galioides
Tetratheca hirsuta
Tetratheca nuda
Tetratheca setigera
Tremandra diffusa
Tremandra hirsuta
Typhaceae
Typha domingensis
* Typha orientalis
Urticaceae
Parietaria debilis
Violaceae
Hybanthus debilissimus
Hybanthus floribundus
Xanthorrhoeaceae
Xanthorrhoea gracilis
Xanthorrhoea preissii
Zamiaceae
Macrozamia riedlei
Zannichelliaceae
Lepilaena australis

NOOBIJUP NATURE RESERVE

Reserve number 26680 **Class** A
Location 34 24 18S 116 47 11E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 183 ha

Biological values

Flora 348 taxa have been recorded from the reserve (see flora list below) including four priority taxa (*Anthotium junciforme* (Priority 4), *Leucopogon tamariscinus* (Priority 2), *Rhodanthe pyrethrum* (Priority 3), and *Villarsia submersa* (Priority 4)).

Vegetation description Nine vegetation units have been mapped in the reserve. These include one clearly resulting from salinity and raised water tables (Map 6). More detailed vegetation mapping has recently been undertaken (D. Gardner[3], personal communication).

1. **Jarrah-marri forest and woodland** on laterite occur in the south-west and along the eastern boundary of the reserve. Species composition is similar to that described previously on this surface with a diverse understorey of shrubs, herbs and grasses. Typical understorey shrubs include *Astroloma* spp., *Leucopogon* spp. and peas such as *Bossiaea* spp. and *Gompholobium* spp. *Xanthorrhoea gracilis. Thysanotus* spp. and *Dryandra armata* are also typical of this community.

2. **Jarrah-marri open woodland** on sand occurs on the flats around the lake. Within this unit some minor lateritic ridges occur on the eastern side of the lake. Typical understorey elements include *Hakea ruscifolia, Hakea prostrata, Dryandra lindleyana, Hibbertia* spp., *Astroloma ciliatum, Mesomelaena tetragona, Lepidosperma* spp. and *Mesomelaena tetragona* and a diverse array of annual Asteraceae and Anthericaceae. Close to the lake edge *Agonis juniperina, Hypocalymma angustifolium, Pericalymma ellipticum* and *Lepidosperma longitudinale* become more common.

3. ***Eucalyptus decipiens* open woodland** occurs on the clayey soils in the north-west corner of the reserve. This unit is essentially similar to that described for Lake Muir and Galamup Nature Reserves. The understorey is diverse in both shrubs and herbs and the dominants include *Calothamnus lateralis, Kunzea micrantha, Hakea varia* and *Daviesia incrassata.* The unit grades into the wet heath on clay flats (unit 6) which occupies the more water logged sites.

4. ***Melaleuca rhaphiophylla-Eucalyptus rudis* open woodland** occurs on a small wet flat near the eastern boundary of the reserve. The understorey is dominated by a pink weeping species of *Astartea* and by *Calothamnus lateralis.*

5. ***Melaleuca rhaphiophylla* low forest** occurs as a narrow band on the eastern margin of the lake with *Lepidosperma longitudinale* being the dominant element in the understorey.

6. **Wet heath** on clay flats is floristically diverse in terms of both the shrub and herb layers. This unit is dominated by *Melaleuca densa, M. lateritica,* and *M. rhaphiophylla* and becomes inundated in winter. As the wetland dries aquatic species such as *Villarsia submersa*, and *Schoenus natans* dominate to be replace by a diverse herbland which includes *Rhodanthe pyrethrum, Anthotium junciforme, Tribonanthes violacea, Trithuria bibracteata, Trithuria submersa, Polypompholyx multifida*, and *Utricularia inaequalis.* Perennial rushes are also an obvious component of this wetland (primarily *Leptocarpus tenax, Lepyrodia muirii* and *Meeboldina cana*). Three of the four priority taxa recorded for the reserve are found in this area. Rising water table and salt intrusion from the private property to the east are having significant impacts on this vegetation.

7. **Open *Baumea* sedgeland** occurs in the northern portion of Lake Noobijup and is dominated by *Baumea articulata* in deeper water, closer to the shore *Triglochin huegelii* and *Villarsia albiflora* are also found. This vegetation unit is very species-poor.

8. **Closed *Baumea* sedgeland** is essentially similar to unit 7, however, the *Baumea articulata* tends to be denser.

9. **Salt-affected vegetation** occurs on the western and southern edges of the reserve and is caused by a rising watertable and increasing salinity coming from private property. Initially the herbaceous layer is killed followed by death of the shrub layer and finally the tree cover. The area of impact appears to be spreading north through the wet heath on the western side of the reserve.

Vegetation change Oblique aerial photographs from April 1980 show the firebreak along the western boundary had recently been cleared as had an area of bushland on the private property that has now been inundated by rising ground water. The area of wet heath that has subsequently been destroyed by the rise in ground water (and increases in salinity) appeared in good condition in the 1980 photography. Further clearance along the western boundary has taken place since 1980. The *Baumea* sedgeland in Lake Noobijup appears to be denser in the 1980 photography. Permanent long-term

[3] D. Gardner, CALM, Manjimup.

monitoring sites (as part of the Salinity Action Plan wetland monitoring program) have been established in the Lake Noobijup Nature Reserve (Odgen and Froend 1998[4]).

Disturbance or threats Rising ground water on the western side of the reserve since clearance in 1980 has resulted in destruction of high diversity seasonal clay pan communities. The area impacted is continuing to increase. The vegetation in the Lake itself appears to be becoming less dense. It appears that saline water is entering the lake from the south, the north (at times of high flow) and perhaps from the west via ground water.

Noobijup Nature Reserve flora list.

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Arthropodium preissii
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Johnsonia acaulis
- Johnsonia lupulina
- Sowerbaea laxiflora
- Thysanotus patersonii
- Thysanotus tenellus
- Thysanotus thyrsoideus
- Thysanotus triandrus
- Tricoryne elatior
- Tricoryne humilis
- Tricoryne tenella

Apiaceae
- Daucus glochidiatus
- Eryngium ?pinnatifidum
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle callicarpa
- Platysace filiformis
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- Angianthus preissianus
- Asteridea athrixioides
- Blennospora drummondii
- Brachyscome iberidifolia
- Cotula coronopifolia
- Craspedia variabilis
- Euchiton sphaericus
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia tenuifolia
- Podolepis gracilis
- Podotheca angustifolia
- Quinetia urvillei
- Rhodanthe citrina
- Rhodanthe pyrethrum
- Senecio glomeratus
- Senecio minimus
- Siloxerus humifusus
- * Sonchus asper
- * Sonchus oleraceus
- Trichocline spathulata
- * Vellereophyton dealbatum

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii

Caryophyllaceae
- * Cerastium glomeratum
- * Petrorhagia velutina
- * Spergularia salina

Casuarinaceae
- Allocasuarina humilis
- Allocasuarina lehmanniana

Centrolepidaceae
- Aphelia cyperoides
- Brizula drummondii
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis glabra
- Centrolepis polygyna

Chenopodiaceae
- Halosarcia indica

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Burchardia multiflora

Crassulaceae
- Crassula colorata
- * Crassula natans
- Crassula peduncularis

Cupressaceae
- Actinostrobus pyramidalis

Cyperaceae
- Baumea articulata
- Baumea juncea
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Gahnia trifida
- Isolepis cernua
- * Isolepis marginata
- Isolepis nodosa
- Isolepis oldfieldiana
- Lepidosperma angustatum
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma ?tenue
- Mesomelaena stygia
- Mesomelaena tetragona
- Schoenus bifidus
- Schoenus ?efoliatus
- Schoenus elegans
- Schoenus sp.
- Schoenus tenellus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia compressa

Dasypogonaceae
- Chamaexeros serra
- Dasypogon bromeliifolius
- Lomandra caespitosa
- Lomandra collina
- Lomandra micrantha
- Lomandra sericea
- Lomandra sonderi

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia amplexicaulis
- Hibbertia commutata
- Hibbertia cunninghamii
- Hibbertia racemosa
- Hibbertia spicata
- Hibbertia stellaris

[4] Odgen, G. and Froend, R.H. (1998). Salinity Action Plan. Wetland vegetation monitoring 1997/98. Unpublished report. Centre for Ecosystem Management, Edith Cowan University, Perth.

Droseraceae
- Drosera bulbosa
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera macrantha
- Drosera menziesii
- Drosera neesii

Epacridaceae
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon glabellus
- Leucopogon pendulus
- Leucopogon propinquus
- Leucopogon ?sprengelioides
- Leucopogon tamariscinus
- Leucopogon verticillatus
- Styphelia tenuiflora

Euphorbiaceae
- Phyllanthus calycinus
- Poranthera huegelii
- Poranthera microphylla

Gentianaceae
- * Cicendia filiformis

Geraniaceae
- Pelargonium littorale

Goodeniaceae
- Anthotium junciforme
- Dampiera alata
- Dampiera cuneata
- Goodenia micrantha
- Goodenia mimuloides
- Scaevola phlebopetala
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos manglesii
- Conostylis aculeata
- Conostylis laxiflora
- Conostylis setigera
- Haemodorum laxum
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Tribonanthes longipetala
- Tribonanthes violacea

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus paniculatus
- Myriophyllum crispatum

Hydatellaceae
- Trithuria bibracteata
- Trithuria submersa

Hypoxidaceae
- Hypoxis occidentalis

Iridaceae
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)

Isoetaceae
- Isoetes drummondii

Juncaceae
- * Juncus bufonius
- Juncus pallidus

Juncaginaceae
- Triglochin centrocarpum
- Triglochin huegelii
- Triglochin mucronatum

Lamiaceae
- Hemiandra pungens

Lauraceae
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Utricularia inaequalis

Linaceae
- Linum marginale

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Lobelia alata
- Lobelia tenuior

Loganiaceae
- Logania serpyllifolia

Menyanthaceae
- Villarsia albiflora
- Villarsia submersa

Mimosaceae
- Acacia browniana
- Acacia cochlearis
- Acacia cyclops
- Acacia extensa
- Acacia incurva
- Acacia myrtifolia
- Acacia pulchella
- Acacia saligna
- Acacia stenoptera

Myrtaceae
- Agonis juniperina
- Astartea sp. (pink weeping)
- Calothamnus lateralis
- Eucalyptus calophylla
- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus occidentalis
- Eucalyptus rudis
- Hypocalymma angustifolium
- Kunzea micrantha
- Kunzea recurva
- Melaleuca cordata
- Melaleuca densa
- Melaleuca leptoclada
- Melaleuca rhaphiophylla
- Melaleuca thymoides
- Melaleuca viminea
- Melaleuca violacea
- Pericalymma ellipticum

Orchidaceae
- Caladenia flava
- Caladenia longicauda
- Caladenia radialis
- Caladenia radiata
- Cryptostylis ovata
- Diuris laxiflora
- Diuris longifolia
- Elythranthera brunonis
- Elythranthera emarginata
- Lyperanthus serratus
- Microtis atrata
- Microtis media
- Microtis orbicularis
- * Monadenia bracteata
- Prasophyllum elatum
- Prasophyllum macrostachyum
- Pterostylis recurva
- Pyrorchis nigricans
- Thelymitra crinita
- Thelymitra flexuosa
- Thelymitra macrophylla

Orobanchaceae
- * Orobanche minor

Oxalidaceae
- Oxalis perennans

Papilionaceae
- Bossiaea eriocarpa
- Bossiaea linophylla
- Bossiaea ornata
- Brachysema melanopetalum
- Brachysema praemorsum
- Callistachys lanceolata
- Daviesia incrassata
- Daviesia preissii

- Gompholobium marginatum
- Gompholobium polymorphum
- Gompholobium preissii
- Gompholobium tomentosum
- Hovea trisperma var. grandiflora
- Isotropis cuneifolia
- Jacksonia furcellata
- Kennedia coccinea
- Kennedia prostrata
- Sphaerolobium vimineum
- Viminaria juncea

Philydraceae
- Philydrella pygmaea

Phormiaceae
- Dianella revoluta
- Stypandra glauca

Pittosporaceae
- Sollya heterophylla

Poaceae
- * Aira caryophyllea
- Amphipogon amphipogonoides
- Amphipogon laguroides
- Amphipogon turbinatus
- * Avena barbata
- Austrodanthonia caespitosa
- Austrostipa pycnostachya
- * Briza maxima
- * Briza minor
- Deyeuxia quadriseta
- Hemarthria uncinata
- * Holcus lanatus
- * Hordeum murinum
- Neurachne alopecuroidea
- Poa poiformis
- * Polypogon monspeliensis
- Tetrarrhena laevis
- * Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma flavum
- Comesperma virgatum
- Comesperma volubile
- * Polygala myrtifolia

Potamogetonaceae
- Ruppia megacarpa

Primulaceae
- * Anagallis arvensis
- Samolus junceus

Proteaceae
- Banksia grandis
- Banksia littoralis
- Dryandra armata
- Dryandra lindleyana
- Grevillea leptobotrys
- Hakea lissocarpha
- Hakea oleifolia
- Hakea prostrata
- Hakea ruscifolia
- Hakea sulcata
- Hakea trifurcata
- Hakea undulata
- Hakea varia
- Isopogon polycephalus
- Isopogon teretifolius
- Persoonia longifolia
- Petrophile media
- Petrophile serruriae
- Petrophile squamata
- Synaphea ?favosa
- Synaphea petiolaris

Restionaceae
- Anarthria laevis
- Anarthria prolifera
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Harperia lateriflora
- Hypolaena exsulca
- Leptocarpus tenax
- Lepyrodia drummondiana
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina cana ms

Rhamnaceae
- Trymalium ledifolium

Rosaceae
- * Acaena echinata

Rubiaceae
- Opercularia apiciflora
- Opercularia hispidula
- Opercularia vaginata
- * Sherardia arvensis

Rutaceae
- Boronia crenulata
- Boronia megastigma
- Boronia spathulata

Santalaceae
- Leptomeria cunninghamii
- Leptomeria scrobiculata

Scrophulariaceae
- * Parentucellia latifolia

Selaginellaceae
- Selaginella gracillima

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium brunonianum ssp. minor
- Stylidium calcaratum
- Stylidium junceum ssp. brevius
- Stylidium luteum
- Stylidium petiolare
- Stylidium pulchellum
- Stylidium repens
- Stylidium schoenoides
- Stylidium sp.
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea cracens ssp. glabra
- Pimelea imbricata
- Pimelea ?lanata
- Pimelea preissii
- Pimelea rosea
- Pimelea suaveolens
- Pimelea sylvestris

Tremandraceae
- Platytheca galioides
- Tetratheca hispidissima

Violaceae
- Hybanthus floribundus

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

PINDICUP NATURE RESERVE

Reserve number 26679 **Class** A
Location 34 24 49S 116 43 14E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 281 ha

Biological values

Flora A total of 303 taxa, including three priority taxa (*Anthotium junciforme* (Priority 4), *Euchiton gymnocephalus* (Priority 3), *Leucopogon tamariscinus* (Priority 2)), have been recorded from the reserve (see flora list below).

Vegetation description Lake Pindicup is a naturally saline wetland and is the major feature in the Pindicup Nature Reserve: several small freshwater wetlands also occur in the reserve, the largest being Bodjinup Swamp located near the southern boundary of the reserve. Thirteen vegetation units have been recorded from the reserve (Map 8), with the disturbed areas (unit 13) and the areas of *Eucalyptus decipiens* woodland (unit 6) being too small to show on the vegetation map.

1. **Jarrah-marri forest and woodland** on laterite occur as a series of ridges on the western side of the reserve. In terms of species composition they are essentially similar to those described for Noobijup Nature Reserve. The understorey is typically diverse in both herbs and shrubs.

2. **Jarrah-marri open woodland** on sand occurs in the valleys between the laterite ridges, along dunes on northern and eastern boundaries and on the flats to the west of the Lake. The vegetation is again essentially similar to the sandy jarrah unit described for Noobijup Nature Reserve.

3. **Jarrah-marri forest and woodland over *Agonis* scrub** occurred on the wet sandy flats in the north-eastern corner of the reserve. This community had an understorey dominated by *Agonis parviceps* which can form dense thickets. Where it was more open *Bossiaea praetermissa, Gompholobium confertum, Astroloma baxteri* were common as well as the sedges *Caustis* sp. Boyanup, *Lepidosperma squamatum* and *Anarthria scabra.* The collection of *Caustis* sp. Boyanup represents the most southern collection of this taxon.

4. ***Melaleuca cuticularis* woodland** occurs on the flats at the edge of the lake. This unit usually has an understorey of *Gahnia trifida.* Immediately adjacent to the lake the *Melaleuca* can drop out and the vegetation intergrades into a *Gahnia* sedgeland (unit 11). The inland boundary of this unit around the lake is some narrow ridges of *Eucalyptus decipiens* woodland (unit 6) running parallel to the shoreline. This unit was too narrow to map.

5. ***Melaleuca preissiana-Banksia littoralis* woodland** occupies sandy substrates in more low-lying situations than the sandy jarrah-marri woodland (unit 2). *Banksia ilicifolia* can occur as a co-dominant canopy species. Common components of the understorey include *Lepidosperma longitudinale, Baumea juncea, Agonis parviceps, Astartea* sp., *Calothamnus lateralis, Kunzea recurva* and in the wettest parts *Pericalymma ellipticum.* This unit intergrades with the wet heath unit (unit 7).

6. ***Eucalyptus decipiens* open woodland** forms a narrow band around the edge of the lake immediately inland of the *Melaleuca cuticularis* woodland. South of the lake it occurs on narrow raised dunes at the inland side of the *Melaleuca cuticularis* flat. This community also occurs on the ecotone between the sandy jarrah unit (unit 2) and the wet flats; in this situation it has a diverse understorey dominated by *Astartea* sp., *Melaleuca viminea,* and *Pericalymma ellipticum.*

7. ***Melaleuca rhaphiophylla* low forest** is the dominant vegetation on long seasonally inundated wetlands and the fringing unit around the freshwater basin wetlands. It is typically dense with a sparse understorey usually dominated by *Lepidosperma longitudinale,* in slightly more open areas *Melaleuca viminea, Aotus intermedia* and the perennial rushes *Meeboldina tephrina* and *Meeboldina roycei* are found.

8. **Wet heath** dominated by *Pericalymma ellipticum, Melaleuca viminea* and *Lepidosperma longitudinale* occupy the lowest lying areas outside the basin wetlands.

9. ***Baumea articulata* sedgeland** occurs along the south-western edge of Lake Pindicup, in a small basin wetland immediately south of Lake Pindicup and in Bodjinup Swamp near the southern boundary of the reserve. In the deepest sections *Baumea articulata* is the sole dominant while closer to the shore *Triglochin huegelii* becomes more apparent.

10. ***Baumea vaginalis* sedgeland** occurs on the lake floor and is flooded late into summer. The sedgeland generally comprises monospecific stands of *B. vaginalis* although in some areas *B. arthrophylla* may dominate or co-dominate.

11. ***Gahnia* sedgeland** occurs on the flats on the eastern side of the lake. *Gahnia trifida* was the dominant taxon but species such as the shrubs *Thomasia grandiflora,* and *Grevillea ?diversifolia,* and the annuals *Cotula cotuloides, Gnephosis ?tenuissima, Vellereophyton dealbatum* were also common.

12. **Lake bed** was clayey and before it completely dried out was covered with an annual herbland primarily made up of *Myriophyllum verrucosum*. While the lake contained water *Lepilaena australis* was a common aquatic.

13. **Disturbed areas** are small and confined to areas near tracks and firebreaks; a series of weedy grasses and *Rumex* spp. were collected from these areas.

Vegetation change Oblique aerial photographs from February and April 1980 show little change since then in the vegetation of Bodjinup Swamp or Lake Pindicup itself.

Disturbance or threats No immediate threat is apparent but 1995 aerial photographs show further recent clearance.

Pindicup Nature Reserve flora list.

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Arthropodium preissii
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus manglesianus
- Thysanotus sparteus
- Thysanotus tenellus
- Tricoryne elatior

Apiaceae
- Daucus glochidiatus
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Platysace filiformis
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- * Arctotheca calendula
- Asteridea pulverulenta
- Cotula cotuloides
- * Cotula turbinata
- Craspedia variabilis
- Euchiton gymnocephalus
- Gnephosis ?tenuissima
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia myosotidifolia
- Podolepis gracilis
- Podotheca angustifolia
- Pogonolepis stricta
- Pterochaeta paniculata
- Quinetia urvillei
- Rhodanthe citrina
- Rutidosis multiflora
- Siloxerus humifusus
- * Sonchus hydrophilus
- * Sonchus oleraceus
- * Vellereophyton dealbatum

Caesalpiniaceae
- Labichea punctata

Campanulaceae
- Wahlenbergia preissii

Caryophyllaceae
- * Cerastium glomeratum

Casuarinaceae
- Allocasuarina humilis
- Allocasuarina thuyoides

Centrolepidaceae
- Aphelia cyperoides
- Brizula drummondii
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis glabra
- Centrolepis mutica
- Centrolepis pilosa

Colchicaceae
- Burchardia congesta
- Burchardia monantha

Crassulaceae
- Crassula colorata
- Crassula peduncularis

Cupressaceae
- Actinostrobus pyramidalis

Cyperaceae
- Baumea arthrophylla
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Caustis sp. Boyanup(*G.S. McCutcheon* 1706)
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Gahnia trifida
- Isolepis cernua
- Isolepis stellata
- Lepidosperma angustatum
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma tenue
- Mesomelaena tetragona
- Schoenus ?caespititius
- Schoenus curvifolius
- Schoenus humilis
- Schoenus laevigatus
- Schoenus subbulbosus
- Schoenus subfascicularis
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii

Dasypogonaceae
- Dasypogon bromeliifolius
- Lomandra collina
- Lomandra micrantha
- Lomandra sericea
- Lomandra sonderi
- Lomandra suaveolens

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia ?commutata
- Hibbertia amplexicaulis
- Hibbertia cunninghamii
- Hibbertia glomerata
- Hibbertia racemosa
- Hibbertia stellaris

Droseraceae
- Drosera glanduligera
- Drosera macrantha
- Drosera menziesii
- Drosera stolonifera

Epacridaceae
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Astroloma prostratum

- Leucopogon ?sprengelioides
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon glabellus
- Leucopogon pendulus
- Leucopogon tamariscinus
- Leucopogon verticillatus

Euphorbiaceae
- Amperea volubilis
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera microphylla

Gentianaceae
- * Centaurium erythraea
- Centaurium spicatum

Geraniaceae
- * Erodium botrys

Goodeniaceae
- Anthotium junciforme
- Dampiera alata
- Dampiera fasciculata
- Dampiera linearis
- Goodenia micrantha
- Goodenia pulchella
- Scaevola phlebopetala
- Velleia trinervis

Haemodoraceae
- Anigozanthos flavidus
- Conostylis aculeata
- Conostylis laxiflora
- Conostylis setigera
- Haemodorum laxum
- Haemodorum spicatum

Hydatellaceae
- Hydatella sp.

Haloragaceae
- Myriophyllum verrucosum

Iridaceae
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)
- * Romulea rosea

Juncaceae
- * Juncus bufonius
- * Juncus capitatus
- Juncus pallidus

Juncaginaceae
- Triglochin huegelii

Lamiaceae
- Hemiandra pungens
- * Mentha pulegium

Lauraceae
- Cassytha glabella
- Cassytha racemosa

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Lobelia alata
- Lobelia gibbosa

Loganiaceae
- Logania serpyllifolia
- Phyllangium paradoxum

Loranthaceae
- Nuytsia floribunda

Menyanthaceae
- Villarsia parnassifolia

Mimosaceae
- Acacia ?biflora
- Acacia extensa
- Acacia huegelii
- Acacia myrtifolia
- Acacia stenoptera

Myoporaceae
- Myoporum caprarioides

Myrtaceae
- Agonis parviceps
- Astartea sp. (pink weeping)
- Baeckea camphorosmae
- Calothamnus ?schaueri
- Calothamnus lateralis
- Calytrix flavescens
- Calytrix leschenaultii
- Calytrix sp.
- Eucalyptus calophylla
- Eucalyptus decipiens
- Eucalyptus marginata
- Hypocalymma angustifolium
- Kunzea ericifolia
- Kunzea recurva
- Melaleuca cuticularis
- Melaleuca densa
- Melaleuca lateritia
- Melaleuca preissiana
- Melaleuca rhaphiophylla
- Melaleuca sp.
- Melaleuca thymoides
- Melaleuca viminea
- Pericalymma ellipticum

Onagraceae
- Epilobium billardierianum

Orchidaceae
- Caladenia flava
- Cyrtostylis robusta
- Elythranthera brunonis
- Microtis atrata
- Microtis media
- Microtis orbicularis
- * Monadenia bracteata
- Praecoxanthus aphyllus ms
- Thelymitra benthamiana
- Thelymitra crinita
- Thelymitra flexuosa
- Thelymitra pauciflora

Orobanchaceae
- * Orobanche minor

Papilionaceae
- Aotus intermedia
- Bossiaea eriocarpa
- Bossiaea linophylla
- Bossiaea ornata
- Bossiaea praetermissa
- Brachysema melanopetalum
- Chorizema aciculare
- Daviesia ?physodes
- Gompholobium confertum
- Gompholobium knightianum
- Gompholobium marginatum
- Gompholobium preissii
- Gompholobium tomentosum
- Hovea chorizemifolia
- Hovea trisperma
- Jacksonia furcellata
- Kennedia coccinea
- Kennedia prostrata
- * Ornithopus compressus
- Pultenaea ochreata
- Viminaria juncea

Phormiaceae
- Dianella revoluta
- Stypandra glauca

Pittosporaceae
- Billardiera variifolia
- Pronaya fraseri
- Sollya heterophylla

Poaceae
- Agrostis avenacea
- * Aira caryophyllea
- Amphipogon turbinatus
- Austrodanthonia occidentalis
- Austrostipa pycnostachya
- * Briza minor
- * Bromus diandrus
- Deyeuxia quadriseta

- Hemarthria uncinata
- * Hordeum leporinum
- Neurachne alopecuroidea
- Tetrarrhena laevis
- * Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma volubile

Polygonaceae
- Persicaria prostrata
- * Rumex acetosella
- * Rumex pulcher

Primulaceae
- Samolus junceus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Dryandra armata
- Dryandra lindleyana
- Grevillea ?diversifolia
- Hakea corymbosa
- Hakea lissocarpha
- Hakea prostrata
- Hakea sulcata
- Hakea trifurcata
- Hakea varia
- Persoonia longifolia
- Petrophile acicularis
- Petrophile serruriae
- Synaphea ?petiolaris

Ranunculaceae
- Clematis pubescens

Restionaceae
- Anarthria prolifera
- Anarthria scabra
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Hypolaena exsulca
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina ?coangustata ms
- Meeboldina ?tephrina ms
- Meeboldina cana ms
- Meeboldina roycei ms
- Restio sp.
- Stenopa ramosissima ms

Rhamnaceae
- Trymalium ledifolium

Rubiaceae
- Opercularia apiciflora
- Opercularia hispidula
- Opercularia vaginata

Rutaceae
- Boronia crenulata
- Boronia ramosa
- Boronia sp.
- Boronia spathulata

Santalaceae
- Leptomeria spinosa
- Leptomeria squarrulosa

Selaginellaceae
- Selaginella gracillima

Solanaceae
- * Solanum nigrum

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Sterculiaceae
- Thomasia grandiflora
- Thomasia pauciflora

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium brunonianum ssp. minor
- Stylidium caespitosum
- Stylidium corymbosum
- Stylidium repens
- Stylidium schoenoides
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea ciliata
- Pimelea sulphurea

Tremandraceae
- Tetratheca affinis

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

Zannichelliaceae
- Lepilaena australis

PINTICUP NATURE RESERVE

Reserve number 26682 **Class** A
Location 34 27 59S 116 48 27E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 75 ha

Biological values

Flora A total of 297 taxa have been recorded from the reserve (see flora list below). This includes six priority taxa (*Anthotium junciforme* (Priority 4), *Apodasmia ceramophila* ms (Priority 2), *Jacksonia sparsa* ms (Priority 3), *Rhodanthe pyrethrum* (Priority 3), *Stylidium mimeticum* (Priority 3), *Villarsia submersa* (Priority 4)).

Vegetation description Fourteen vegetation units were identified in Pinticup Nature Reserve, two of these (jarrah-marri woodland on laterite - unit 13; and the disturbed areas - unit 14) were too small to map (Map 9).

1. **Jarrah-marri open woodland** on sand occurs on the sandy rises and the better drained flats. This community is essentially similar to sandy jarrah-marri in Galamup and Noobijup Nature Reserves. The understorey is diverse in shrubs and herbs with *Leucopogon* spp., *Acacia* spp., *Melaleuca thymoides*, *Gompholobium* spp. and *Hakea ruscifolia* the obvious components. In the dampest areas *Hypocalymma angustifolium* and *Kunzea micrantha* become more common.

2. **Logged jarrah-marri open woodland** on sand occurs near the western boundary of the reserve. The result has been an opening up of the canopy, species composition is the same as in vegetation unit 1.

3. **Jarrah-marri-yate open woodland** occurs on the sand dune on the eastern side of Pinticup Swamp. It has a similar species composition to the jarrah-marri open woodland with the addition of yate as a canopy co-dominant.

4. ***Banksia ilicifolia* woodland** occurs on poorly drained sandy flats in the western part of the reserve. Common understorey elements include *Adenanthos obovatus, Hakea sulcata, Brachysema melanopetalum* and *Lysinema ciliatum. Franklandia fucifolia* was also found in this unit. In the wettest sites this community grades into *Melaleuca preissiana-Banksia littoralis* woodland (vegetation unit 6).

5. ***Melaleuca cuticularis* woodland** occupies most of a small basin wetland in the north-west of the reserve. The understorey is dominated by *Gahnia trifida* with other common taxa including *Astartea, Melaleuca lateritia, Melaleuca viminea, Chaetanthus aristatus*, and *Meeboldina cana*. The soil in this area has a higher clay content than the surrounding areas.

6. ***Melaleuca preissiana-Banksia littoralis* woodland** occurs on the poorest drained areas of sandy soil. As a consequence the understorey is variously dominated by *Anigozanthos flavidus, Agonis juniperina, Calothamnus lateralis, Hypocalymma angustifolium, Melaleuca* spp. (including *Melaleuca densa* and *Melaleuca viminea), Pericalymma ellipticum, Hakea varia*, and the perennial rushes *Lepyrodia muirii, Meeboldina tephrina, Tremulina tremula. Eucalyptus rudis* occasionally occurs in the canopy layer.

7. ***Eucalyptus decipiens* open woodland** occurs on the wet clay flats on the southern boundary of the reserve. It is a diverse community with rich shrub layer and large numbers of annual herbs as has been described for Noobijup Nature Reserve.

8. ***Melaleuca rhaphiophylla* low forest** occurs in areas of the longest inundation and as the fringing vegetation on the western shore of Pinticup Swamp. It typically has a sparse understorey of *Lepidosperma longitudinale, Baumea articulata, Baumea vaginalis, Villarsia albiflora*, and where gaps in canopy occur *Astartea fascicularis* and *Callistachys lanceolata* occur.

9. ***Hakea prostrata* heath** occurs in a small area in the south-west corner of the reserve. This is an equivalent unit to that described in Galamup Nature Reserve.

10. **Wet heath** occurs on the wettest parts of the clay flats in the south-eastern corner of the reserve. These flats are dominated by *Melaleuca* spp. and perennial rushes (*Apodasmia ceramophila* and *Harperia lateriflora).* In late winter the flats are completely flooded and aquatic taxa such as *Villarsia submersa* are conspicuous. As the wetland dries a diverse suite of annual herbs emerges. These include annual *Schoenus* spp., *Tribonanthes violacea*, and an array of orchids.

11. ***Baumea* sedgeland** occurs in the two basin wetlands, the deepest parts being dominated by *Baumea articulata* while toward the shore *Triglochin huegelii* and *Villarsia albiflora* co-dominate.

12. ***Lepidosperma longitudinale* sedgeland** occurs in a small patch in the south-west corner of the reserve in a winter-wet drainage line.

13. **Disturbed areas** occur associated with firebreaks; these areas are too small to map but are a major source of weed concentration.

14. **Jarrah-marri woodland** on laterite occurs as small patches within the sandy jarrah-marri unit (vegetation unit 1). This unit was also too small to map but did show significant change in understorey species as has been described for other reserves.

Vegetation change Oblique aerial photographs from February and April 1980 showed no obvious changes in the vegetation.

Disturbance or threats No obvious threat is apparent at this time, run-off from tree farming which occurs on three sides of the reserve should be monitored.

Pinticup Nature Reserve flora list.

Aizoaceae
- Carpobrotus modestus

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Johnsonia acaulis
- Johnsonia lupulina
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus arenarius
- Thysanotus manglesianus
- Thysanotus patersonii
- Thysanotus sparteus
- Thysanotus tenellus
- Thysanotus triandrus
- Tricoryne elatior

Apiaceae
- Daucus glochidiatus
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle pilifera
- Platysace juncea
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- * Arctotheca calendula
- Brachyscome iberidifolia
- Craspedia variabilis
- Euchiton sphaericus
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Milliotia myosotidifolia
- Podolepis gracilis
- Rhodanthe pyrethrum
- Siloxerus humifusus
- * Sonchus hydrophilus
- Trichocline spathulata

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii

Casuarinaceae
- Allocasuarina humilis

Centrolepidaceae
- Aphelia cyperoides
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis mutica

Colchicaceae
- Burchardia congesta
- Burchardia monantha

Crassulaceae
- Crassula colorata

Cyperaceae
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Caustis dioica
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Gahnia ?aristata
- Gahnia trifida
- * Isolepis marginata
- Lepidosperma ?gracile
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma tenue
- Mesomelaena stygia
- Mesomelaena tetragona
- Schoenus curvifolius
- Schoenus efoliatus
- Schoenus elegans
- Schoenus humilis
- Schoenus tenellus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii

Dasypogonaceae
- Dasypogon bromeliifolius
- Lomandra collina
- Lomandra sericea
- Lomandra sonderi
- Lomandra suaveolens

Dennstaedtiaceae
- Pteridium esculentum

Dilleniaceae
- Hibbertia amplexicaulis
- Hibbertia cunninghamii
- Hibbertia racemosa
- Hibbertia stellaris

Droseraceae
- Drosera gigantea
- Drosera glanduligera
- Drosera menziesii

Epacridaceae
- Andersonia sp.
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon glabellus
- Leucopogon oxycedrus
- Lysinema ciliatum
- Sphenotoma gracile

Euphorbiaceae
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera microphylla

Goodeniaceae
- Anthotium junciforme
- Dampiera alata
- Dampiera diversifolia
- Dampiera hederacea
- Dampiera linearis
- Goodenia claytoniacea
- Goodenia micrantha
- Goodenia mimuloides
- Goodenia pulchella
- Scaevola phlebopetala
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos flavidus
- Anigozanthos manglesii
- Conostylis aculeata
- Haemodorum laxum
- Haemodorum simplex
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Tribonanthes violacea

Haloragaceae
- Gonocarpus cordiger
- Gonocarpus hexandrus
- Gonocarpus paniculatus

Hypoxidaceae
- Hypoxis occidentalis

Iridaceae
- Patersonia juncea
- Patersonia umbrosa
- * Watsonia bulbillifera

Juncaceae
- * Juncus bufonius
- Juncus pallidus
- Juncus sp.

Juncaginaceae
- Triglochin huegelii

Lamiaceae
- Hemiandra pungens

Lauraceae
- Cassytha glabella
- Cassytha micrantha
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Lobelia alata

Loganiaceae
- Logania campanulata
- Logania serpyllifolia

Loranthaceae
- Nuytsia floribunda

Menyanthaceae
- Villarsia albiflora
- Villarsia submersa

Mimosaceae
- Acacia biflora
- Acacia extensa
- Acacia incurva
- Acacia stenoptera

Myoporaceae
- Myoporum caprarioides

Myrtaceae
- Agonis juniperina
- Astartea fascicularis
- Astartea sp. (pink weeping)
- Baeckea camphorosmae
- Callistemon phoeniceus
- Calothamnus lateralis
- Calothamnus ?schaueri
- Calytrix angulata
- Calytrix leschenaultii
- Eucalyptus calophylla
- Eucalyptus cornuta
- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus occidentalis
- Eucalyptus rudis
- Hypocalymma angustifolium
- Kunzea micrantha
- Melaleuca cuticularis
- Melaleuca densa
- Melaleuca lateritia
- Melaleuca leptoclada
- Melaleuca preissiana
- Melaleuca rhaphiophylla
- Melaleuca thymoides
- Melaleuca viminea
- Pericalymma ellipticum
- Verticordia sp.

Orchidaceae
- Caladenia flava
- Caladenia longicauda
- Caladenia radialis
- Drakaea sp.
- Elythranthera brunonis
- Elythranthera emarginata
- Microtis atrata
- Microtis media
- Microtis orbicularis
- * Monadenia bracteata
- Paracaleana nigrita
- Prasophyllum drummondii
- Prasophyllum macrostachyum
- Pterostylis recurva
- Pterostylis vittata
- Pyrorchis nigricans
- Thelymitra crinita
- Thelymitra pauciflora

Papilionaceae
- Bossiaea linophylla
- Bossiaea ornata
- Bossiaea praetermissa
- Brachysema melanopetalum
- Callistachys lanceolata
- Daviesia hakeoides
- Daviesia incrassata
- Daviesia physodes
- Daviesia preissii
- Gompholobium capitatum
- Gompholobium confertum
- Gompholobium marginatum
- Gompholobium polymorphum
- Gompholobium preissii
- Gompholobium scabrum
- Gompholobium tomentosum
- Hovea chorizemifolia
- Hovea trisperma
- Jacksonia furcellata
- Jacksonia sparsa ms
- Kennedia prostrata
- Oxylobium lineare
- Sphaerolobium vimineum

Philydraceae
- Philydrella pygmaea

Phormiaceae
- Dianella revoluta

Pittosporaceae
- Billardiera parviflora
- Marianthus candidus
- Sollya heterophylla

Poaceae
- Agrostis avenacea
- Amphipogon debilis
- Amphipogon turbinatus
- * Briza maxima
- * Briza minor
- Austrodanthonia setacea
- Austrostipa compressa

- Austrostipa pycnostachya
- Austrostipa trichophylla
- Deyeuxia quadriseta
- Hemarthria uncinata
- * Holcus lanatus
- Neurachne alopecuroidea
- Tetrarrhena laevis
- * Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma flavum
- Comesperma virgatum
- Comesperma volubile

Primulaceae
- Samolus junceus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Dryandra bipinnatifida
- Dryandra lindleyana
- Franklandia fucifolia
- Grevillea depauperata
- Grevillea fasciculata
- Hakea lissocarpha
- Hakea prostrata
- Hakea ruscifolia
- Hakea sulcata
- Hakea undulata
- Hakea varia
- Persoonia longifolia
- Petrophile media
- Stirlingia ?seselifolia
- Synaphea petiolaris

Restionaceae
- Anarthria gracilis
- Anarthria prolifera
- Apodasmia ceramophila ms
- Chaetanthus aristatus ms
- Cytogonidium leptocarpoides ms
- Desmocladus fasciculatus ms
- Harperia lateriflora
- Hypolaena exsulca
- Leptocarpus tenax
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina cana ms
- Meeboldina tephrina ms
- Tremulina tremula ms

Rhamnaceae
- Trymalium ledifolium

Rubiaceae
- Opercularia apiciflora
- Opercularia hispidula
- Opercularia vaginata

Rutaceae
- Boronia crenulata
- Boronia juncea ssp. laniflora
- Boronia spathulata

Santalaceae
- Leptomeria squarrulosa

Selaginellaceae
- Selaginella gracillima

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium brunonianum
- Stylidium crassifolium
- Stylidium guttatum
- Stylidium mimeticum
- Stylidium pulchellum
- Stylidium repens
- Stylidium sp.
- Stylidium spathulatum

Thymelaeaceae
- Pimelea sulphurea

Zamiaceae
- Macrozamia riedlei

Zannichelliaceae
- Lepilaena australis

QUINDINUP NATURE RESERVE

Reserve number 25506 **Class** C
Location 34 24 41S 116 52 41E
Land tenure Nature Reserve
Purpose Conservation of flora and fauna
Area 2653 ha

Biological values

Flora A brief survey was undertaken of Quindinup Reserve, this found 276 taxa. This list should be considered preliminary (see flora list below). One priority flora species (*Eucalyptus aspersa* (Priority 4)) was recorded from the reserve.

Vegetation description No vegetation mapping was undertaken for this reserve. Six major habitat types were defined while compiling the flora.

1. ***Melaleuca rhaphiophylla-M. preissiana* woodland** along creek lines.
2. **Disturbed areas.**
3. **Lateritic heath.**
4. **Jarrah-marri woodland** on sand.
5. **Jarrah-marri woodland** on laterite.
6. **Wandoo woodland.**

Vegetation change This reserve was not photographed in 1980.

Disturbance or threats Upland areas are in excellent condition. An increase in salinity in some of the creek lines is causing impacts to the riparian vegetation.

Quindinup Nature Reserve flora list.

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Johnsonia acaulis
- Johnsonia lupulina
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus manglesianus
- Thysanotus multiflorus
- Thysanotus thyrsoideus
- Tricoryne elatior
- Tricoryne tenella

Apiaceae
- Daucus glochidiatus
- Eryngium pinnatifidum
- Homalosciadium homalocarpum
- Hydrocotyle pilifera
- Platysace juncea
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia atkinsoniana
- Xanthosia candida

Asteraceae
- * Arctotheca calendula
- * Conyza albida
- Cotula coronopifolia
- Craspedia variabilis
- Euchiton sphaericus
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia myosotidifolia
- Olearia paucidentata
- Picris angustifolia
- Podolepis gracilis
- Pterochaeta paniculata
- Quinetia urvillei
- Senecio minimus
- * Sonchus oleraceus
- Trichocline spathulata
- Waitzia nitida
- Waitzia suaveolens

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii

Caryophyllaceae
- * Cerastium glomeratum
- * Petrorhagia velutina

Casuarinaceae
- Allocasuarina ?microstachya

Centrolepidaceae
- Aphelia cyperoides
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis pilosa

Colchicaceae
- Burchardia congesta
- Burchardia multiflora

Crassulaceae
- Crassula colorata

Cyperaceae
- Baumea juncea
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Gahnia drummondii
- Isolepis cernua

* Isolepis marginata
Isolepis oldfieldiana
Isolepis stellata
Lepidosperma angustatum
Lepidosperma tenue
Mesomelaena tetragona
Schoenus nanus
Tetraria capillaris
Tetraria octandra

Dasypogonaceae
Chamaexeros serra
Lomandra caespitosa
Lomandra micrantha
Lomandra purpurea
Lomandra sericea
Lomandra sonderi
Lomandra suaveolens

Dennstaedtiaceae
Pteridium esculentum

Dilleniaceae
Hibbertia ?amplexicaulis
Hibbertia commutata
Hibbertia racemosa
Hibbertia vaginata

Droseraceae
Drosera bulbosa
Drosera erythrorhiza
Drosera gigantea
Drosera glanduligera
Drosera macrantha
Drosera stolonifera

Epacridaceae
Astroloma ciliatum
Astroloma pallidum
Astroloma prostratum
Leucopogon australis
Leucopogon capitellatus
Leucopogon pendulus
Leucopogon propinquus
Leucopogon sp.
Leucopogon verticillatus
Styphelia tenuiflora

Euphorbiaceae
Monotaxis occidentalis
Phyllanthus calycinus
Poranthera microphylla

Gentianaceae
* Centaurium erythraea

Geraniaceae
Geranium solanderi

Goodeniaceae
Dampiera ?alata
Dampiera linearis
Goodenia micrantha
Goodenia pulchella
Lechenaultia biloba
Lechenaultia expansa
Scaevola phlebopetala
Velleia trinervis

Haemodoraceae
Anigozanthos manglesii
Conostylis aculeata
Conostylis setigera
Haemodorum laxum
Haemodorum simplex
Haemodorum sparsiflorum
Haemodorum spicatum

Haloragaceae
Glischrocaryon aureum
Gonocarpus paniculatus

Hypoxidaceae
Hypoxis glabella

Iridaceae
Patersonia juncea
Patersonia occidentalis
Patersonia umbrosa

Juncaceae
* Juncus acutus
* Juncus bufonius
* Juncus capitatus
Luzula meridionalis

Lauraceae
Cassytha glabella
Cassytha racemosa

Lentibulariaceae
Polypompholyx multifida

Lindsaeaceae
Lindsaea linearis

Lobeliaceae
Lobelia tenuior

Loganiaceae
Logania serpyllifolia
Phyllangium paradoxum

Mimosaceae
Acacia extensa
Acacia incurva
Acacia myrtifolia
Acacia nervosa
Acacia pulchella
Acacia saligna
Acacia stenoptera
Acacia willdenowiana

Myrtaceae
Agonis juniperina
Astartea sp. (pink weeping)
Baeckea camphorosmae
Eucalyptus aspersa
Eucalyptus calophylla
Eucalyptus marginata
Eucalyptus wandoo
Hypocalymma angustifolium
Kunzea ?micrantha
Kunzea recurva
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca thymoides
Melaleuca viminea
Verticordia densiflora

Olacaceae
Olax benthamiana

Onagraceae
Epilobium billardierianum

Orchidaceae
Caladenia flava
Caladenia longiclavata
Caladenia marginata
Caladenia nana
Caladenia varians ms
Cryptostylis ovata
Cyanicula deformis ms
Diuris longifolia
Elythranthera brunonis
Elythranthera emarginata
Eriochilus dilatatus
Eriochilus scaber
Leporella fimbriata
Microtis media
* Monadenia bracteata
Pterostylis barbata
Pterostylis recurva
Pterostylis vittata
Thelymitra antennifera
Thelymitra crinita

Orobanchaceae
* Orobanche minor

Oxalidaceae
Oxalis perennans

Papilionaceae
Aotus intermedia
Bossiaea linophylla
Bossiaea ornata
Bossiaea praetermissa

Daviesia cordata
Daviesia preissii
Gastrolobium bilobum
Gompholobium confertum
Gompholobium knightianum
Gompholobium marginatum
Gompholobium preissii
Gompholobium tomentosum
Hardenbergia comptoniana
Hovea chorizemifolia
Hovea trisperma
Isotropis cuneifolia
Jacksonia furcellata
Kennedia prostrata
Sphaerolobium medium
* Trifolium campestre
* Trifolium dubium
* Trifolium subterraneum

Philydraceae
Philydrella pygmaea

Phormiaceae
Dianella brevicaulis
Dianella revoluta

Pittosporaceae
Billardiera ?variifolia
Sollya heterophylla

Poaceae
Agrostis avenacea
* Aira caryophyllea
Amphipogon turbinatus
* Briza minor
Austrodanthonia occidentalis
Austrostipa compressa
Austrostipa pycnostachya
* Holcus lanatus
Microlaena stipoides
Neurachne alopecuroidea
* Polypogon monspeliensis
Tetrarrhena laevis
* Vulpia myuros

Polygalaceae
Comesperma virgatum

Primulaceae
* Anagallis arvensis

Proteaceae
Banksia grandis
Banksia littoralis
Dryandra armata
Dryandra lindleyana
Dryandra sessilis
Grevillea fasciculata
Hakea amplexicaulis
Hakea lissocarpha
Hakea prostrata
Hakea undulata
Hakea varia
Persoonia longifolia
Petrophile serruriae
Stirlingia tenuifolia
Synaphea petiolaris

Ranunculaceae
Clematis aristata
Ranunculus colonorum

Restionaceae
Anarthria prolifera
Desmocladus fasciculatus ms
Desmocladus flexuosus ms
Hypolaena exsulca
Lyginia barbata

Rhamnaceae
Trymalium ledifolium

Rubiaceae
Opercularia apiciflora
Opercularia hispidula

Rutaceae
Boronia ramosa
Boronia spathulata

Santalaceae
Leptomeria scrobiculata
Leptomeria squarrulosa

Scrophulariaceae
* Bellardia trixago
* Parentucellia latifolia

Selaginellaceae
Selaginella gracillima

Stackhousiaceae
Stackhousia monogyna
Tripterococcus brunonis

Stylidiaceae
Levenhookia pusilla
Levenhookia stipitata
Stylidium amoenum
Stylidium brunonianum ssp. minor
Stylidium calcaratum
Stylidium junceum
Stylidium luteum
Stylidium piliferum
Stylidium repens
Stylidium schoenoides
Stylidium spathulatum

Thymelaeaceae
Pimelea angustifolia
Pimelea rosea

Tremandraceae
Tetratheca ?hirsuta

Violaceae
Hybanthus floribundus

Xanthorrhoeaceae
Xanthorrhoea gracilis
Xanthorrhoea preissii

Zamiaceae
Macrozamia riedlei

UNICUP NATURE RESERVE

Reserve number 25798 **Class** A
Location 34 21 35S 116 43 18E
Land tenure Nature Reserve
Purpose Conservation of flora and fauna
Area 3296 ha

Biological values

Flora Using Griffin (1984) data as a basis, a flora list of 512 taxa was compiled from the reserve (see flora list below). This included ten priority taxa (*Anthotium junciforme* (Priority 4), *Dryandra porrecta* (Priority 4), *Eucalyptus latens* (Priority 4), *Hibbertia silvestris* (Priority 4), *Opercularia rubioides* (Priority 2), *Pithocarpa corymbulosa* (Priority 2), *Schoenus loliaceus* (Priority 2), *Schoenus natans* (Priority 4), *Stylidium mimeticum* (Priority 3), *Synaphea decumbens* (Priority 1)).

Vegetation description Griffin (1984) mapped the reserve and described 12 vegetation units. Brief descriptions of these units are given below.

2. ***Eucalyptus marginata* (jarrah) forest (Type 1)** Jarrah/marri forest on the top and upper slopes of the lateritic ridges.

3/9. ***Eucalyptus marginata* (jarrah) forest (Type 2)/*Agonis parviceps* thicket** Variable unit similar to Kodjinup vegetation unit 2, common on low-lying sandy substrates.

5. ***Eucalyptus wandoo* forest** occurs as small patches in jarrah forest on loamy gravels or clayey soils.

7. ***Eucalyptus decipiens* open low woodland B (Type 1)** occurs on loamy sand usually on terraces above drainage lines. It is essentially similar to the Lake Muir vegetation unit 6.

9. ***Agonis parviceps* thicket** A variable unit which may have an overstorey of jarrah and/or *Banksia ilicifolia*. Appears essentially similar to Muir vegetation unit 3.

10. ***Melaleuca preissiana-Banksia littoralis* open low woodland A** A complex unit essentially similar to Kodjinup vegetation unit 6.

12. ***Melaleuca lateritia* dense low heath** Essentially similar to Galamup vegetation unit 6, these are small basin wetlands on loamy clays.

13. ***Melaleuca rhaphiophylla* dense low forest B** Occurs as circular or ring shaped areas in centre of some basin wetlands. This unit is equivalent to Muir vegetation unit 15.

15. ***Melaleuca cuticularis* complex** *Melaleuca cuticularis* woodlands to forests with an understorey variously dominated by *Melaleuca densa, Kunzea recurva, Pericalymma ellipticum* or *Gahnia trifida* giving way to very little understoreys under the densest canopies

17. ***Halosarcia-Wilsonia* mat plants** form areas of herbland around several of the salt lakes. Similar in many respects to Muir vegetation unit 27.

19. ***Baumea* sedges** occupying basin wetlands, essentially the same as Kodjinup vegetation units 10 and 11.

24. ***Leptocarpus* sedges** Clay flats dominated by *Apodasmia ceramophila* ms. Griffin (1984) states that there are few herbs, however, these winter-wet flats have a diverse annual herb flora in spring and early summer as these seasonally inundated wetlands dry.

Disturbed areas These were not mapped by Griffin (1984) but were used in compiling the species lists.

Vegetation change This reserve was not photographed in 1980.

Disturbance or threats Inundation of a small wetland on the eastern side of the reserve owing to rising water table. Destruction of woodland communities on the eastern boundary owing to rising saline water table.

Unicup Nature Reserve flora list.

Aizoaceae
- Carpobrotus modestus

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Arthropodium preissii
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Chamaescilla spiralis
- Johnsonia acaulis
- Johnsonia lupulina
- Laxmannia minor
- Laxmannia sessiliflora
- Sowerbaea laxiflora
- Thysanotus manglesianus
- Thysanotus patersonii
- Thysanotus tenellus
- Thysanotus thyrsoideus
- Tricoryne elatior
- Tricoryne humilis

Apiaceae
- Daucus glochidiatus
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle pilifera
- Platysace filiformis
- Platysace juncea
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Aspleniaceae
- Asplenium flabellifolium

Asteraceae
- Angianthus preissianus
- Angianthus tomentosus
- * Arctotheca calendula
- Asteridea pulverulenta
- Brachyscome ciliaris
- Brachyscome iberidifolia
- Cotula coronopifolia
- Cotula cotuloides
- Craspedia variabilis
- Euchiton sphaericus
- Gnephosis tenuissima
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia tenuifolia
- Olearia paucidentata
- Pithocarpa corymbulosa
- Podolepis gracilis
- Podolepis lessonii
- Podotheca angustifolia
- Pogonolepis stricta
- * Pseudognaphalium luteoalbum
- Pterochaeta paniculata
- Quinetia urvillei
- Rhodanthe citrina
- Rutidosis multiflora
- Senecio glomeratus
- Senecio minimus
- Siloxerus humifusus
- * Vellereophyton dealbatum
- Vittadinia australasica

Campanulaceae
- Wahlenbergia multicaulis
- Wahlenbergia preissii
- Wahlenbergia stricta

Caryophyllaceae
- * Cerastium glomeratum
- Petrorhagia prolifera
- * Silene gallica

Casuarinaceae
- Allocasuarina humilis
- Allocasuarina microstachya
- Allocasuarina thuyoides

Centrolepidaceae
- Aphelia cyperoides
- Centrolepis alepyroides
- Centrolepis aristata
- Centrolepis drummondiana
- Centrolepis glabra
- Centrolepis pilosa
- Centrolepis polygyna

Chenopodiaceae
- Dysphania glomulifera ssp. glomulifera
- Dysphania plantaginella
- Halosarcia ?indica
- Sarcocornia quinqueflora

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Burchardia multiflora

Convolvulaceae
- Wilsonia backhousei
- Wilsonia humilis

Crassulaceae
- Crassula colorata
- Crassula pedicellosa

Cupressaceae
- Actinostrobus pyramidalis

Cyperaceae
- Baumea articulata
- Baumea juncea
- Baumea rubiginosa
- Baumea vaginalis
- Caustis dioica
- Chorizandra enodis
- Cyathochaeta avenacea
- Cyathochaeta clandestina
- Gahnia trifida
- Isolepis cernua
- Isolepis fluitans
- * Isolepis marginata
- Isolepis oldfieldiana
- Isolepis stellata
- Lepidosperma angustatum
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma ?tenue
- Mesomelaena graciliceps
- Mesomelaena stygia
- Mesomelaena tetragona
- Schoenus curvifolius
- Schoenus efoliatus
- Schoenus elegans
- Schoenus grandiflorus
- Schoenus humilis
- Schoenus loliaceus
- Schoenus nanus
- Schoenus natans
- Schoenus odontocarpus
- Schoenus subbulbosus
- Schoenus subflavus
- Schoenus sublateralis
- Schoenus submicrostachyus
- Schoenus tenellus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii

Dasypogonaceae
- Chamaexeros serra
- Dasypogon bromeliifolius

- Lomandra caespitosa
- Lomandra collina
- Lomandra hermaphrodita
- Lomandra micrantha
- Lomandra nigricans
- Lomandra purpurea
- Lomandra sericea
- Lomandra suaveolens

Dilleniaceae
- Hibbertia acerosa
- Hibbertia commutata
- Hibbertia cunninghamii
- Hibbertia ?polystachya
- Hibbertia pulchra
- Hibbertia racemosa
- Hibbertia silvestris
- Hibbertia stellaris
- Hibbertia subvaginata
- Hibbertia vaginata

Droseraceae
- Drosera bulbigena
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera macrantha
- Drosera menziesii
- Drosera paleacea
- Drosera pallida
- Drosera stolonifera

Epacridaceae
- Andersonia ?caerulea
- Astroloma ?baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Astroloma prostratum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon conostephioides
- Leucopogon ?elatior
- Leucopogon gibbosus
- Leucopogon pendulus
- Leucopogon propinquus
- Leucopogon verticillatus
- Lysinema ciliatum

Euphorbiaceae
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera huegelii
- Poranthera microphylla
- Pseudanthus virgatus

Gentianaceae
- * Centaurium erythraea
- * Cicendia filiformis
- Sebaea ovata

Geraniaceae
- Geranium solanderi
- Pelargonium littorale

Goodeniaceae
- Anthotium junciforme
- Dampiera ?alata
- Dampiera linearis
- Dampiera trigona
- Goodenia micrantha
- Goodenia pulchella
- Velleia trinervis

Haemodoraceae
- Anigozanthos humilis
- Anigozanthos manglesii
- Conostylis aculeata
- Conostylis setigera
- Haemodorum laxum
- Haemodorum simplex
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Tribonanthes sp Lake Muir

Haloragaceae
- Glischrocaryon aureum

Hydatellaceae
- Hydatella sp.
- Trithuria submersa

Hypoxidaceae
- Hypoxis occidentalis

Iridaceae
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)
- * Romulea rosea

Juncaceae
- * Juncus bufonius
- Juncus pallidus

Juncaginaceae
- Triglochin calcitrapum
- Triglochin centrocarpum
- Triglochin huegelii
- Triglochin mucronatum

Lamiaceae
- Hemiandra pungens

Lauraceae
- Cassytha glabella
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Polypompholyx tenella
- Utricularia volubilis

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Grammatotheca bergiana
- Isotoma hypocrateriformis
- Lobelia alata
- Lobelia gibbosa
- Lobelia heterophylla

Loganiaceae
- Logania serpyllifolia
- Phyllangium paradoxum

Loranthaceae
- Nuytsia floribunda

Lycopodiaceae
- Phylloglossum drummondii

Lythraceae
- * Lythrum hyssopifolia

Menyanthaceae
- Villarsia albiflora
- Villarsia parnassifolia

Mimosaceae
- Acacia biflora
- Acacia cyclops
- Acacia extensa
- Acacia huegelii
- Acacia laricina var. laricina
- Acacia latipes
- Acacia pulchella
- Acacia rostellifera
- Acacia saligna
- Acacia stenoptera
- Acacia tetragonocarpa
- Acacia varia

Myoporaceae
- Myoporum caprarioides

Myrtaceae
- Actinodium cunninghamii
- Agonis parviceps
- Astartea sp. (pink weeping)
- Astartea sp. (pink weeping)
- Baeckea camphorosmae
- Calothamnus lateralis
- Calothamnus lehmannii
- Calothamnus ?preissii
- Calytrix flavescens
- Calytrix leschenaultii

Calytrix ?tenuiramea
Darwinia ?vestita
Eremaea pauciflora
Eucalyptus calophylla
Eucalyptus cornuta
Eucalyptus decipiens
Eucalyptus ?latens
Eucalyptus occidentalis
Eucalyptus rudis
Eucalyptus wandoo
Hypocalymma angustifolium
Hypocalymma strictum
Kunzea ericifolia
Kunzea recurva
Leptospermum erubescens
Melaleuca cuticularis
Melaleuca densa
Melaleuca lateritia
Melaleuca pauciflora
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca thymoides
Melaleuca viminea
Pericalymma ellipticum
Verticordia densiflora
Verticordia habrantha

Olacaceae
Olax phyllanthi

Onagraceae
Epilobium billardierianum

Ophioglossaceae
Ophioglossum lusitanicum

Orchidaceae
Caladenia cairnsiana
Caladenia flava
Caladenia latifolia
Caladenia longicauda
Caladenia macrostylis
Caladenia magniclavata
Caladenia marginata
Caladenia radiata
Caladenia reptans
Caladenia rhomboidiformis
Caladenia splendens ms
Corybas recurvus
Cryptostylis ovata
Cyrtostylis robusta
Drakaea livida
Elythranthera brunonis
Elythranthera emarginata
Leporella fimbriata
Lyperanthus serratus
Microtis atrata
Microtis media
Microtis orbicularis
* Monadenia bracteata
Paracaleana nigrita
Praecoxanthus aphyllus ms
Prasophyllum macrostachyum
Pterostylis barbata
Pterostylis nana
Pterostylis recurva
Pterostylis sanguinea
Pyrorchis nigricans
Thelymitra antennifera
Thelymitra benthamiana
Thelymitra crinita
Thelymitra flexuosa
Thelymitra pauciflora

Orobanchaceae
* Orobanche minor

Oxalidaceae
Oxalis perennans
* Oxalis purpurea

Papilionaceae
Bossiaea eriocarpa
Bossiaea linophylla
Bossiaea ornata
Bossiaea praetermissa
Brachysema melanopetalum
Brachysema praemorsum
Chorizema aciculare
Chorizema ?ilicifolium
Daviesia cordata
Daviesia hakeoides
Daviesia ?incrassata
Daviesia preissii
Gompholobium aristatum
Gompholobium burtonioides
Gompholobium capitatum
Gompholobium confertum
Gompholobium knightianum
Gompholobium marginatum
Gompholobium ovatum
Gompholobium polymorphum
Gompholobium preissii
Gompholobium scabrum
Hovea chorizemifolia
Hovea trisperma var. grandiflora
Isotropis cuneifolia
Jacksonia ?furcellata
Kennedia prostrata
Pultenaea ericifolia
Pultenaea ochreata
Pultenaea reticulata
Sphaerolobium drummondii
Sphaerolobium linophyllum
Sphaerolobium medium
* Trifolium campestre
* Trifolium cernuum
Viminaria juncea

Philydraceae
Philydrella pygmaea

Phormiaceae
Dianella brevicaulis
Dianella revoluta
Stypandra glauca

Pittosporaceae
Billardiera drummondiana var.
Billardiera erubescens
Billardiera parviflora var. parviflora
Marianthus candidus
Sollya heterophylla

Poaceae
Agrostis avenacea
* Aira caryophyllea
Amphipogon debilis
Amphipogon strictus
* Anthoxanthum odoratum
* Briza maxima
* Briza minor
* Bromus diandrus
Austrodanthonia occidentalis
Austrostipa compressa
Austrostipa ?pycnostachya
Deyeuxia quadriseta
Dichelachne crinita
Hemarthria uncinata
* Holcus lanatus
* Holcus setiger
* Lolium multiflorum
Microlaena stipoides
Neurachne alopecuroidea
Poa drummondiana
Poa poiformis
* Polypogon monspeliensis
Polypogon tenellus
Sporobolus virginicus
Tetrarrhena laevis
* Vulpia myuros

Polygalaceae
- Comesperma calymega
- Comesperma drummondii
- Comesperma flavum
- Comesperma ?volubile

Polygonaceae
- Muehlenbeckia adpressa
- Persicaria prostrata

Potamogetonaceae
- Potamogeton drummondii
- Ruppia megacarpa

Primulaceae
- * Anagallis arvensis
- Samolus junceus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Banksia meisneri ssp. meisneri
- Conospermum capitatum
- Conospermum flexuosum ssp. laevigatum
- Dryandra armata
- Dryandra bipinnatifida
- Dryandra lindleyana
- Dryandra porrecta
- Franklandia fucifolia
- Grevillea brownii
- Grevillea leptobotrys
- Grevillea pilulifera
- Grevillea pulchella
- Grevillea quercifolia
- Hakea ceratophylla
- Hakea corymbosa
- Hakea gilbertii
- Hakea lissocarpha
- Hakea prostrata
- Hakea ruscifolia
- Hakea trifurcata
- Hakea undulata
- Hakea varia
- Isopogon ?attenuatus
- Isopogon teretifolius
- Persoonia longifolia
- Petrophile acicularis
- Petrophile divaricata
- Petrophile ?longifolia
- Petrophile media
- Petrophile rigida
- Petrophile serruriae
- Petrophile squamata
- Stirlingia simplex
- Synaphea decumbens
- Synaphea petiolaris
- Synaphea ?reticulata

Ranunculaceae
- Clematis pubescens
- Ranunculus colonorum

Restionaceae
- Anarthria ?gracilis
- Anarthria prolifera
- Anarthria scabra
- Chaetanthus aristatus ms
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Harperia lateriflora
- Hypolaena exsulca
- Leptocarpus ?tenellus
- Lepyrodia macra
- Lepyrodia muirii
- Lyginia barbata
- Meeboldina coangustata ms
- Meeboldina scariosa ms
- Meeboldina tephrina ms
- Tremulina tremula ms

Rhamnaceae
- Cryptandra sp.
- Trymalium ?ledifolium

Rubiaceae
- * Galium murale
- Opercularia apiciflora
- Opercularia hispidula
- Opercularia ?rubioides
- Opercularia vaginata

Rutaceae
- Boronia crenulata
- Boronia megastigma
- Boronia nematophylla
- Boronia ramosa
- Boronia spathulata

Santalaceae
- Leptomeria cunninghamii
- Leptomeria spinosa
- Leptomeria squarrulosa

Scrophulariaceae
- Gratiola peruviana
- * Parentucellia latifolia
- * Parentucellia viscosa

Selaginellaceae
- Selaginella gracillima

Stackhousiaceae
- Stackhousia monogyna
- Tripterococcus brunonis

Sterculiaceae
- Thomasia foliosa
- Thomasia pauciflora

Stylidiaceae
- Levenhookia pusilla
- Levenhookia stipitata
- Stylidium amoenum
- Stylidium assimile
- Stylidium brunonianum ssp. minor
- Stylidium calcaratum
- Stylidium guttatum
- Stylidium inundatum
- Stylidium junceum ssp. brevius
- Stylidium mimeticum
- Stylidium perpusillum
- Stylidium petiolare
- Stylidium repens
- Stylidium ?roseonanum
- Stylidium scandens
- Stylidium schoenoides
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea rosea
- Pimelea suaveolens

Tremandraceae
- Tetratheca setigera
- Tetratheca virgata
- Tremandra diffusa

Typhaceae
- * Typha orientalis

Violaceae
- Hybanthus floribundus

Xanthorrhoeaceae
- Xanthorrhoea gracilis
- Xanthorrhoea preissii

Zamiaceae
- Macrozamia riedlei

Zannichelliaceae
- Lepilaena australis

YARNUP NATURE RESERVE

Reserve number 29601 **Class** A
Location 34 22 34S 116 51 53E
Land tenure Nature Reserve
Purpose Water, and Conservation of flora and fauna
Area 62 ha

Biological values

Flora Using Griffin (1984) data as a basis, a flora list of 272 taxa was compiled from the reserve (see flora list below). This included three priority taxa (*Euchiton gymnocephalus* (Priority 3), *Hydatella australis* (Priority 1), *Stylidium mimeticum* (Priority 3))

Vegetation description Griffin (1984) mapped the reserve and described six vegetation units. Brief descriptions of these units are given below.

2. ***Eucalyptus marginata* (jarrah) forest (Type 1)** Jarrah/marri forest on the top and upper slopes of the lateritic ridges.

3/9. ***Eucalyptus marginata* (jarrah) forest (Type 2)/*Agonis parviceps* thicket** Variable unit similar to Kodjinup vegetation unit 2, common on low-lying sandy substrates.

10. ***Melaleuca preissiana-Banksia littoralis* open low woodland A** A complex unit essentially similar to Kodjinup vegetation unit 6.

13. ***Melaleuca rhaphiophylla* dense low forest B** Occurs as circular or ring shaped areas in the centre of some basin wetlands. This unit is equivalent to Muir vegetation unit 15.

17. ***Halosarcia-Wilsonia* mat plants** form areas of herbland around several of the salt lakes. Similar in many respects to Muir vegetation unit 27.

19. ***Baumea* sedges** Occupying basin wetlands, essentially the same as Kodjinup vegetation units 10 and 11.

Disturbed areas These were not mapped by Griffin (1984) but were used in compiling the species lists.

Vegetation change Oblique aerial photographs from April 1980 show extensive recent (1980) clearing to the south of the reserve. The area of salt scald crossing the road on the south side of the swamp is not visible on the 1980 photography. Halse *et al.*[5] (1993) reported that the salt scalding had been noted since 1988. The area of open water visible in the swamp in 1980 is comparable to that mapped in 1984 by Griffin and to the 1995 aerial photography (WA3619-5172).

Disturbance or threats Death of woodland communities on the western boundary, south of the swamp, appears to be the result of saline run-off from private property.

Yarnup Nature Reserve flora list.

Aizoaceae
- Carpobrotus modestus

Amaranthaceae
- Ptilotus manglesii

Anthericaceae
- Agrostocrinum scabrum
- Arthropodium preissii
- Borya scirpoidea
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa
- Chamaescilla sp.
- Johnsonia lupulina
- Sowerbaea laxiflora
- Thysanotus manglesianus
- Tricoryne elatior
- Tricoryne tenella

Apiaceae
- Daucus glochidiatus
- Eryngium pinnatifidum
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle callicarpa
- Schoenolaena tenuior
- Trachymene pilosa
- Xanthosia candida
- Xanthosia huegelii

Asteraceae
- Blennospora drummondii
- Cotula coronopifolia
- Craspedia variabilis
- * Dittrichia graveolens

[5] Halse, S.A., Pearson, G.B. and Patrick, S. (1993). Vegetation of depth-gauged wetlands in nature reserves of south-west Western Australia. Department of Conservation and Land Management *Technical Report* No. 30.

- Euchiton gymnocephalus
- Hyalosperma cotula
- * Hypochaeris glabra
- Lagenifera huegelii
- Millotia myosotidifolia
- Myriocephalus occidentalis
- Podolepis gracilis
- * Pseudognaphalium luteoalbum
- Rhodanthe citrina
- Senecio glomeratus
- Siloxerus humifusus
- * Sonchus asper
- * Sonchus oleraceus
- Trichocline sp.
- * Vellereophyton dealbatum

Centrolepidaceae
- Aphelia cyperoides
- Centrolepis aristata
- Centrolepis glabra
- Centrolepis humillima
- Centrolepis polygyna

Chenopodiaceae
- * Atriplex prostrata

Colchicaceae
- Burchardia congesta
- Burchardia monantha
- Burchardia multiflora

Cyperaceae
- Baumea articulata
- Baumea juncea
- Baumea vaginalis
- Chorizandra enodis
- Cyathochaeta avenacea
- * Cyperus tenellus
- Isolepis cernua
- Isolepis oldfieldiana
- Lepidosperma angustatum
- Lepidosperma longitudinale
- Lepidosperma squamatum
- Lepidosperma tenue
- Mesomelaena stygia
- Mesomelaena tetragona
- Schoenus brevisetis
- Schoenus efoliatus
- Schoenus laevigatus
- Tetraria capillaris
- Tetraria octandra
- Tricostularia neesii var. neesii

Dasypogonaceae
- Chamaexeros serra
- Lomandra caespitosa
- Lomandra sericea
- Lomandra suaveolens

Dilleniaceae
- Hibbertia ?amplexicaulis
- Hibbertia commutata
- Hibbertia cunninghamii
- Hibbertia racemosa
- Hibbertia spicata ssp. spicata
- Hibbertia stellaris

Droseraceae
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera macrantha
- Drosera neesii

Epacridaceae
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma pallidum
- Leucopogon capitellatus
- Leucopogon parviflorus
- Leucopogon propinquus
- Leucopogon verticillatus

Euphorbiaceae
- Phyllanthus calycinus
- Poranthera microphylla

Gentianaceae
- * Centaurium erythraea
- * Cicendia filiformis

Geraniaceae
- Geranium solanderi

Goodeniaceae
- Dampiera alata
- Dampiera linearis
- Lechenaultia formosa
- Scaevola platyphylla

Haemodoraceae
- Anigozanthos manglesii
- Conostylis aculeata
- Conostylis aurea
- Haemodorum laxum
- Haemodorum simplex
- Haemodorum spicatum
- Tribonanthes australis
- Tribonanthes longipetala
- Tribonanthes violacea

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus paniculatus
- Myriophyllum limnophilum

Hydatellaceae
- Hydatella australis

Hypoxidaceae
- Hypoxis occidentalis

Iridaceae
- Patersonia juncea
- Patersonia occidentalis

Isoetaceae
- Isoetes drummondii

Juncaceae
- * Juncus bufonius
- * Juncus capitatus

Juncaginaceae
- Triglochin centrocarpum
- Triglochin huegelii

Lauraceae
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Utricularia hookeri

Linaceae
- Linum marginale

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Lobelia alata
- Lobelia gibbosa

Loganiaceae
- Logania serpyllifolia

Lycopodiaceae
- Phylloglossum drummondii

Menyanthaceae
- Villarsia albiflora

Mimosaceae
- Acacia alata
- Acacia extensa
- Acacia huegelii
- Acacia incurva
- Acacia nervosa
- Acacia pulchella
- Acacia saligna
- Acacia stenoptera

Myrtaceae
- Agonis parviceps
- Calothamnus preissii
- Eucalyptus calophylla
- Eucalyptus cornuta

- Eucalyptus decipiens
- Eucalyptus marginata
- Eucalyptus rudis
- Hypocalymma angustifolium
- Kunzea ?micrantha
- Kunzea recurva
- Melaleuca lateritia
- Melaleuca preissiana
- Melaleuca rhaphiophylla
- Melaleuca thymoides
- Melaleuca viminea
- Pericalymma ellipticum

Onagraceae
- Epilobium billardierianum

Orchidaceae
- Caladenia flava
- Caladenia longicauda
- Caladenia marginata
- Caladenia radialis
- Cyrtostylis robusta
- Diuris carinata
- Diuris laxiflora
- Elythranthera brunonis
- Elythranthera emarginata
- Microtis media
- * Monadenia bracteata
- Pterostylis nana
- Pterostylis recurva
- Pterostylis vittata
- Pyrorchis nigricans
- Thelymitra antennifera
- Thelymitra crinita
- Thelymitra flexuosa
- Thelymitra pauciflora

Papilionaceae
- Bossiaea eriocarpa
- Bossiaea linophylla
- Bossiaea ornata
- Brachysema praemorsum
- Chorizema aciculare
- Daviesia preissii
- Gompholobium marginatum
- Gompholobium ovatum
- Gompholobium preissii
- Gompholobium tomentosum
- Jacksonia furcellata
- Kennedia prostrata
- * Lotus angustissimus
- Sphaerolobium medium
- Viminaria juncea

Philydraceae
- Philydrella drummondii
- Philydrella pygmaea

Phormiaceae
- Dianella brevicaulis
- Dianella revoluta
- Stypandra glauca

Pittosporaceae
- Sollya heterophylla

Plantaginaceae
- Plantago debilis

Poaceae
- * Aira caryophyllea
- Austrostipa compressa
- Austrostipa pycnostachya
- * Briza maxima
- * Briza minor
- * Bromus diandrus
- Deyeuxia quadriseta
- Hemarthria uncinata
- * Hordeum leporinum
- * Hordeum ?murinum
- * Lolium rigidum
- Microlaena stipoides
- Neurachne alopecuroidea
- Poa poiformis
- * Polypogon monspeliensis
- Tetrarrhena laevis
- * Vulpia myuros

Polygalaceae
- Comesperma virgatum
- Comesperma volubile

Polygonaceae
- * Rumex pulcher

Primulaceae
- Samolus junceus

Proteaceae
- Banksia grandis
- Banksia littoralis
- Dryandra lindleyana
- Grevillea fasciculata
- Grevillea pilulifera
- Hakea corymbosa
- Hakea lissocarpha
- Hakea prostrata
- Hakea ruscifolia
- Hakea varia
- Persoonia longifolia
- Petrophile media
- Synaphea aff. petiolaris
- Synaphea petiolaris

Restionaceae
- Anarthria prolifera
- Chordifex laxus ms
- Desmocladus fasciculatus ms
- Desmocladus flexuosus ms
- Harperia lateriflora
- Hypolaena exsulca
- Lepyrodia macra
- Lyginia barbata
- Meeboldina cana ms

Rosaceae
- * Acaena echinata

Rubiaceae
- Opercularia hispidula

Rutaceae
- Boronia spathulata

Santalaceae
- Leptomeria squarrulosa

Scrophulariaceae
- * Parentucellia latifolia
- * Parentucellia viscosa

Selaginellaceae
- Selaginella gracillima

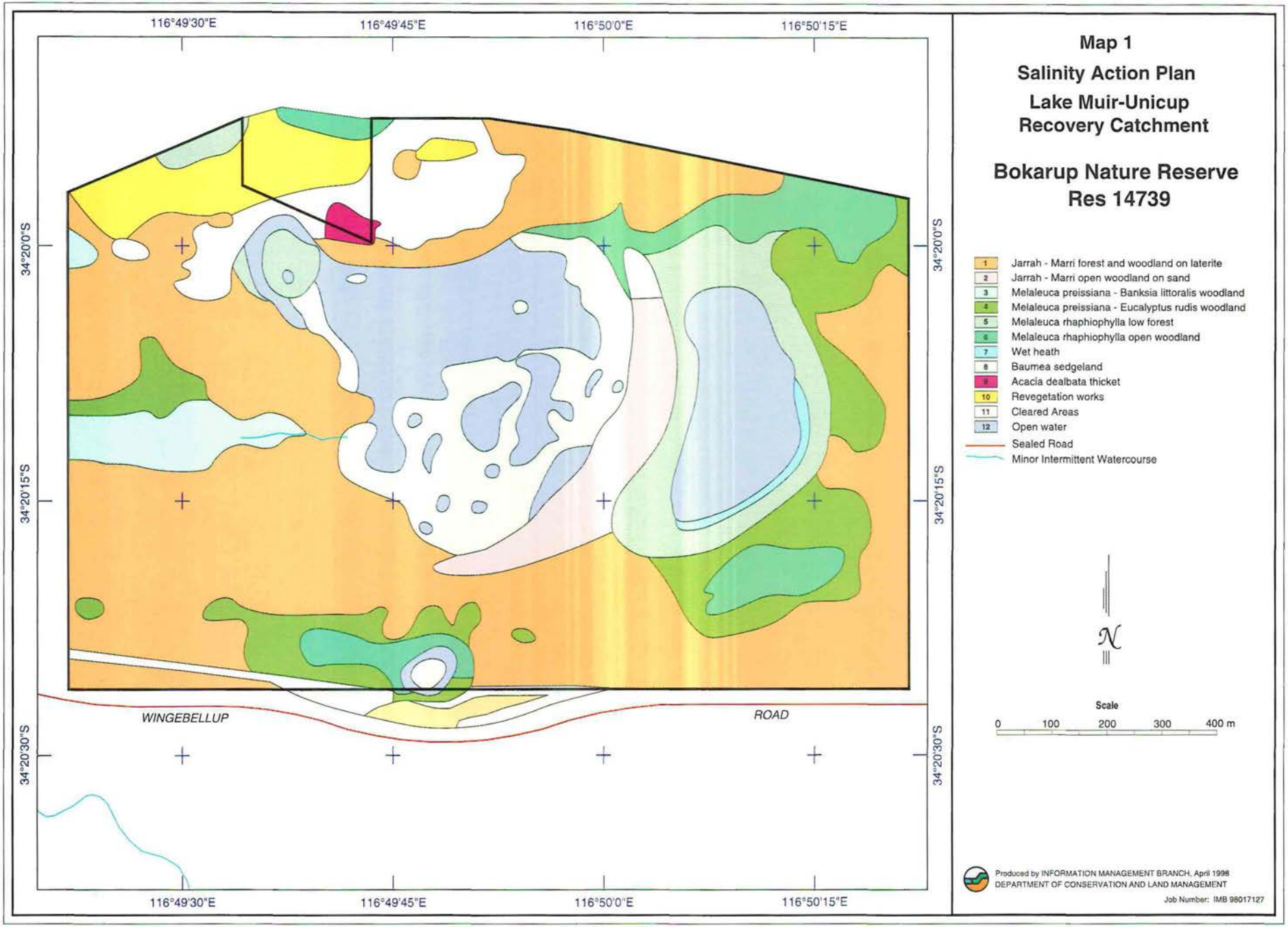
Stackhousiaceae
- Stackhousia monogyna

Stylidiaceae
- Stylidium brunonianum ssp. minor
- Stylidium calcaratum
- Stylidium ecorne
- Stylidium inundatum
- Stylidium junceum
- Stylidium mimeticum
- Stylidium petiolare
- Stylidium pulchellum
- Stylidium repens
- Stylidium sp.
- Stylidium spathulatum

Thymelaeaceae
- Pimelea angustifolia
- Pimelea lehmanniana

Tremandraceae
- Platytheca galioides
- Tetratheca affinis
- Tetratheca setigera
- Tetratheca virgata

Violaceae
    Hybanthus floribundus
Xanthorrhoeaceae
    Xanthorrhoea gracilis
    Xanthorrhoea preissii
Zamiaceae
    Macrozamia riedlei


116°49'30"E
116°49'45"E
116°50'0"E
116°50'15"E
34°20'0"S
34°20'15"S
34°20'30"S
WINGEBELLUP
ROAD
Map 1
Salinity Action Plan
Lake Muir-Unicup
Recovery Catchment
Bokarup Nature Reserve
Res 14739
1 Jarrah - Marri forest and woodland on laterite
2 Jarrah - Marri open woodland on sand
3 Melaleuca preissiana - Banksia littoralis woodland
4 Melaleuca preissiana - Eucalyptus rudis woodland
5 Melaleuca rhaphiophylla low forest
6 Melaleuca rhaphiophylla open woodland
7 Wet heath
8 Baumea sedgeland
9 Acacia dealbata thicket
10 Revegetation works
11 Cleared Areas
12 Open water
Sealed Road
Minor Intermittent Watercourse
N
Scale
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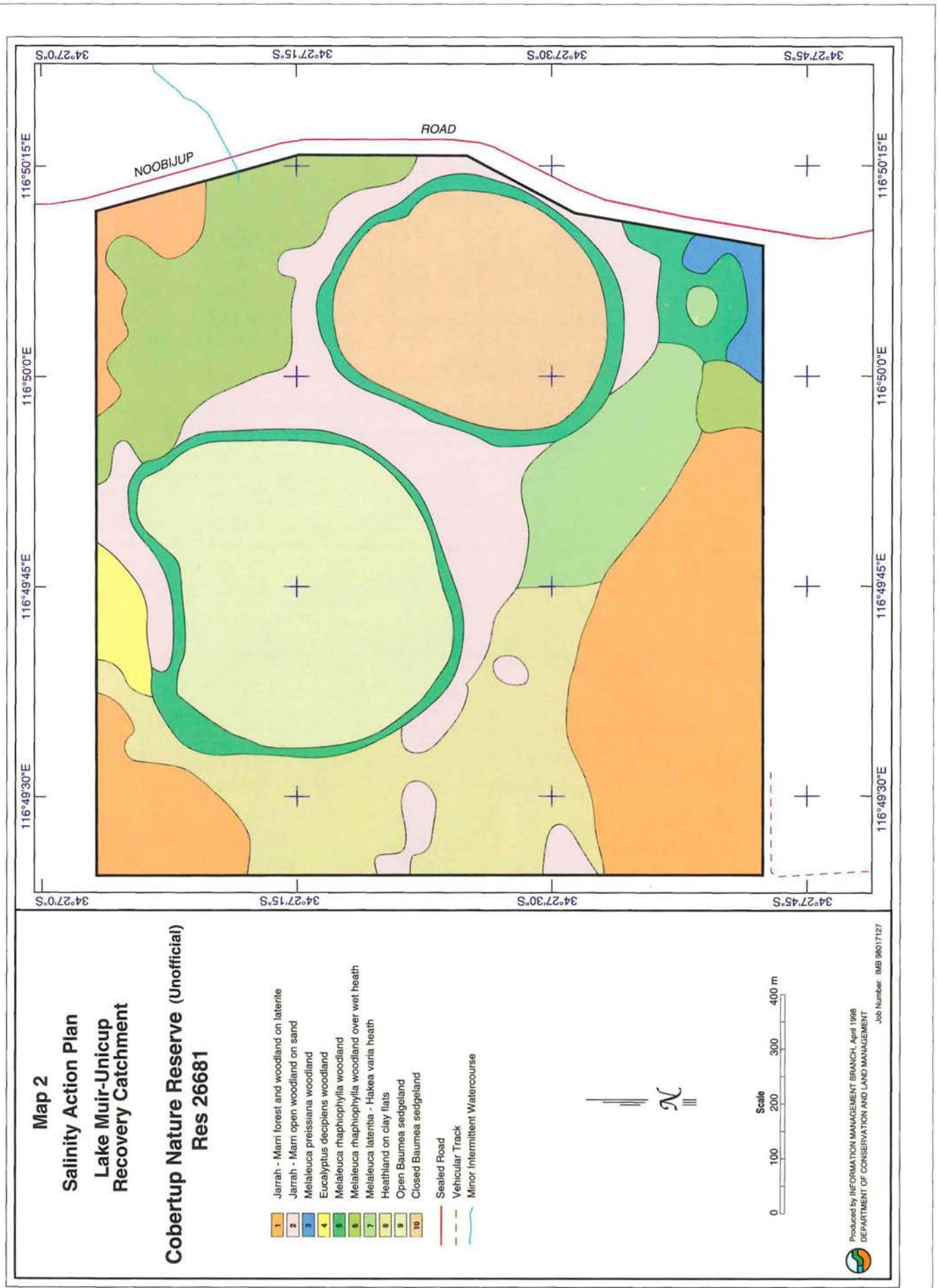
Produced by INFORMATION MANAGEMENT BRANCH, April 1998
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number: IMB 98017127


Map 2
Salinity Action Plan
Lake Muir-Unicup
Recovery Catchment
Cobertup Nature Reserve (Unofficial)
Res 26681
ROAD
NOOBIJUP
116°50'15"E
116°50'0"E
116°49'45"E
116°49'30"E
34°27'0"S
34°27'15"S
34°27'30"S
34°27'45"S
1 Jarrah - Marri forest and woodland on laterite
2 Jarrah - Marri open woodland on sand
3 Melaleuca preissiana woodland
4 Eucalyptus decipiens woodland
5 Melaleuca rhaphiophylla woodland
6 Melaleuca rhaphiophylla woodland over wet heath
7 Melaleuca laterita - Hakea varia heath
8 Heathland on clay flats
9 Open Baumea sedgeland
10 Closed Baumea sedgeland
Sealed Road
Vehicular Track
Minor Intermittent Watercourse
N
Scale
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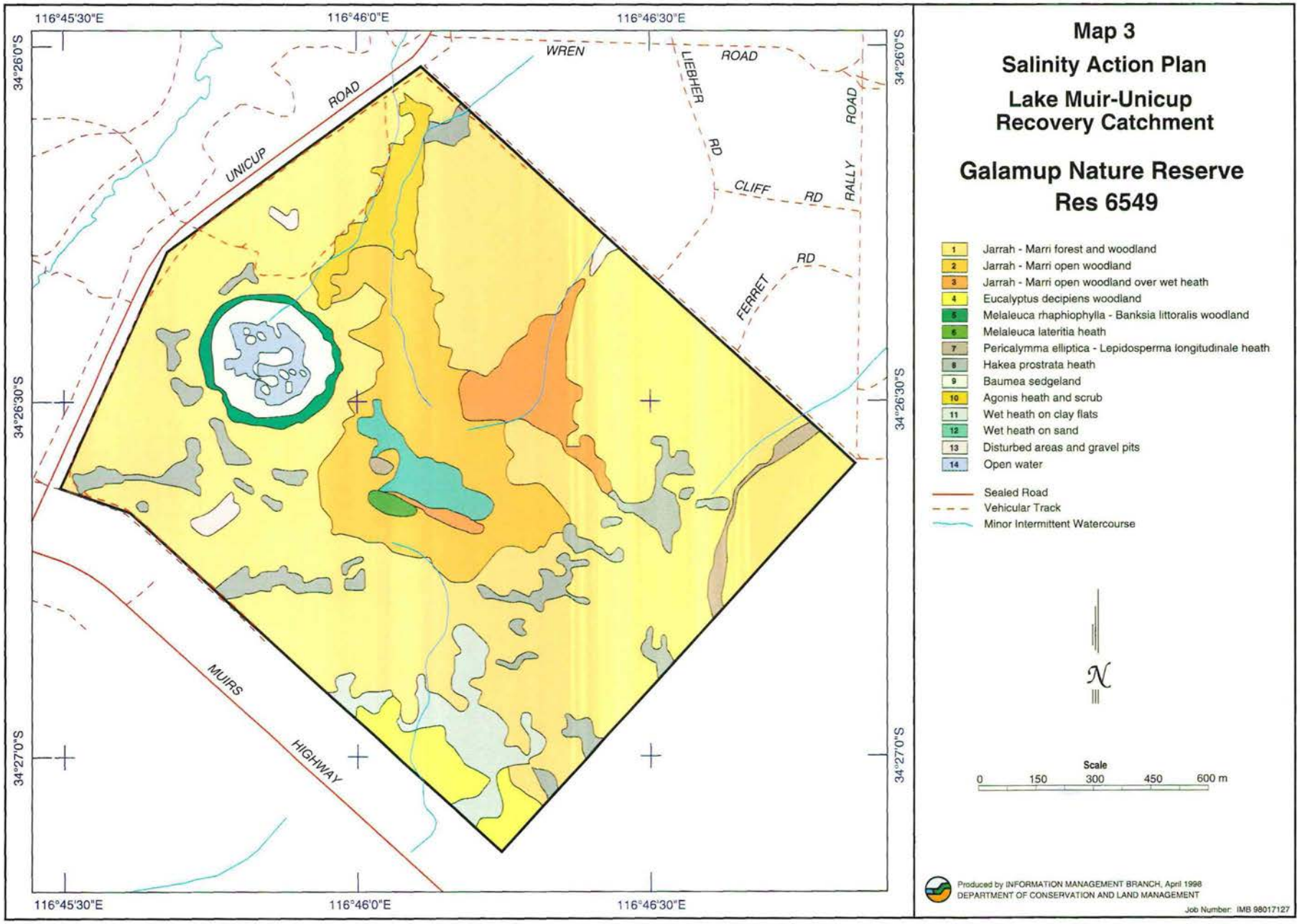
Produced by INFORMATION MANAGEMENT BRANCH, April 1998
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number IMB 98017127


116°45'30"E
116°46'0"E
116°46'30"E
34°26'0"S
34°26'30"S
34°27'0"S
WREN
ROAD
UNICUP
ROAD
LIEBHER
RD
ROAD
CLIFF
RD
RALLY
FERRET
RD
MUIRS
HIGHWAY
Map 3
Salinity Action Plan
Lake Muir-Unicup
Recovery Catchment
Galamup Nature Reserve
Res 6549
1 Jarrah - Marri forest and woodland
2 Jarrah - Marri open woodland
3 Jarrah - Marri open woodland over wet heath
4 Eucalyptus decipiens woodland
5 Melaleuca rhaphiophylla - Banksia littoralis woodland
6 Melaleuca lateritia heath
7 Pericalymma elliptica - Lepidosperma longitudinale heath
8 Hakea prostrata heath
9 Baumea sedgeland
10 Agonis heath and scrub
11 Wet heath on clay flats
12 Wet heath on sand
13 Disturbed areas and gravel pits
14 Open water
Sealed Road
Vehicular Track
Minor Intermittent Watercourse
N
Scale
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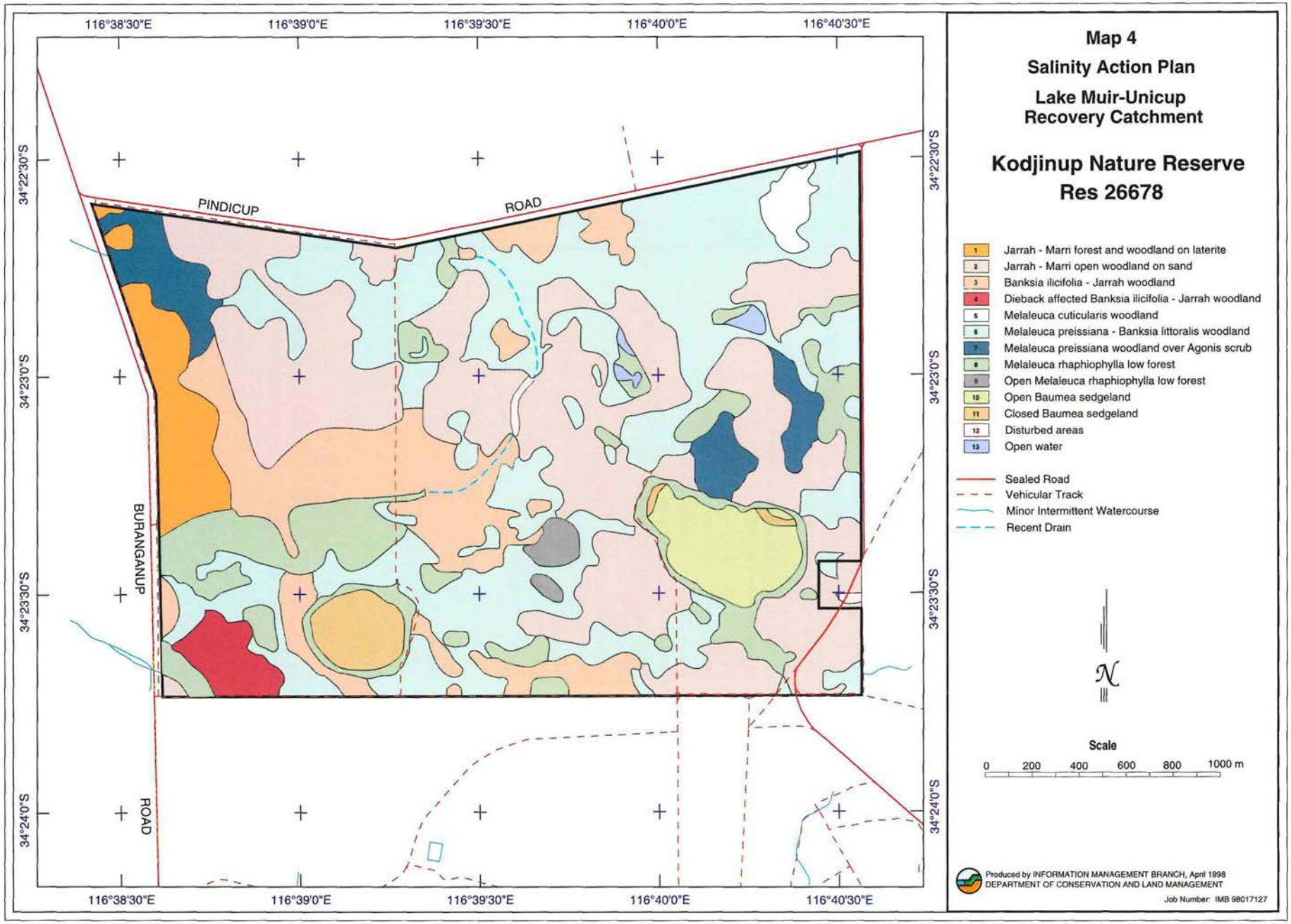
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number: IMB 98017127


116°38'30"E
116°39'0"E
116°39'30"E
116°40'0"E
116°40'30"E
34°22'30"S
34°23'0"S
34°23'30"S
34°24'0"S
PINDICUP ROAD
BURANGANUP ROAD
Map 4
Salinity Action Plan
Lake Muir-Unicup Recovery Catchment
Kodjinup Nature Reserve
Res 26678
1 Jarrah - Marri forest and woodland on laterite
2 Jarrah - Marri open woodland on sand
3 Banksia ilicifolia - Jarrah woodland
4 Dieback affected Banksia ilicifolia - Jarrah woodland
5 Melaleuca cuticularis woodland
6 Melaleuca preissiana - Banksia littoralis woodland
7 Melaleuca preissiana woodland over Agonis scrub
8 Melaleuca rhaphiophylla low forest
9 Open Melaleuca rhaphiophylla low forest
10 Open Baumea sedgeland
11 Closed Baumea sedgeland
12 Disturbed areas
13 Open water
Sealed Road
Vehicular Track
Minor Intermittent Watercourse
Recent Drain
N
Scale
0 200 400 600 800 1000 m
Produced by INFORMATION MANAGEMENT BRANCH, April 1998
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number: IMB 98017127

Map 5

Salinity Action Plan
Lake Muir-Unicup Recovery Catchment

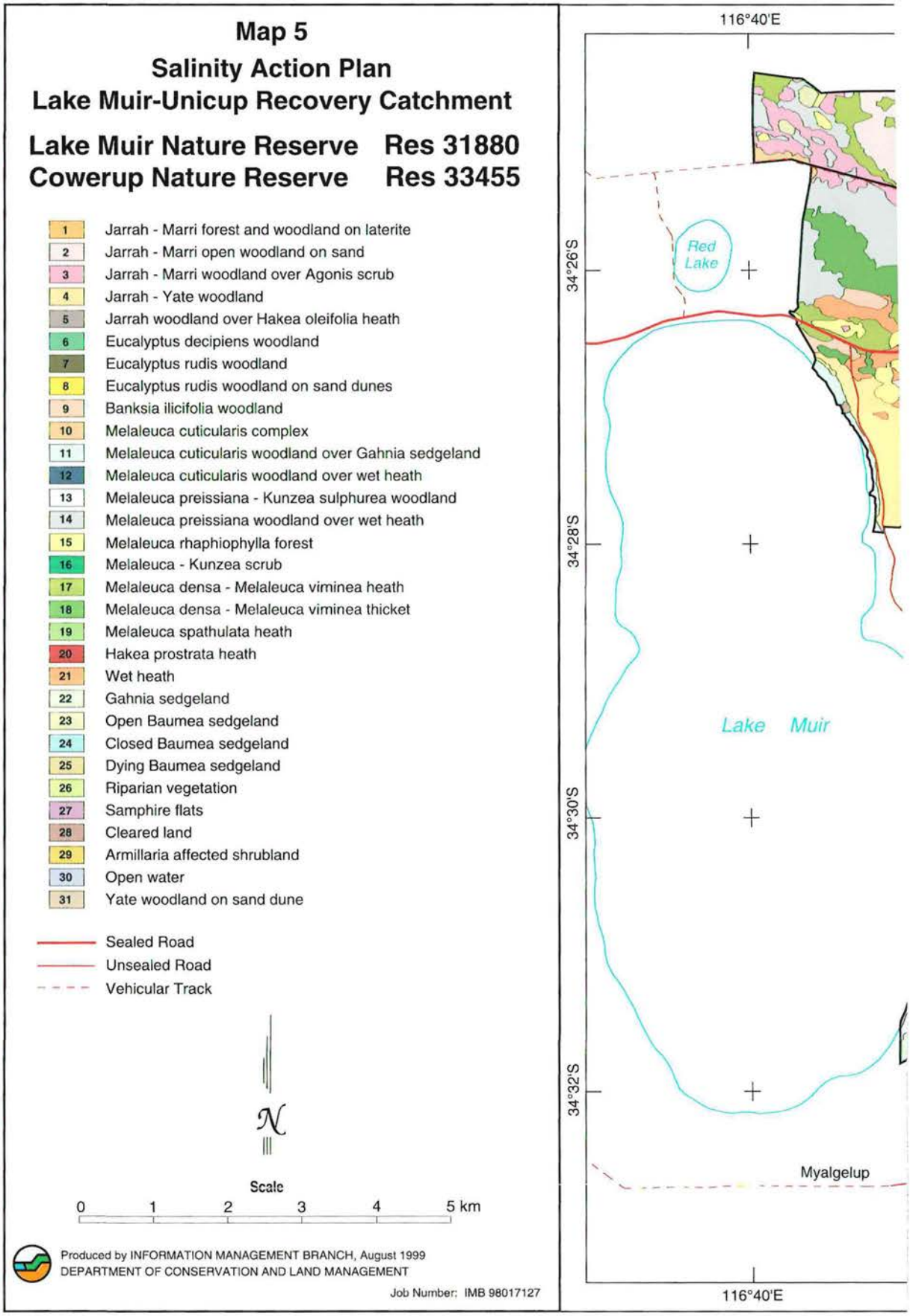
Lake Muir Nature Reserve Res 31880
Cowerup Nature Reserve Res 33455

1	Jarrah - Marri forest and woodland on laterite
2	Jarrah - Marri open woodland on sand
3	Jarrah - Marri woodland over Agonis scrub
4	Jarrah - Yate woodland
5	Jarrah woodland over Hakea oleifolia heath
6	Eucalyptus decipiens woodland
7	Eucalyptus rudis woodland
8	Eucalyptus rudis woodland on sand dunes
9	Banksia ilicifolia woodland
10	Melaleuca cuticularis complex
11	Melaleuca cuticularis woodland over Gahnia sedgeland
12	Melaleuca cuticularis woodland over wet heath
13	Melaleuca preissiana - Kunzea sulphurea woodland
14	Melaleuca preissiana woodland over wet heath
15	Melaleuca rhaphiophylla forest
16	Melaleuca - Kunzea scrub
17	Melaleuca densa - Melaleuca viminea heath
18	Melaleuca densa - Melaleuca viminea thicket
19	Melaleuca spathulata heath
20	Hakea prostrata heath
21	Wet heath
22	Gahnia sedgeland
23	Open Baumea sedgeland
24	Closed Baumea sedgeland
25	Dying Baumea sedgeland
26	Riparian vegetation
27	Samphire flats
28	Cleared land
29	Armillaria affected shrubland
30	Open water
31	Yate woodland on sand dune

Sealed Road
Unsealed Road
Vehicular Track

N

Scale
0 1 2 3 4 5 km



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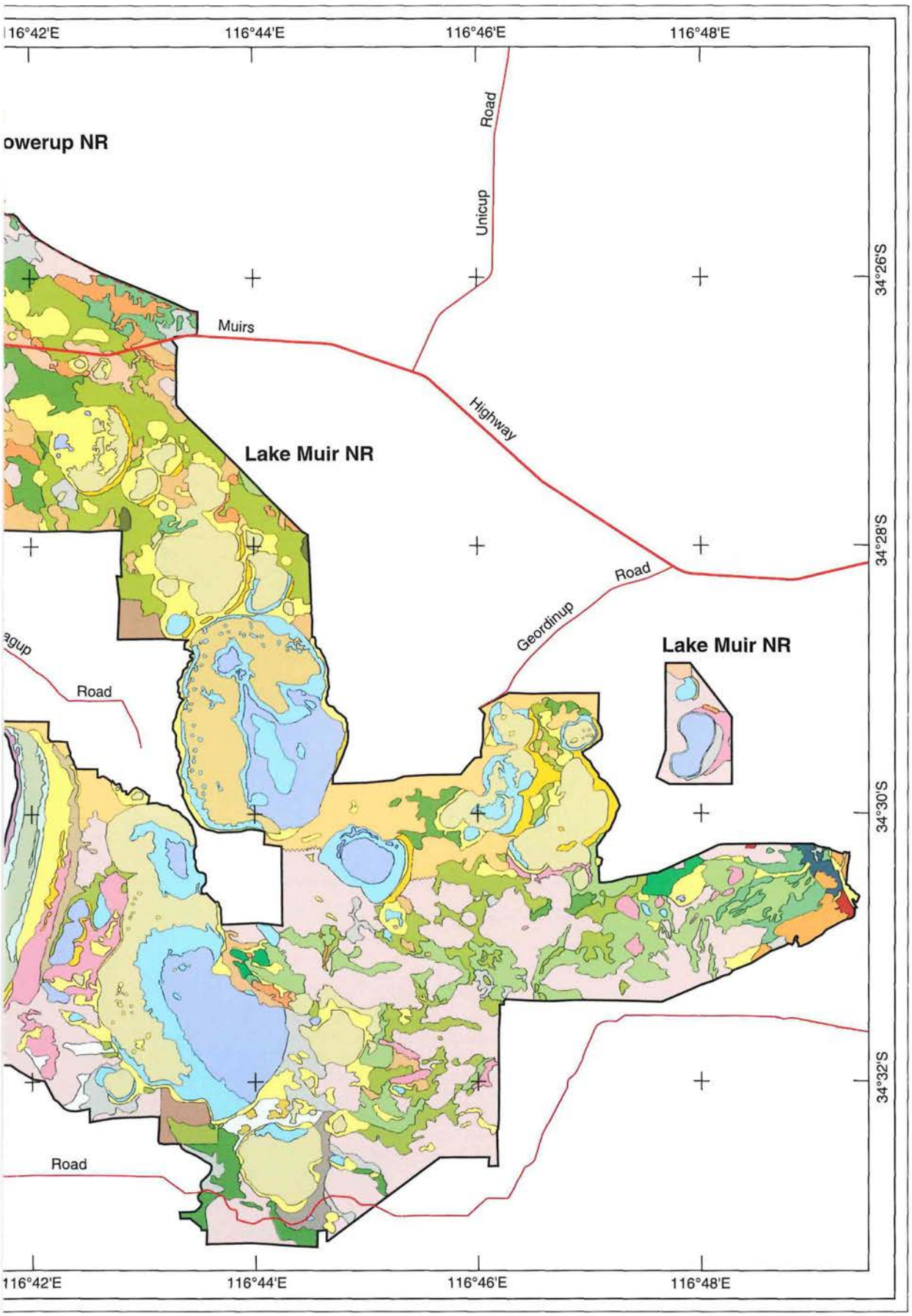
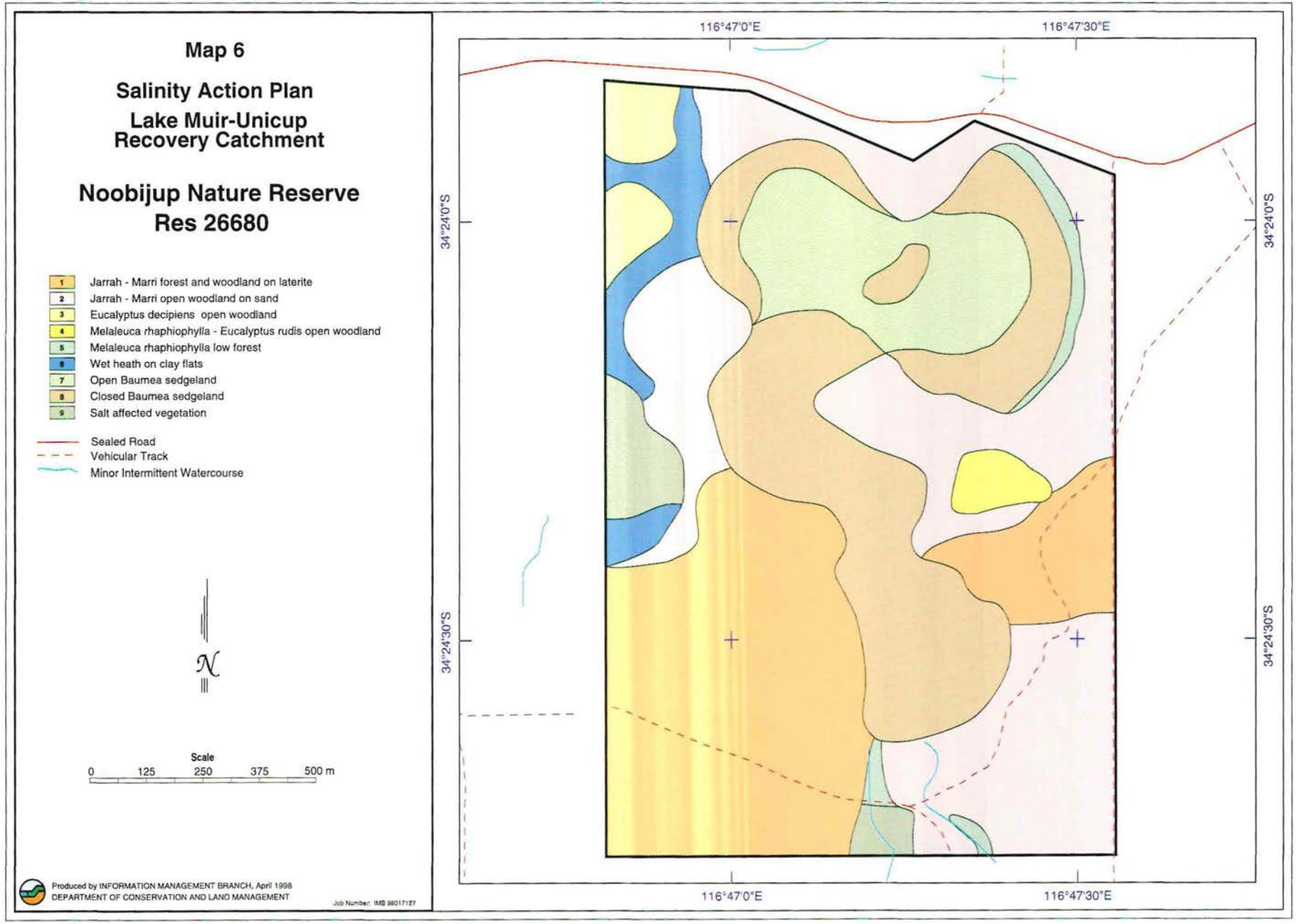
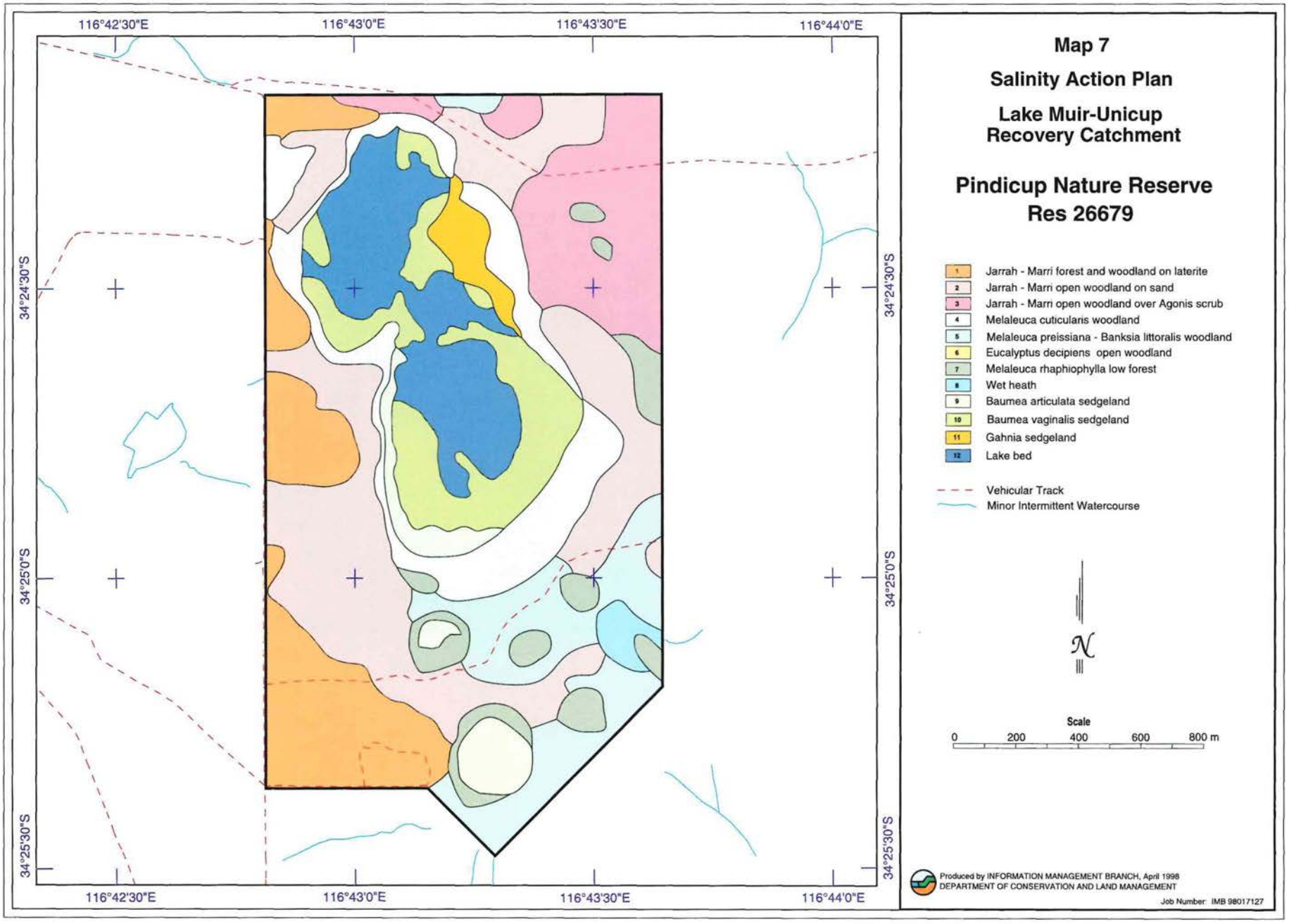
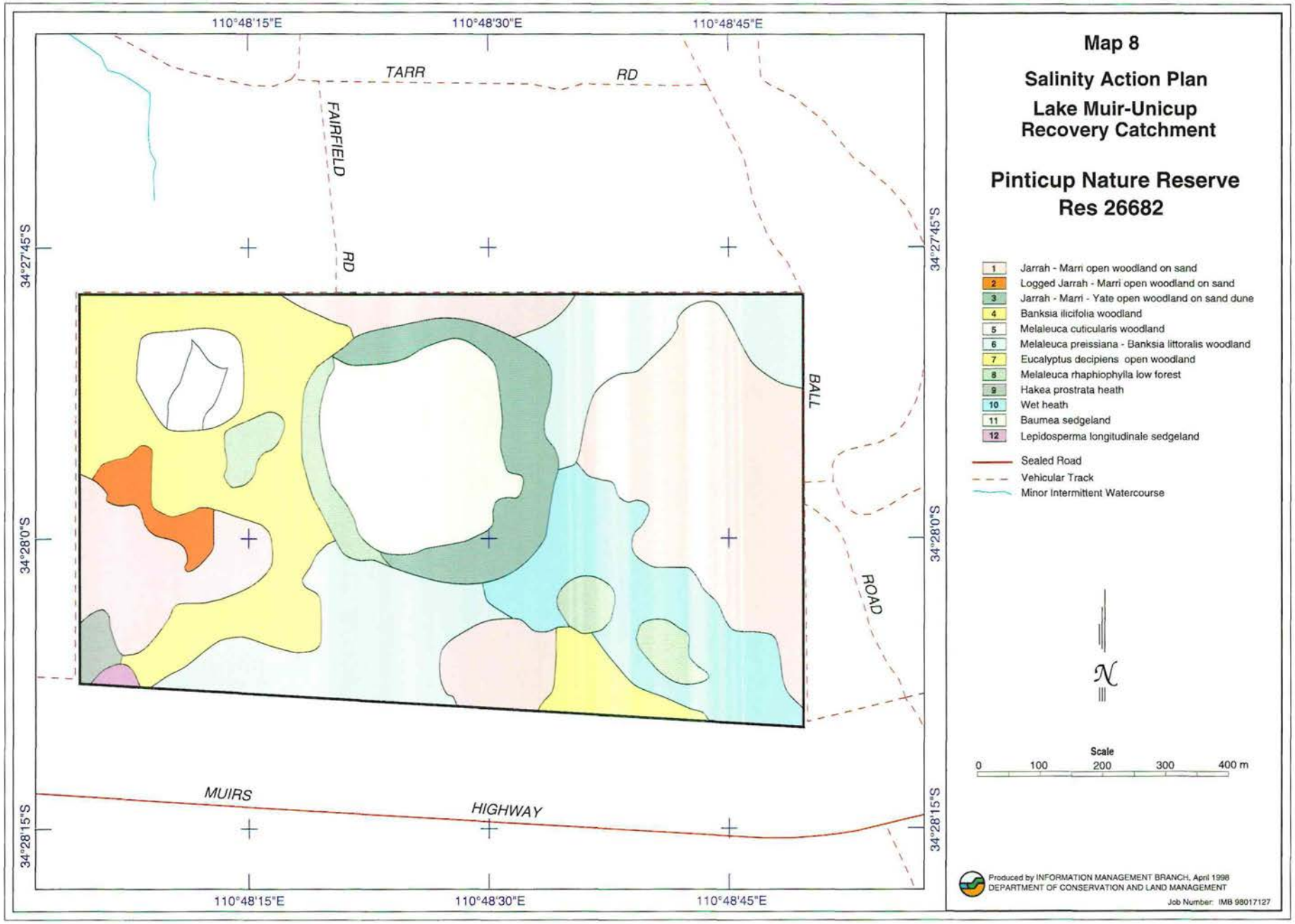

116°42'E
116°44'E
116°46'E
116°48'E
owerup NR
Road
Unicup
Muirs
Highway
Lake Muir NR
34°26'S
34°28'S
Road
Geordinup
Lake Muir NR
agup
Road
34°30'S
34°32'S
Road
116°42'E
116°44'E
116°46'E
116°48'E


Map 6
Salinity Action Plan
Lake Muir-Unicup
Recovery Catchment
Noobijup Nature Reserve
Res 26680
1 Jarrah - Marri forest and woodland on laterite
2 Jarrah - Marri open woodland on sand
3 Eucalyptus decipiens open woodland
4 Melaleuca rhaphiophylla - Eucalyptus rudis open woodland
5 Melaleuca rhaphiophylla low forest
6 Wet heath on clay flats
7 Open Baumea sedgeland
8 Closed Baumea sedgeland
9 Salt affected vegetation
Sealed Road
Vehicular Track
Minor Intermittent Watercourse
N
Scale
0 125 250 375 500 m
Produced by INFORMATION MANAGEMENT BRANCH, April 1998
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number: IMB 98017127
116°47'0"E
116°47'30"E
34°24'0"S
34°24'30"S


116°42'30"E
116°43'0"E
116°43'30"E
116°44'0"E
34°24'30"S
34°25'0"S
34°25'30"S
Map 7
Salinity Action Plan
Lake Muir-Unicup
Recovery Catchment
Pindicup Nature Reserve
Res 26679
1 Jarrah - Marri forest and woodland on laterite
2 Jarrah - Marri open woodland on sand
3 Jarrah - Marri open woodland over Agonis scrub
4 Melaleuca cuticularis woodland
5 Melaleuca preissiana - Banksia littoralis woodland
6 Eucalyptus decipiens open woodland
7 Melaleuca rhaphiophylla low forest
8 Wet heath
9 Baumea articulata sedgeland
10 Baumea vaginalis sedgeland
11 Gahnia sedgeland
12 Lake bed
Vehicular Track
Minor Intermittent Watercourse
N
Scale
0 200 400 600 800 m
Produced by INFORMATION MANAGEMENT BRANCH, April 1998
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number: IMB 98017127


110°48'15"E
110°48'30"E
110°48'45"E
TARR
RD
FAIRFIELD
RD
34°27'45"S
34°28'0"S
34°28'15"S
BALL
ROAD
MUIRS
HIGHWAY
Map 8
Salinity Action Plan
Lake Muir-Unicup
Recovery Catchment
Pinticup Nature Reserve
Res 26682
1 Jarrah - Marri open woodland on sand
2 Logged Jarrah - Marri open woodland on sand
3 Jarrah - Marri - Yate open woodland on sand dune
4 Banksia ilicifolia woodland
5 Melaleuca cuticularis woodland
6 Melaleuca preissiana - Banksia littoralis woodland
7 Eucalyptus decipiens open woodland
8 Melaleuca rhaphiophylla low forest
9 Hakea prostrata heath
10 Wet heath
11 Baumea sedgeland
12 Lepidosperma longitudinale sedgeland
Sealed Road
Vehicular Track
Minor Intermittent Watercourse
N
Scale
0 100 200 300 400 m
Produced by INFORMATION MANAGEMENT BRANCH, April 1998
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Job Number: IMB 98017127

APPENDIX 2

Total flora list for the 13 reserves of the Byenup-Muir wetland system.

(* indicates an introduced taxon, ms indicates a manuscript name)

Aizoaceae
* Carpobrotus edulis
Carpobrotus modestus
Amaranthaceae
Alternanthera nodiflora
Hemichroa diandra
Ptilotus drummondii
Ptilotus manglesii
Amaryllidaceae
* Amaryllis belladonna
Anthericaceae
Agrostocrinum scabrum
Arthropodium capillipes
Arthropodium preissii
Borya scirpoidea
Borya sphaerocephala
Caesia micrantha
Caesia occidentalis
Chamaescilla corymbosa
Chamaescilla spiralis
Johnsonia acaulis
Johnsonia lupulina
Laxmannia minor
Laxmannia sessiliflora
Sowerbaea laxiflora
Thysanotus arenarius
Thysanotus manglesianus
Thysanotus multiflorus
Thysanotus patersonii
Thysanotus sparteus
Thysanotus tenellus
Thysanotus thyrsoideus
Thysanotus triandrus
Tricoryne elatior
Tricoryne humilis
Tricoryne tenella
Apiaceae
Actinotus glomeratus
Apium annuum
Apium prostratum
Centella cordifolia
Daucus glochidiatus
Eryngium pinnatifidum
Eryngium sp. Lake Muir (*E.Wittwer* 2293)
Homalosciadium homalocarpum
Hydrocotyle alata
Hydrocotyle callicarpa
Hydrocotyle diantha
Hydrocotyle pilifera var. glabrata
Lilaeopsis polyantha
Platysace filiformis
Platysace juncea
Schoenolaena juncea
Schoenolaena tenuior
Trachymene pilosa
Xanthosia atkinsoniana
Xanthosia candida
Xanthosia ciliata
Xanthosia huegelii
Aspleniaceae
Asplenium flabellifolium
Asteraceae
Angianthus preissianus
Angianthus sp.
Angianthus tomentosus
* Arctotheca calendula
* Aster subulatus
Asteridea athrixioides
Asteridea pulverulenta
Blennospora drummondii
Brachyscome bellidioides
Brachyscome ciliaris
Brachyscome iberidifolia
Calotis erinacea
* Carduus pycnocephalus
* Centaurea melitensis
* Cirsium vulgare
* Conyza albida
Cotula australis
Cotula coronopifolia
Cotula cotuloides
* Cotula turbinata
Craspedia variabilis
* Dittrichia graveolens
Euchiton gymnocephalus
Euchiton sphaericus
Gnephosis tenuissima
* Hedypnois rhagadioloides
Hyalosperma cotula
Hyalosperma simplex
* Hypochaeris glabra
Ixiolaena viscosa
* Lactuca serriola
Lagenifera huegelii
Millotia myosotidifolia
Millotia tenuifolia
Myriocephalus occidentalis
Olearia axillaris
Olearia elaeophila
Olearia paucidentata
Picris angustifolia
Pithocarpa corymbulosa
Pithocarpa pulchella
Podolepis gracilis
Podolepis lessonii
Podotheca angustifolia
Pogonolepis stricta
* Pseudognaphalium luteoalbum
Pterochaeta paniculata
Quinetia urvillei
Rhodanthe citrina
Rhodanthe pyrethrum
Rutidosis multiflora
Senecio glomeratus
Senecio lautus
Senecio minimus
Senecio picridioides
Senecio quadridentatus
Siloxerus humifusus
* Sonchus asper
* Sonchus hydrophilus
* Sonchus oleraceus
* Tolpis barbata
Trichocline sp.
Trichocline spathulata
* Ursinia anthemoides
* Vellereophyton dealbatum
Vittadinia australasica var. australasica
Waitzia nitida
Waitzia suaveolens
Brassicaceae
* Cardamine paucijuga
* Lepidium africanum
* Sisymbrium officinale
Caesalpiniaceae
Labichea punctata
Callitrichaceae
* Callitriche stagnalis
Campanulaceae
Wahlenbergia gracilenta
Wahlenbergia multicaulis
Wahlenbergia preissii
Wahlenbergia stricta

Caryophyllaceae
* Cerastium glomeratum
* Corrigiola litoralis
Petrorhagia prolifera
* Petrorhagia velutina
* Silene gallica
* Spergularia salina
Casuarinaceae
Allocasuarina humilis
Allocasuarina lehmanniana
Allocasuarina microstachya
Allocasuarina thuyoides
Centrolepidaceae
Aphelia cyperoides
Brizula drummondii
Centrolepis alepyroides
Centrolepis aristata
Centrolepis drummondiana
Centrolepis glabra
Centrolepis humillima
Centrolepis mutica
Centrolepis pilosa
Centrolepis polygyna
Chenopodiaceae
* Atriplex prostrata
* Chenopodium murale
Dysphania glomulifera ssp. glomulifera
Dysphania plantaginella
Halosarcia indica
Halosarcia leptoclada
Rhagodia baccata
Sarcocornia quinqueflora
Suaeda australis
Clusiaceae
Hypericum gramineum
Colchicaceae
Burchardia congesta
Burchardia monantha
Burchardia multiflora
Wurmbea dioica ssp. alba
Convolvulaceae
Dichondra repens
Pronaya fraseri
Wilsonia backhousei
Wilsonia humilis
Crassulaceae
Crassula colorata
Crassula decumbens var. decumbens
Crassula exserta
* Crassula natans
Crassula pedicellosa
Crassula peduncularis
Cupressaceae
Actinostrobus acuminatus
Actinostrobus pyramidalis
Cyperaceae
Baumea arthrophylla
Baumea articulata
Baumea juncea
Baumea rubiginosa
Baumea vaginalis
Carex appressa
Carex preissii
Caustis dioica
Caustis sp. Boyanup (*G.S. McCutcheon* 1706)
Chorizandra enodis
Cyathochaeta avenacea
Cyathochaeta clandestina
* Cyperus eragrostis
* Cyperus tenellus
Eleocharis sphacelata
Gahnia ancistrophylla
Gahnia aristata
Gahnia drummondii
Gahnia trifida
Isolepis cernua
Isolepis congrua
Isolepis cyperoides
Isolepis fluitans
* Isolepis marginata
Isolepis nodosa
Isolepis oldfieldiana
Isolepis producta
* Isolepis prolifera
Isolepis stellata
Lepidosperma angustatum
Lepidosperma gladiatum
Lepidosperma ?gracile
Lepidosperma longitudinale
Lepidosperma squamatum
Lepidosperma tenue
Mesomelaena graciliceps
Mesomelaena stygia
Mesomelaena tetragona
Schoenus asperocarpus
Schoenus benthamii
Schoenus bifidus
Schoenus brevisetis
Schoenus capillifolius
Schoenus curvifolius
Schoenus efoliatus
Schoenus elegans
Schoenus grandiflorus
Schoenus humilis
Schoenus laevigatus
Schoenus loliaceus
Schoenus maschalinus
Schoenus nanus
Schoenus natans
Schoenus obtusifolius
Schoenus odontocarpus
Schoenus plumosus
Schoenus rigens
Schoenus sculptus
Schoenus subbulbosus
Schoenus subflavus
Schoenus ?sublateralis
Schoenus submicrostachyus
Schoenus tenellus
Schoenus unispiculatus
Tetraria capillaris
Tetraria octandra
Tricostularia compressa
Tricostularia neesii var. elatior
Tricostularia neesii var. neesii
Dasypogonaceae
Chamaexeros serra
Dasypogon bromeliifolius
Lomandra caespitosa
Lomandra collina
Lomandra hermaphrodita
Lomandra micrantha
Lomandra nigricans
Lomandra purpurea
Lomandra sericea
Lomandra sonderi
Lomandra suaveolens
Dennstaedtiaceae
Pteridium esculentum
Dilleniaceae
Hibbertia acerosa
Hibbertia amplexicaulis
Hibbertia commutata
Hibbertia cunninghamii
Hibbertia glomerata
Hibbertia gracilipes
Hibbertia microphylla
Hibbertia ?polystachya
Hibbertia pulchra
Hibbertia racemosa
Hibbertia silvestris
Hibbertia spicata ssp. spicata

- Hibbertia stellaris
- Hibbertia subvaginata
- Hibbertia vaginata

Droseraceae
- Drosera bulbigena
- Drosera bulbosa
- Drosera erythrorhiza
- Drosera gigantea
- Drosera glanduligera
- Drosera heterophylla
- Drosera macrantha
- Drosera menziesii
- Drosera neesii
- Drosera paleacea
- Drosera pallida
- Drosera pulchella
- Drosera rosulata
- Drosera stolonifera

Epacridaceae
- Andersonia caerulea
- Astroloma baxteri
- Astroloma ciliatum
- Astroloma microcalyx
- Astroloma pallidum
- Astroloma prostratum
- Leucopogon australis
- Leucopogon capitellatus
- Leucopogon conostephioides
- Leucopogon ?elatior
- Leucopogon gibbosus
- Leucopogon glabellus
- Leucopogon lasiophyllus
- Leucopogon oxycedrus
- Leucopogon parviflorus
- Leucopogon pendulus
- Leucopogon ?polymorphus
- Leucopogon propinquus
- Leucopogon pulchellus
- Leucopogon ?sprengelioides
- Leucopogon tamariscinus
- Leucopogon unilateralis
- Leucopogon verticillatus
- Lysinema ciliatum
- Needhamiella pumilio
- Sphenotoma capitatum
- Sphenotoma gracile
- Styphelia tenuiflora

Euphorbiaceae
- Amperea simulans
- Amperea volubilis
- Monotaxis occidentalis
- Phyllanthus calycinus
- Poranthera huegelii
- Poranthera microphylla
- Pseudanthus virgatus

Fumariaceae
- * Fumaria capreolata

Gentianaceae
- * Centaurium erythraea
- Centaurium spicatum
- * Cicendia filiformis
- Sebaea ovata

Geraniaceae
- * Erodium botrys
- * Erodium cicutarium
- * Erodium moschatum
- Geranium solanderi
- Pelargonium littorale

Goodeniaceae
- Anthotium humile
- Anthotium junciforme
- Dampiera alata
- Dampiera cuneata
- Dampiera diversifolia
- Dampiera fasciculata
- Dampiera hederacea
- Dampiera ?juncea
- Dampiera linearis
- Dampiera pedunculata
- Dampiera trigona
- Goodenia claytoniacea
- Goodenia micrantha
- Goodenia mimuloides
- Goodenia pulchella
- Lechenaultia biloba
- Lechenaultia expansa
- Lechenaultia formosa
- Scaevola globulifera
- Scaevola lanceolata
- Scaevola phlebopetala
- Scaevola platyphylla
- Velleia trinervis

Haemodoraceae
- Anigozanthos bicolor
- Anigozanthos flavidus
- Anigozanthos humilis
- Anigozanthos manglesii
- Anigozanthos viridis
- Conostylis aculeata
- Conostylis aurea
- Conostylis laxiflora
- Conostylis setigera
- Haemodorum laxum
- Haemodorum simplex
- Haemodorum sparsiflorum
- Haemodorum spicatum
- Phlebocarya ciliata
- Tribonanthes australis
- Tribonanthes brachypetala
- Tribonanthes longipetala
- Tribonanthes sp Lake Muir (*GJK & NG* 2387)
- Tribonanthes violacea

Haloragaceae
- Glischrocaryon aureum
- Gonocarpus cordiger
- Gonocarpus hexandrus ssp. integrifolius
- Gonocarpus paniculatus
- Gonocarpus pithyoides
- Haloragis brownii
- Myriophyllum crispatum
- Myriophyllum drummondii
- Myriophyllum limnophilum
- Myriophyllum tillaeoides
- Myriophyllum verrucosum

Hydatellaceae
- Hydatella australis
- Hydatella sp.
- Trithuria bibracteata
- Trithuria submersa

Hypoxidaceae
- Hypoxis glabella
- Hypoxis occidentalis

Iridaceae
- * Gladiolus undulatus
- * Homeria flaccida
- * Iris germanica
- Patersonia juncea
- Patersonia occidentalis
- Patersonia occidentalis (swamp form)
- Patersonia umbrosa
- * Romulea rosea
- * Watsonia bulbillifera

Isoetaceae
- Isoetes drummondii

Juncaceae
- * Juncus acutus
- * Juncus articulatus
- * Juncus bufonius
- * Juncus capitatus
- Juncus holoschoenus
- Juncus kraussii
- Juncus pallidus

- Juncus planifolius
- Juncus radula
- Luzula meridionalis

Juncaginaceae
- Triglochin calcitrapum
- Triglochin centrocarpum
- Triglochin huegelii
- Triglochin lineare
- Triglochin minutissimum
- Triglochin mucronatum
- Triglochin striatum

Lamiaceae
- Hemiandra pungens
- * Mentha pulegium

Lauraceae
- Cassytha flava
- Cassytha glabella
- Cassytha micrantha
- Cassytha racemosa

Lentibulariaceae
- Polypompholyx multifida
- Utricularia australis
- Utricularia hookeri
- Utricularia inaequalis
- Utricularia simplex
- Utricularia sp.
- Utricularia violacea
- Utricularia volubilis

Linaceae
- Linum marginale

Lindsaeaceae
- Lindsaea linearis

Lobeliaceae
- Grammatotheca bergiana
- Isotoma hypocrateriformis
- Isotoma scapigera
- Lobelia alata
- Lobelia gibbosa
- Lobelia heterophylla
- Lobelia rhombifolia
- Lobelia tenuior

Loganiaceae
- Logania campanulata
- Logania serpyllifolia
- Phyllangium palustre
- Phyllangium paradoxum

Loranthaceae
- Amyema miquelii
- Nuytsia floribunda

Lycopodiaceae
- Phylloglossum drummondii

Lythraceae
- * Lythrum hyssopifolia

Malvaceae
- Lawrencia spicata
- * Malva parviflora
- Sida hookeriana

Marsileaceae
- Pilularia novae-hollandiae

Menyanthaceae
- Villarsia albiflora
- Villarsia capitata
- Villarsia parnassifolia
- Villarsia submersa
- Villarsia violifolia

Mimosaceae
- Acacia alata
- Acacia biflora
- Acacia browniana
- Acacia cochlearis
- Acacia cyclops
- * Acacia dealbata
- Acacia extensa
- Acacia huegelii
- Acacia incurva
- Acacia laricina var. laricina
- Acacia latipes ssp. latipes ms
- * Acacia longifolia ssp. longifolia ms
- Acacia myrtifolia
- Acacia nervosa
- Acacia pentadenia
- Acacia pulchella var. goadbyi
- Acacia pulchella var. pulchella
- Acacia rostellifera
- Acacia saligna
- Acacia stenoptera
- Acacia tetragonocarpa
- Acacia urophylla
- Acacia varia
- Acacia willdenowiana

Molluginaceae
- Macarthuria apetala

Myoporaceae
- Myoporum caprarioides

Myrtaceae
- Actinodium cunninghamii
- Agonis hypericifolia
- Agonis juniperina
- Agonis linearifolia
- Agonis parviceps
- Astartea fascicularis
- Astartea sp. (pink weeping)
- Astartea sp. (white erect)
- Baeckea camphorosmae
- Baeckea aff. preissiana
- Baeckea pygmaea
- Callistemon phoeniceus
- Calothamnus lateralis
- Calothamnus lehmannii
- Calothamnus preissii
- Calothamnus sanguineus
- Calothamnus schaueri
- Calytrix angulata
- Calytrix flavescens
- Calytrix leschenaultii
- Calytrix ?tenuiramea
- Darwinia oederoides
- Darwinia vestita
- Eremaea pauciflora
- Eucalyptus aspersa
- Eucalyptus calophylla
- Eucalyptus cornuta
- Eucalyptus decipiens
- Eucalyptus latens
- Eucalyptus marginata
- Eucalyptus megacarpa
- Eucalyptus occidentalis
- Eucalyptus patens
- Eucalyptus rudis
- Eucalyptus wandoo
- Hypocalymma angustifolium
- Hypocalymma strictum
- Kunzea ericifolia
- Kunzea micrantha
- Kunzea recurva
- Kunzea sulphurea
- Leptospermum erubescens
- Melaleuca cordata
- Melaleuca cuticularis
- Melaleuca densa
- Melaleuca lateriflora
- Melaleuca lateritia
- Melaleuca leptoclada
- Melaleuca pauciflora
- Melaleuca preissiana
- Melaleuca pritzelii
- Melaleuca rhaphiophylla
- Melaleuca spathulata
- Melaleuca thymoides
- Melaleuca viminea
- Melaleuca violacea
- Pericalymma ellipticum

Verticordia densiflora ssp. caespitosa
Verticordia habrantha
Verticordia plumosa
Olacaceae
Olax benthamiana
Olax phyllanthi
Onagraceae
Epilobium billardierianum
Epilobium hirtigerum
Ophioglossaceae
Ophioglossum lusitanicum
Orchidaceae
Caladenia caesarea ssp. caesarea ms
Caladenia cairnsiana
Caladenia christineae ms
Caladenia drummondii
Caladenia ferruginea
Caladenia flava
Caladenia harringtoniae
Caladenia latifolia
Caladenia longicauda
Caladenia longiclavata
Caladenia macrostylis
Caladenia magniclavata
Caladenia marginata
Caladenia nana
Caladenia radialis
Caladenia radiata
Caladenia reptans
Caladenia rhomboidiformis
Caladenia splendens ms
Caladenia starteorum ms
Caladenia varians ssp. varians ms
Corybas dilatatus
Corybas recurvus
Cryptostylis ovata
Cyanicula deformis ms
Cyanicula ?gemmata ms
Cyrtostylis huegelii
Cyrtostylis robusta
Diuris carinata
Diuris drummondii
Diuris laxiflora
Diuris longifolia
Drakaea glyptodon
Drakaea livida
Drakonorchis barbarossa ms
Elythranthera brunonis
Elythranthera emarginata
Eriochilus dilatatus ssp. undulatus ms
Eriochilus scaber
Gastrodia lacista
Leporella fimbriata
Leptoceras menziesii
Lyperanthus serratus
Microtis atrata
Microtis media
Microtis orbicularis
* Monadenia bracteata
Paracaleana nigrita
Praecoxanthus aphyllus ms
Prasophyllum drummondii
Prasophyllum elatum
Prasophyllum fimbria
Prasophyllum macrostachyum
Prasophyllum plumiforme
Pterostylis barbata
Pterostylis nana
Pterostylis pyramidalis
Pterostylis recurva
Pterostylis sanguinea
Pterostylis turfosa
Pterostylis vittata
Pyrorchis nigricans
Thelymitra antennifera
Thelymitra benthamiana
Thelymitra crinita
Thelymitra cucullata
Thelymitra flexuosa
Thelymitra fuscolutea
Thelymitra macrophylla
Thelymitra nuda
Thelymitra pauciflora
Orobanchaceae
* Orobanche minor
Oxalidaceae
Oxalis perennans
* Oxalis purpurea
Papilionaceae
Aotus intermedia
Bossiaea aquifolium
Bossiaea eriocarpa
Bossiaea linophylla
Bossiaea ornata
Bossiaea praetermissa
Bossiaea rufa
Brachysema melanopetalum
Brachysema praemorsum
Callistachys lanceolata
Chorizema aciculare
Chorizema ilicifolium
Chorizema nanum
Daviesia cordata
Daviesia hakeoides
Daviesia incrassata
Daviesia physodes
Daviesia preissii
Eutaxia virgata
Gastrolobium bilobum
Gompholobium aristatum
Gompholobium burtonioides
Gompholobium capitatum
Gompholobium confertum
Gompholobium knightianum
Gompholobium marginatum
Gompholobium ovatum
Gompholobium polymorphum
Gompholobium preissii
Gompholobium scabrum
Gompholobium tomentosum
Goodia lotifolia
Hardenbergia comptoniana
Hovea chorizemifolia
Hovea elliptica
Hovea trisperma var. grandiflora
Isotropis cuneifolia
Jacksonia furcellata
Jacksonia sparsa ms
Kennedia coccinea
Kennedia prostrata
Latrobea tenella
* Lotus angustissimus
* Lotus suaveolens
* Lotus uliginosus
* Ornithopus compressus
Oxylobium lineare
Pultenaea ericifolia
Pultenaea ochreata
Pultenaea reticulata
Sphaerolobium drummondii
Sphaerolobium linophyllum
Sphaerolobium macranthum
Sphaerolobium medium
Sphaerolobium vimineum
* Trifolium arvense
* Trifolium campestre
* Trifolium cernuum
* Trifolium dubium
* Trifolium fragiferum
* Trifolium glomeratum
* Trifolium repens
* Trifolium subterraneum
Viminaria juncea

Philydraceae
- Philydrella drummondii
- Philydrella pygmaea

Phormiaceae
- Dianella brevicaulis
- Dianella revoluta
- Stypandra glauca

Pinaceae
- * Pinus pinaster

Pittosporaceae
- Billardiera drummondiana var. drummondiana
- Billardiera erubescens
- Billardiera parviflora var. parviflora
- Billardiera variifolia
- Marianthus candidus
- Sollya heterophylla

Plantaginaceae
- Plantago debilis
- Plantago exilis

Poaceae
- Agrostis avenacea
- * Aira caryophyllea
- Amphibromus nervosus
- Amphibromus vickeryae
- Amphipogon amphipogonoides
- Amphipogon debilis
- Amphipogon laguroides
- Amphipogon strictus
- Amphipogon turbinatus
- * Anthoxanthum odoratum
- * Avena barbata
- * Avena fatua
- Austrodanthonia caespitosa
- Austrodanthonia occidentalis
- Austrodanthonia setacea
- Austrostipa compressa
- Austrostipa juncifolia
- Austrostipa pycnostachya
- Austrostipa trichophylla
- * Briza maxima
- * Briza minor
- * Bromus diandrus
- * Cynodon dactylon
- * Cynosurus echinatus
- Deyeuxia quadriseta
- Dichelachne crinita
- Eragrostis ?brownii
- Eragrostis elongata
- Hemarthria uncinata
- * Holcus lanatus
- * Holcus setiger
- * Hordeum geniculatum
- * Hordeum leporinum
- * Hordeum murinum
- * Lolium multiflorum
- * Lolium rigidum
- Microlaena stipoides
- Neurachne alopecuroidea
- * Parapholis incurva
- * Poa annua
- Poa drummondiana
- Poa poiformis
- * Polypogon monspeliensis
- Polypogon tenellus
- Sporobolus virginicus
- * Stenotaphrum secundatum
- Tetrarrhena laevis
- * Vulpia bromoides
- * Vulpia myuros

Podocarpaceae
- Podocarpus drouynianus

Polygalaceae
- Comesperma calymega
- Comesperma ciliatum
- Comesperma drummondii
- Comesperma flavum
- Comesperma virgatum
- Comesperma volubile
- * Polygala myrtifolia

Polygonaceae
- Muehlenbeckia adpressa
- Persicaria prostrata
- * Polygonum arenastrum
- * Rumex acetosella
- * Rumex brownii
- * Rumex conglomeratus
- * Rumex crispus
- * Rumex pulcher

Portulacaceae
- Calandrinia ?composita
- Calandrinia granulifera
- Montia australasica

Potamogetonaceae
- Potamogeton drummondii
- Potamogeton tricarinatus
- Ruppia megacarpa

Primulaceae
- * Anagallis arvensis var. arvensis
- * Anagallis arvensis var. caerulea
- Samolus caespitosus
- Samolus junceus

Proteaceae
- Adenanthos obovatus
- Banksia grandis
- Banksia ilicifolia
- Banksia littoralis
- Banksia meisneri ssp. meisneri
- Conospermum capitatum
- Conospermum flexuosum ssp. laevigatum
- Dryandra armata
- Dryandra bipinnatifida
- Dryandra lindleyana
- Dryandra porrecta
- Dryandra sessilis
- Franklandia fucifolia
- Grevillea brownii
- Grevillea depauperata
- Grevillea ?diversifolia
- Grevillea fasciculata
- Grevillea leptobotrys
- Grevillea pilulifera
- Grevillea pulchella
- Grevillea quercifolia
- Hakea amplexicaulis
- Hakea ceratophylla
- Hakea corymbosa
- Hakea gilbertii
- Hakea lissocarpha
- Hakea oleifolia
- Hakea prostrata
- Hakea ruscifolia
- Hakea sulcata
- Hakea trifurcata
- Hakea undulata
- Hakea varia
- Isopogon ?attenuatus
- Isopogon polycephalus
- Isopogon teretifolius
- Persoonia longifolia
- Petrophile acicularis
- Petrophile divaricata
- Petrophile ?longifolia
- Petrophile media
- Petrophile rigida
- Petrophile serruriae
- Petrophile squamata
- Stirlingia anethifolia
- Stirlingia ?seselifolia
- Stirlingia ?simplex
- Stirlingia tenuifolia
- Synaphea decumbens
- Synaphea favosa

Synaphea petiolaris
Synaphea ?reticulata
Ranunculaceae
Clematis aristata
Clematis pubescens
Ranunculus colonorum
* Ranunculus muricatus
Restionaceae
Anarthria gracilis
Anarthria laevis
Anarthria prolifera
Anarthria scabra
Apodasmia ceramophila ms
Chaetanthus aristatus ms
Chordifex laxus ms
Cytogonidium leptocarpoides ms
Desmocladus fasciculatus ms
Desmocladus flexuosus ms
Harperia lateriflora
Hypolaena exsulca
Hypolaena ?humilis ms
Leptocarpus tenax
Lepyrodia drummondiana
Lepyrodia macra
Lepyrodia muirii
Lyginia barbata
Meeboldina cana ms
Meeboldina coangustata ms
Meeboldina denmarkica
Meeboldina kraussii ms
Meeboldina roycei ms
Meeboldina scariosa ms
Meeboldina sp.
Meeboldina tephrina ms
Sporadanthus strictus ms
Stenopa ramosissima ms
Tremulina tremula ms
Rhamnaceae
Cryptandra arbutiflora ssp. minor
Trymalium floribundum
Trymalium ledifolium
Rosaceae
* Acaena echinata
Rubiaceae
* Galium divaricatum
* Galium murale
Opercularia apiciflora
Opercularia hispidula
Opercularia ?rubioides
Opercularia vaginata
* Sherardia arvensis
Rutaceae
Boronia capitata
Boronia crenulata
Boronia juncea ssp. laniflora
Boronia megastigma
Boronia nematophylla
Boronia ramosa
Boronia spathulata
Eriostemon nodiflorus ssp. lasiocalyx
Santalaceae
Leptomeria cunninghamii
Leptomeria lehmannii
Leptomeria pauciflora
Leptomeria scrobiculata
Leptomeria spinosa
Leptomeria squarrulosa
Santalum acuminatum
Schizaeaceae
Schizaea dichotoma
Scrophulariaceae
* Bartsia trixago
Euphrasia scabra
Glossostigma diandrum
Glossostigma drummondii
Gratiola peruviana
Gratiola pedunculata
Limosella australis
* Parentucellia latifolia
* Parentucellia viscosa
Selaginellaceae
Selaginella gracillima
Solanaceae
* Solanum americanum
* Solanum nigrum
Stackhousiaceae
Stackhousia monogyna
Tripterococcus brunonis
Sterculiaceae
Rulingia corylifolia
Thomasia foliosa
Thomasia paniculata
Thomasia pauciflora
Stylidiaceae
Levenhookia pusilla
Levenhookia stipitata
Stylidium adnatum
Stylidium affine
Stylidium amoenum
Stylidium assimile
Stylidium brunonianum ssp. brunonianum
Stylidium brunonianum ssp. minor
Stylidium caespitosum
Stylidium calcaratum
Stylidium carnosum
Stylidium corymbosum
Stylidium crassifolium
Stylidium ecorne
Stylidium emarginatum
Stylidium guttatum
Stylidium hispidum
Stylidium inundatum
Stylidium junceum ssp. brevius
Stylidium lepidum
Stylidium luteum
Stylidium mimeticum
Stylidium miniatum
Stylidium periscelianthum
Stylidium perpusillum
Stylidium petiolare
Stylidium piliferum
Stylidium pulchellum
Stylidium repens
Stylidium rhipidium
Stylidium roseonanum
Stylidium scandens
Stylidium schoenoides
Stylidium spathulatum
Stylidium spinulosum
Stylidium violaceum
Thymelaeaceae
Pimelea angustifolia
Pimelea argentea
Pimelea ciliata ssp. ciliata
Pimelea cracens ssp. cracens
Pimelea cracens ssp. glabra
Pimelea imbricata var. gracillima
Pimelea imbricata var. major
Pimelea imbricata var. piligera
Pimelea ?lanata
Pimelea lehmanniana
Pimelea preissii
Pimelea rosea
Pimelea suaveolens
Pimelea sulphurea
Pimelea sylvestris
Tremandraceae
Platytheca galioides
Tetratheca affinis
Tetratheca hirsuta
Tetratheca hispidissima
Tetratheca nuda

Tetratheca setigera
Tetratheca virgata
Tremandra diffusa
Typhaceae
Typha domingensis
• Typha orientalis
Urticaceae
Parietaria debilis
Violaceae
Hybanthus debilissimus
Hybanthus floribundus
Xanthorrhoeaceae
Xanthorrhoea gracilis
Xanthorrhoea preissii
Zamiaceae
Macrozamia riedlei
Zannichelliaceae
Lepilaena australis

NOTES ON CONTRIBUTORS

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