32

DEPARTMENT OF
FISHERIES AND WILDLIFE
WESTERN AUSTRALIA

REPORT No 32

Published by the Director of Fisheries and Wildlife, Perth,
under the authority of the Hon. Minister for Fisheries and Wildlife

The Wildlife of the Proposed Wandana Nature Reserve, near Yuna, Western Australia

BY

A. A. BURBIDGE

P. J. FULLER

AND

A. McCUSKER

1978

PERTH
WESTERN AUSTRALIA

Department of Fisheries and Wildlife

108 Adelaide Terrace

PERTH

REPORT
No. 32

THE WILDLIFE OF THE PROPOSED WANDANA NATURE RESERVE, NEAR YUNA, WESTERN AUSTRALIA

BY

A.A. BURBIDGE[1], P.J. FULLER[1] AND A. McCUSKER[2]

1978

[1] Western Australian Wildlife Research Centre, P.O. Box 51, Wanneroo, W.A. 6065.

[2] Australian Biological Resources Study, c/o CSIRO Division of Land Use Research, P.O. Box 1666, Canberra City, A.C.T. 2601.

CONTENTS

FIGURES

TABLES

PLATES

APPENDICES

Dept. Fish. Wildl. West. Aust. Rept. No. 32, 1978, 1-55.

THE WILDLIFE OF THE PROPOSED WANDANA NATURE RESERVE, NEAR YUNA, WESTERN AUSTRALIA.

A.A. Burbidge, P.J. Fuller (Western Australian Wildlife Research Centre, P.O. Box 51, Wanneroo, W.A. 6065) and A. McCusker (Australian Biological Resources Study, c/o CSIRO Division of Land Use Research, P.O. Box 1666, Canberra City, A.C.T. 2601).

ABSTRACT

Following a Cabinet endorsed recommendation by the Environmental Protection Authority in 1976 an area of vacant Crown land (the Wandana Area) north-east of Yuna, Western Australia, was examined during March and September, 1977.

The geology, soils and vegetation of the area are described and annotated lists of mammals, birds, reptiles and amphibians are presented. The area lies near or on the boundary of the South-Western and Eremaean Botanical Provinces and vegetation formations typical of both occur. The vertebrate fauna is a mixture of South-Western and Eyrean species and is especially rich in reptiles, 41 species being recorded. Comparisons between the Wandana Area and other existing and proposed conservation reserves near the boundary of the South-West and the Eremaea show that there are many differences.

The Wandana Area provides an opportunity to protect ecosystems and species not at present within conservation reserves and an opportunity to preserve species of plants and animals which are still common in this region. A recommendation is made for a Class A Reserve of approximately 26 600 ha.

I INTRODUCTION

In its report to the Environmental Protection Authority the Conservation Through Reserves Committee (1974), under the heading "Vacant Crown Land North-East of Yuna", recommended:

"The Committee recommends that a Class A reserve for Conservation of Flora and Fauna, vested in the W.A. Wild Life Authority, be declared north-east of Yuna, the boundaries to be determined after the completion of a survey coordinated by the Department of Fisheries and Fauna" (p.5-9).

In 1976 the Environmental Protection Authority made the following recommendation to Cabinet:

"The EPA recommends that:

(1) a Class C reserve for Conservation of Flora and Fauna, vested in the W.A. Wildlife Authority, be declared north-east of Yuna, the boundaries to be determined after completion of surveys coordinated on one hand by the Director of Fisheries and Wildlife and on the other hand by the Under Secretary for Mines for clarification of their interest by mining companies (sic);

(2) the status, purpose and vesting be reviewed by the EPA at the end of the 1977 calendar year taking due cognizance of the existence of the much smaller East Yuna reserve".

The recommendation was endorsed by Cabinet on 20 October 1976.

The piece of land referred to lies within 28°02' - 28°18'S and 115°06' - 115°25'E and is in the Shire of Chapman Valley. In this report it is termed the "Wandana Area" (Fig. 1).

This report is based on two surveys of the area conducted during 1977. The first took place from 8 March to 17 March inclusive and the second from 12 September to 21 September inclusive. Personnel involved were: A.A. Burbidge, K. Cashin, P.J. Fuller, M. Onus, J.K. Rolfe (Western Australian Wildlife Research Centre) and A. McCusker (Australian Biological Resources Study).

II METHODS

The vegetation was examined initially from a low-flying aircraft and later by traversing all available access tracks on the ground (Fig. 1). Twenty-eight representative sites were chosen for detailed observation and at each of these sites estimates of canopy cover and measurements of canopy height and diameter at breast height (DBH) (where appropriate) were made for each stratum, and specimens of the most abundant species were collected for identification.

Except in areas burnt very recently the vegetation as a whole was dense, with a total canopy cover of 70% or more, separated into usually three but occasionally only two layers. The upper canopy, however, was sparse or very sparse over most of the area. Thus it was considered more appropriate to adopt, for detailed description of the vegetation, a system of classification which would take account of all layers than to employ Specht's system (Specht 1970). The method of classification devised for wheatbelt vegetation by Muir (1977), which is a modification of the Beard and Webb (1974) classification, met the requirements of the present survey and was adopted. Structural formations based on the Muir system were recorded for each sample site.

Mammal trapping was carried out using the following types of traps. The total trapping effort for each type of trap is also shown.

1. Large Elliott, 50 x 17 x 17 cm - 104 trap-nights.
2. Medium Elliott, 32 x 10 x 10 cm - 2320 trap-nights.
3. Break-back, commercial metal rat trap - 1888 trap-nights.
4. Cage, 48 x 17 x 17 cm - 237 trap-nights.
5. Pit, approx 30 x 30 x 70 cm deep - 84 trap-nights.
6. Water trap. A PVC ice-cream container, sunk in the ground and half-filled with water - 109 trap-nights.

Total trap-nights = 4742.

The medium Elliott traps were baited with a mixture of peanut paste, sultanas, rolled oats and bacon fat and the break-back traps were baited with brazil nuts. Large Elliotts and cage traps were baited with raw meat or the peanut paste mixture. Pit traps were not baited, but bacon was smeared on the rim of water traps.

Traplines were laid so as to include all major vegetation formations. The same traplines were used during both the March and September visits. Mammals were also observed and collected during spotlight traverses in a vehicle at night. Bats were collected using the technique of Youngson and McKenzie (1977a) and by shooting bats located with the aid of a spotlight.

Observations were made on birds at the campsites, during vehicle traverses, during walks and in the spotlight at night. Reptiles and frogs were collected opportunistically while doing other work, by digging out heaps of bulldozer spoil and burrows and by turning over logs, litter and rubbish heaps. In September clumps of spinifex (*Triodia* sp.) were burnt in order to flush reptiles and the remaining roots were dug out to locate burrowing species. (No spinifex was burnt in March due to high bush fire danger.) Nocturnal species were collected during spotlight traverses and with the aid of a head torch.

III DESCRIPTION

A. CLIMATE

Meteorological data from Mullewa and Chapman Research Station (28°28'S, 114°46'E) are given in Tables 1 and 2.

Inspection of rainfall isohyets shows that the Wandana Area would have a rainfall similar to, or slightly below, that at Mullewa. Temperature and humidity would also be similar.

TABLE 1. METEOROLOGICAL DATA - MULLEWA (1925-1975)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total or Mean
Rainfall (mm)													
Average	14	16	20	19	45	70	61	43	21	13	8	7	337
Highest monthly	92	140	171	112	187	192	136	238	82	55	70	53	238
Lowest monthly	0	0	0	0	0	13	6	8	0	0	0	0	0
Av. No. of rain days	2	2	2	4	7	11	11	10	6	4	2	2	63
Temperature													
Mean maximum	36.6	35.9	33.5	28.1	23.6	19.7	18.3	19.7	22.9	27.0	31.1	34.6	27.6
Mean minimum	19.8	20.0	18.3	14.9	11.7	9.4	7.4	7.2	8.7	11.4	14.6	17.7	13.4
Relative Humidity (%)													
9. a.m.	37	41	44	56	63	79	77	70	58	44	37	35	53
3. p.m.	20	23	25	32	39	52	51	43	34	26	22	20	32

TABLE 2. METEOROLOGICAL DATA - CHAPMAN RESEARCH STATION (1905-1975)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total or Mean
Rainfall (mm)													
Average	8	12	15	21	63	107	98	64	36	23	10	6	463
Highest monthly	81	118	133	117	218	318	229	176	108	93	58	29	318
Lowest monthly	0	0	0	0	0	28	9	17	0	0	0	0	0
Av. No. of rain days	2	2	3	5	9	13	14	12	8	6	3	2	79
Temperature (°C)													
Mean maximum	34.1	34.8	32.5	27.9	23.5	19.7	18.5	19.0	21.3	26.0	28.9	33.1	26.6
Mean minimum	18.0	19.1	17.4	14.4	11.1	9.8	7.6	7.1	7.4	10.3	13.2	16.4	12.7
Relative Humidity (%)													
9. a.m.	47	49	47	62	63	77	81	72	63	49	44	38	58
3. p.m.	-	-	-	-	-	no data		-	-	-	-	-	-

TABLE 3. RAINFALL 1976 and 1977

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
(a) CHAPMAN RESEARCH													
Average	8	12	15	21	63	107	98	64	36	23	10	6	463
1976	0.8	16.1	1.4	19.0	42.4	30.0	18.4	53.8	29.6	35.7	24.6	4.1	275.9
1977	1.2	0.8	9.6	46.2	43.6	40.8	16.3	71.3					
(b) TALLERING													
Average	12	17	21	19	38	54	45	29	11	7	6	7	267
1976	0	12.0	0	17.0	38.0	18.0	8.0	38.0	12.0	36.0	0	0	179
1977	0	0	0	32.5	17.6	26.0	5.6	2.5	0				

The winters of 1976 and 1977 were both very dry and the Yuna area was subject to drought conditions during both years. Rainfall measurements are no longer made at Mullewa. Data presented are for Chapman Research Station and Tallering Pastoral Station (Table 3).

We believe the data for Tallering more closely reflect the rainfall at the Wandana Area than do data from the Chapman Research Station. Crops to the west of Yuna showed reasonable growth in 1977 while those around the Wandana Area were a total failure.

B. GEOLOGY AND SOILS

The geology of the region has been mapped at 1:250 000 by Playford *et al.* 1970. The Wandana Area lies on the Victoria Plateau which averages about 250 m above sea level. It comprises a gently undulating sandplain overlying laterite of Pleistocene and/or late Tertiary age. The laterite crops out where the sand has been stripped away. Two small areas of Palaeozoic Tumblagooda Sandstone are exposed in the western part of the vacant Crown land (site 12, Fig. 1).

Soils are described and mapped at 1:2 000 000 in the Atlas of Australian Soils, Sheet 5 (Northcote *et al.* 1967). The Wandana Area lies within a region designated as Ac9 - "Gently undulating plateau underlain by sedimentary rocks; some dune tracts in places; some breakaways at margins; some areas of block laterite: chief soils are yellow earthy sands" (p.13). Our inspection of the Wandana Area showed it to contain extensive yellow sandplains with numerous dunes, especially in the western half. Laterite is exposed in places but there are no breakaways nor exposures of block laterite. There are also areas of red earths, associated with *Eucalyptus* woodlands and tree mallee, which probably should be mapped within the My49 map unit.

C. VEGETATION

The vegetation of the area has been mapped at 1:250 000 and described by Beard (see Beard and Burns 1976). He mapped four communities within the area of vacant Crown land:

(i) scrub heath inland association on sandplain,

(ii) *Acacia/Casuarina* thicket,

(iii) mallee and wattle with scattered eucalypts, and

(iv) Bowgada *(Acacia ramulosa)* with eucalypts and cypress pines.

As mapped, communities (i) and (ii) occupy the western and eastern portions respectively and are shown occurring together in a broad central strip. Communities (iii) and (iv) barely encroach parts of the eastern margins.

During the present study identification of the species comprising each vegetation type was severely handicapped by the lack of flowering material caused by the extremely dry season. An attempt was made to list the most conspicuous components of each layer of the vegetation at each collecting site but many specimens, especially from the heath and low/dwarf scrub layers remain unidentified. A short list of the most conspicuous species associated with each of the major soil types is given in Table 4. The relatively small size of the total area under survey and the seral nature of much of the vegetation made it impractical to attempt the description of alliances (*sensu* Specht) within it.

TABLE 4. PLANT SPECIES MOST CONSPICUOUS ON RED AND YELLOW SOILS WITHIN THE WANDANA AREA.

Red Soils	Yellow sandplain Soils
Eucalyptus loxophleba	*Eucalyptus dongarraensis*
E. dongarraensis	*E. eudesmoides*
E. oleosa	*E. oldfieldii*
E. transcontinentalis	*E. leptopoda*
E. foecunda	*Actinostrobus arenarius*
Callitris columellaris	*Banksia sceptrum*
Melaleuca adnata var. *adnata*	*B. ashbyi*
Acacia acuminata	*Xylomelum angustifolium*
Acacia tetragonophylla	*Melaleuca cordata*
Eremophila spp.	*Casuarina campestris*
Casuarina prinsepiana	*C. acutivalvis*
Cassia nemophila	*C. corniculata*
(succulent chenopodiaceous dwarf shrubs)	*Calothamnus* spp.
	Grevillea annulifera
	G. eriostachya
	Hakea bucculenta
	(myrtaceous dwarf shrubs)

Structural descriptions of the vegetation of each site are given in Appendix 1. The vegetation structure was not exactly the same at any two of the 28 sampling sites, much of the variation being attributed to the complex mosaic of old and recent fires.

For the purpose of constructing a vegetation map (Fig 2), five structural groupings were recognised, namely:

(i) Low woodland series, comprising low woodland (Plates 1 and 2) and open low woodland which are confined to red soils and are characterised by the presence of Eremaean species in the shrub layers.

(ii) Tree mallee series, comprising tree mallee, open tree mallee and very open tree mallee, also confined to red soils and generally occurring around the margins of low

woodland (Plates 7 and 8).

(iii) Shrub mallee series, comprising shrub mallee, open shrub mallee and very open shrub mallee (Plates 9 and 10). This series occupies the largest area, being the most widespread vegetation type on yellow sandplain soils, and also occurring on patches of orange-yellow lateritic soils near the northern boundary, e.g. at sampling sites 7 and 19. The lower shrub layers in this zone are variable in height and composition, a major factor in the variation being the fire history of the area. In aerial view, fire lines formed the most distinct boundaries within the shrub mallee although only the most recently burnt areas were readily distinguishable on the ground. The conifer *Actinostrobus arenarius* is a conspicuous component of the upper layer in all but the most recently burnt areas (Plate 11).

(v) *Melaleuca/Acacia* thicket, occurring on red soils and characterised by the presence, in abundance, of *Melaleuca adnata* var. *adnata* and/or *Acacia acuminata* ('Jam') (Plate 5). *M. adnata* forms localised patches of dense thicket with no understorey plants (Plates 1 and 6).

(v) *Banksia* thicket, occurring on yellow sand, with the upper layer consisting mainly of *Banksia sceptrum*, occasionally associated with *B. ashbyi* on more level sites and with *Xylomelum angustifolium* on the highest dunes. This formation is common in the western half of the area but is confined to the summits and upper slopes of the larger dunes. *Actinostrobus arenarius* is common towards the lower limit of *B. sceptrum* on dune slopes (Plates 3 and 4).

In the south-western arm of the area the vegetation forms a mosaic, associated with topography, at a scale too fine for inclusion in the map. *Banksia sceptrum* thicket occurs on the ridges of many dunes, while between the dunes are patches of open or very open shrub mallee and, in numerous small depressions, patches of dense myrtaceous heath of very uniform height, about 0.8 m (Plate 3). This mosaic is indicated in Fig. 1 by superimposing the symbols for *Banksia* thicket and open shrub mallee.

The major variation in the vegetation, both structurally and floristically, is edaphically controlled. Woodland and tree mallee communities and *Melaleuca/Acacia* are confined to red soil and orange lateritic soils. Communities of the shrub mallee series and *Banksia* thicket are restricted to yellow sandplain soils. With the notable exception of *Eucalyptus dongarraensis*, which was found to occur commonly as a tree mallee on red soil sites and as a shrub mallee on the sandplain, virtually all of the species which could be positively identified were confined to one soil type or the other (Table 4).

IV VERTEBRATE FAUNA

When describing habitat we have included *Banksia* thicket with the shrub mallee series, and tree mallee, open tree mallee, very open tree mallee, *Melaleuca/Acacia* thicket and open low woodland with low woodland. Where detailed descriptions of the vegetation are given they follow the system of Muir (1977).

A. MAMMALS

In the annotated species list data are presented in the following order: name, month of observation, status or number of observations and/or number of specimens collected, habitat and number of specimens from each habitat and method of observation or collection. Mammals collected were deposited in the Western Australian Museum. Accession numbers were M15437 - 15446 and M15449 - 15455.

ANNOTATED SPECIES LIST

MARSUPALIA

Macropodidae

Macropus fuliginosus (Desmarest) Western Grey Kangaroo

March and September, common.

Shrub mallee and adjacent paddocks.

Sight records, daylight and spotlighting.

On 14 September 1977 a pair were observed copulating during daylight (1430 hrs). The female had a large pouch young.

Macropus robustus Gould Euro

March and September, moderately common.

Sight records, spotlighting.

Megaleia rufa (Desmarest) Red Kangaroo

September, rare.

Tree mallee, adjacent to paddock.

One sighted, spotlighting.

RODENTIA

Muridae

Notomys alexis Thomas Spinifex Hopping Mouse

March (7 ♂, 1 ♀), September (2 ♂, 2 ♀). Skeletal remains of one individual in owl pellets obtained in low woodland.

Top of dune - shrub of *Banksia sceptrum* over 0.5 m shrubs *(Thryptomene* sp.*)* with occasional emergent *Xylomelum angustifolium* (3).
Base of dune - dwarf scrub C of *Melaleuca cordata* and *Thryptomene* sp. and a scattered ground layer of sedges (1). Lateritic clay - low scrub B of *Acacia* sp. over scattered sedges (3).
Sandplain - thicket of *Banksia sceptrum, Actinostrobus arenarius, Casuarina campestris* and *Acacia* sp. (2).
Red sandy earths - low woodland of *Eucalyptus dongarraensis, Callitris columellaris* and *Casuarina prinsepiana* with shrubs of *Melaleuca adnata* and *Acacia* sp. and a ground cover of scattered clumps of *Triodia* sp. (3).

Break-back traps.

Mus musculus Linnaeus — House Mouse

March (2♂). Skeletal remains plentiful in owl pellets collected in low woodland.

Lateritic clay - low scrub B of *Acacia* sp. and scattered sedges (2).

Medium Elliott traps.

LAGOMORPHA

Leporidae

Oryctolagus cuniculus (Linnaeus) — European Rabbit

March, common, shrub mallee and low woodland, adjacent to paddocks.
September, common, shrub mallee and low woodland, adjacent to paddocks.

CHIROPTERA

Vespertilionidae

Nyctophilus geoffroyi Leach — Lesser Long-eared Bat

March (1♂).

Thicket of *Banksia ashbyi, Actinostrobus arenarius, Eucalyptus* spp. including *E. leptopoda.*

Shot, 2100 hrs.

Chalinolobus gouldii (Gray) — Gould's Wattled Bat

March (2♂), September (1♂).

Low woodland of *Eucalyptus loxophleba* over scattered shrubs of *Acacia* spp. (2).

Thicket of *Banksia ashbyi*, *Actinostrobus arenarius*, *Eucalyptus* spp. including *E. leptopoda*.

Shot, 2030 and 2145 hrs (March) 2022 hrs (September).

Tadarida australis (Gray) White-striped Bat

September (2♂).

Low woodland of *Eucalyptus loxophleba* over scattered shrubs of *Acacia* spp.

Shot, 2020 and 2021 hrs.

CARNIVORA

Canidae

Vulpes vulpes (Linnaeus) Fox

March and September, common. Tracks were frequently observed in shrub mallee and in *Banksia* thicket.

Felidae

Felis catus Linnaeus Cat

March, one seen. Tracks were often observed in sandy soils, both visits.

ARTIODACTYLA

Bovidae

Capra hircus Linnaeus Goat

A party of 10 feral goats was seen in a paddock adjacent to Crown land on 18 September.

MONOTREMATA

Tachyglossidae

Tachyglossus aculeatus (Shaw) Echidna

March and September, common.

Diggings consistent with the presence of this species were observed during both visits, especially the latter, in all vegetation types.

The survey revealed only eight native mammal species - 3 macropods, 1 rodent, 3 bats and the echidna. Five species of feral mammals were recorded.

Our surveys were preceded by a year of severe drought and were conducted in another drought year (see Climate). Undoubtedly this resulted in small mammal numbers being low - it is particularly notable that no *Mus* were obtained during the September visit and only two during March. Two owl pellet deposits found in hollow trees near Camp 2 during September contained the remains of numerous *Mus*, only one *Notomys* and no other small mammal species.

Available distribution and habitat data suggest that other species of small terrestrial mammals might also occur at Wandana. These include:

Tarsipes spencerae (Honey Possum) - Kalbarri National Park (Bannister 1969), Binnu area (WAM M6611, 1965).

Sminthopsis murina (Common Dunnart) - Tallering Station (WAM M6386, 1964), 48 km north of Murchison House Station (WAM M7153, 1964), the proposed Karroun Hill Nature Reserve (Youngson and McKenzie 1977b).

Sminthopsis crassicaudata (Fat-tailed Dunnart) - Yuna (WAM M2723, 1946), Tallering Station (WAM M4076, 1959; M6385 and M6548, 1964), Kalbarri National Park (Bannister 1969).

Sminthopsis hirtipes (Hairy-footed Dunnart) - Kalbarri National Park (WAM M10218, 1973).

Pseudomys albocinereus (Ashey-grey Mouse) - Bindoo Hill Nature Reserve (WAM M10260, M10261, 1973).

Pseudomys hermannsburgensis (Sandy Mouse) - 37 km east of Tamala (WAM M6815, 1964), the proposed Karroun Hill Nature Reserve (Youngson and McKenzie 1977b).

Further species of bats may also be present.

B. BIRDS

In the annotated species list, data are presented on the species observed, the month observed and the habitat(s) they were observed in. Status is listed as common, moderately common or uncommon. When only one or two observations were made the actual numbers are given. When describing status we are making a judgement based on our experience with each species here and elsewhere in Western Australia. The status given is relative - "common" for the Galah reflects many sightings of flocks of birds whereas "common" for the Whistling Kite would reflect only a few observations (see Dell and Johnstone 1977).

ANNOTATED SPECIES LIST

Dromaiidae

Dromaius novaehollandiae — Emu

March, fresh tracks, shrub mallee and low woodland.
September, uncommon, single birds in shrub mallee, flock of 10 in adjacent paddock.

Accipitridae

Haliastur sphenurus — Whistling Kite

September, common, shrub mallee and low woodland.

Accipiter fasciatus — Brown Goshawk

March, moderately common, shrub mallee and low woodland.
September, moderately common, shrub mallee and low woodland.

Accipiter cirrocephalus — Collared Sparrowhawk

September, single bird, shrub mallee.

Haliaetus morphnoides — Little Eagle

September, pair, low woodland.

Aquila audax — Wedge-tailed Eagle

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Falconidae

Falco longipennis — Little Falcon

March, uncommon, low woodland.

September, uncommon, low woodland.

Falco cenchroides — Nankeen Kestrel

March, uncommon, shrub mallee and low woodland; plentiful in adjoining paddocks.
September, uncommon, shrub mallee and low woodland. Plentiful in adjoining paddocks.

Falco berigora — Brown Falcon

March, uncommon, low woodland.
September, uncommon, low woodland.

Megapodiidae

Leipoa ocellata — Mallee Fowl

March, moderately common, shrub mallee and low woodland.
September, no birds seen but tracks noted in shrub mallee.

Several nesting mounds were located in shrub mallee but none were active.

Otididae

Otis australis — Australian Bustard

March, single bird, adjacent paddock.
September, flock of 5, shrub mallee adjacent to paddock.

Charadriidae

Vanellus tricolor — Banded Plover

March, common, shrub mallee and adjacent paddocks.
September, common, shrub mallee and adjacent paddocks.

Peltohyas australis — Australian Dotterel

March, flock of 5, adjacent paddock.

Columbidae

Phaps chalcoptera — Common Bronzewing

March, common, low woodland.
September, common, low woodland.

Ocyphaps lophotes — Crested Pigeon

March, common, shrub mallee.
September, common, shrub mallee and low woodland.

Plentiful in areas adjoining paddocks.

Psittacidae

Calyptorhynchus magnificus — Red-tailed Black Cockatoo

March, common, low woodland.
September, common, low woodland.

A nest, located in a hollow spout of a York Gum *(Eucalyptus loxophleba)*, contained a single egg on 18 September.

Cacatua sanguinea — Little Corella

September, uncommon, low woodland.

Cacatua roseicapillus — Galah

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

During the September visit many birds were observed occuping hollows in trees in low woodland with fresh eucalypt leaves on the ground beneath.

Nymphicus hollandicus — Cockatiel

September, common, shrub mallee and low woodland. Flocks of up to 15.

Barnardius zonarius Port Lincoln Parrot

September, common, shrub mallee and low woodland.
March, common, shrub mallee and low woodland.

Psephotus varius Mulga Parrot

September, moderately common, shrub mallee and low woodland.

Neophema bourkii Bourke Parrot

September, a pair in low woodland.

Cuculidae

Cuculis pallidus Pallid Cuckoo

March, one bird, shrub mallee.

Chrysococcyx basalis Horsfield Bronze Cuckoo

September, one bird, low woodland.

Strigidae

Ninox novaeseelandiae Boobook Owl

September, uncommon, low woodland.

Podargidae

Podargus strigoides Tawny Frogmouth

March, uncommon, low woodland.
September, uncommon, low woodland.

Aegothelidae

Aegotheles cristatus Owlet Nightjar

March, single bird, shrub mallee.
September, moderately common, shrub mallee and low woodland.

Caprimulgidae

Eurostopodus guttatus Spotted Nightjar

March, uncommon, low woodland.
September, uncommon, low woodland.

Alcedinidae

Halycon sancta Sacred Kingfisher

March, one bird, shrub mallee.

Meropidae

Merops ornatus — Australian Bee-Eater

March, uncommon, shrub mallee.

Hirundinidae

Cheramoeca leucosternum — White-backed Swallow

September, uncommon, shrub mallee.

A bird was flushed from a nest-tunnel on 18 September.

Petrochelidon nigricans — Tree Martin

March, uncommon, low woodland.
September, common, low woodland.

A nest located in a hollow limb of a York Gum *(Eucalyptus loxophleba)* contained three eggs on 17 September.

Motocillidae

Anthus novaeseelandiae — Australian Pipit

March, common, shrub mallee; abundant in adjacent paddocks.
September, common, shrub mallee; abundant in adjacent paddocks.

Grallinidae

Grallina cyanoleuca — Magpie-Lark

March, uncommon, shrub mallee and low woodland.
September, uncommon, shrub mallee and low woodland.

An old nest was located in woodland.

Campephagidae

Coracina novaehollandiae — Black-faced Cuckoo-Shrike

March, common, shrub mallee and low woodland.
September, uncommon, shrub mallee and low woodland.

Lalage sueurii — White-winged Triller

September, uncommon, shrub mallee.

Timaliidae

Cinclosoma castanotum — Chestnut Quail-Thrush

March, uncommon, shrub mallee.
September, uncommon, shrub mallee.

Pomatostomus superciliosus White-browed Babbler

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

A nest located on 15 September contained one fresh egg. Many old nests found in both shrub mallee and low woodland series.

Maluridae

Malurus splendens Splendid Wren

March, moderately common, shrub mallee.
September, moderately common, shrub mallee.

Malurus leucopterus White-winged Wren

September, moderately common, two parties in shrub mallee and one in *Melaleuca/Acacia* thicket.

Acanthizidae

Smicrornis brevirostris Weebill

March, moderately common, shrub mallee.
September, moderately common, shrub mallee.

Acanthiza apicalis Broad-tailed Thornbill

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Acanthiza uropygialis Chestnut-tailed Thornbill

March, common, low woodland.
September, common, low woodland.

Acanthiza chrysorrhoa Yellow-tailed Thornbill

March, moderately common, shrub mallee and low woodland.
September, moderately common, shrub mallee and low woodland.

Pyrrholaemus brunneus Redthroat

March, common, shrub mallee.
September, common, shrub mallee.

Muscicapidae

Petroica goodenovii Red-capped Robin

March, moderately common, shrub mallee and low woodland.
September, moderately common, shrub mallee and low woodland.

Petroica cucullata Hooded Robin

September, uncommon, shrub mallee.

Rhipidura fuliginosa Grey Fantail

September, common, low woodland.

Rhipidura leucophrys Willie Wagtail

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Pachycephalidae

Pachycephala rufiventris Rufous Whistler

March, single bird, shrub mallee.
September, common, shrub mallee and low woodland.

Colluricincla harmonica rufiventris Western Shrike-Thrush

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Oreoica gutturalis Crested Bell-Bird

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Ephthianuridae

Ephthianura albifrons White-fronted Chat

March, common, shrub mallee.

Ephthianura tricolor Crimson Chat

September, uncommon, shrub mallee; abundant on adjacent paddocks.

Dicaeidae

Dicaeum hirundinaceum Mistletoe-Bird

March, single bird, shrub mallee.

Pardalotus substriatus Striated Pardalote

September, common, low woodland.

Meliphagidae

Meliphaga virescens Singing Honeyeater

March, common, shrub mallee.

Meliphaga plumula Yellow-fronted Honeyeater

March, moderately common, low woodland.

Phylidonyris albifrons White-fronted Honeyeater

March, moderately common, low woodland.

Manorina flavigula Yellow-throated Miner

March, common, shrub mallee and low woodland.
September, uncommon, shrub mallee.

Anthochaera rufogularis Spiny-cheeked Honeyeater

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Spermestidae

Taeniopygia guttata Zebra Finch

March, moderately common, shrub mallee and low woodland.
September, uncommon, shrub mallee.

Also seen at water in adjacent paddocks.

Artamidae

Artamus cinereus Black-faced Wood-Swallow

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Cracticidae

Cracticus nigrogularis Pied Butcher-Bird

March, moderately common, shrub mallee and low woodland.
September, moderately common, shrub mallee and low woodland.

Cracticus torquatus Grey Butcher-Bird

March, common, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Gymnorhina tibicen dorsalis Western Magpie

March, uncommon, shrub mallee and low woodland.
September, common, shrub mallee and low woodland.

Strepera versicolor Grey Currawong

September, single bird, low woodland.

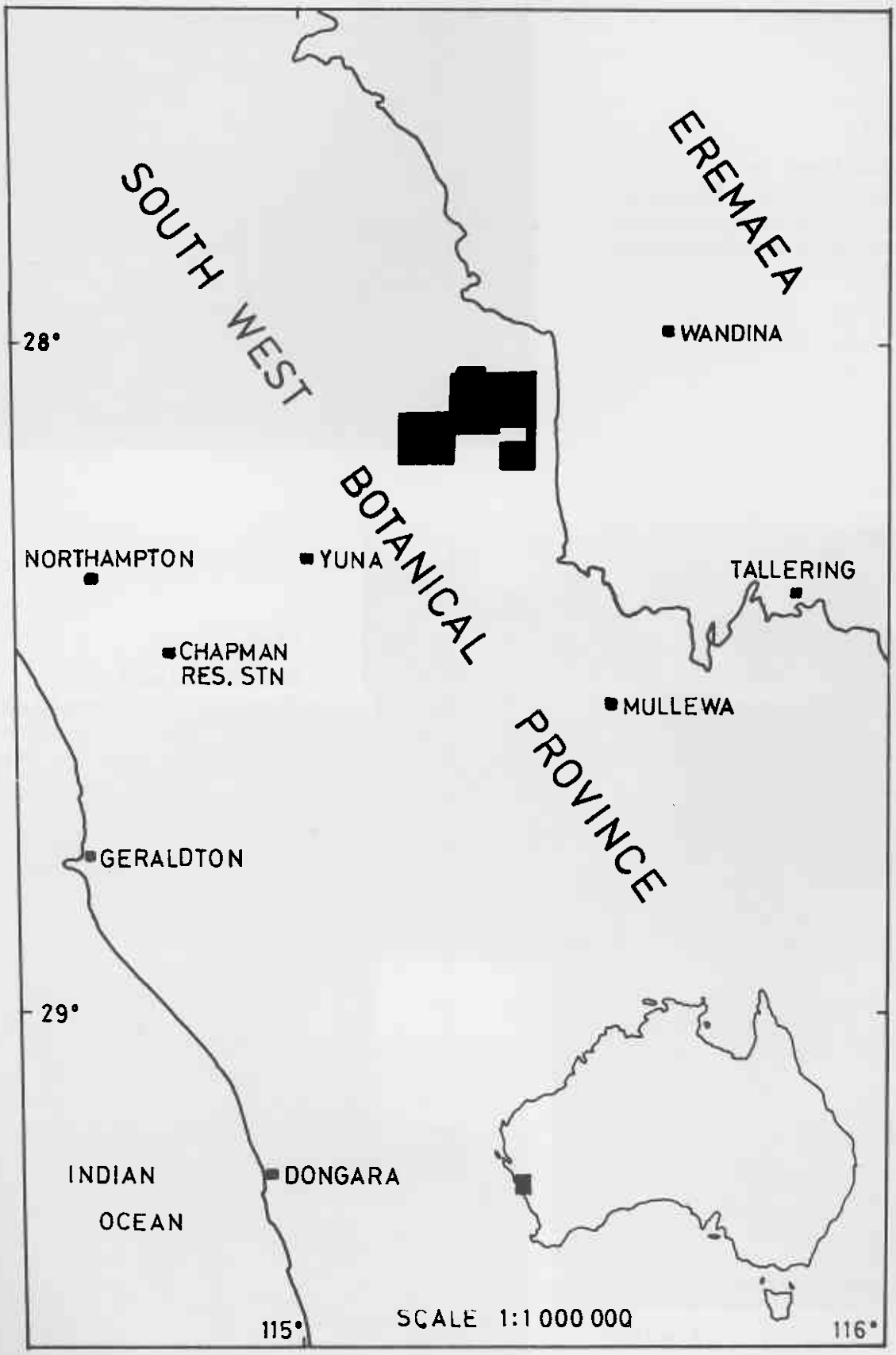


Fig. 1. Location of Proposed Wandana Nature Reserve. Boundaries of Botanical Provinces from Beard (1976).

Plate 1.

Low woodland of *Eucalyptus loxophleba* and *Melaleuca/Acacia* thicket surrounding claypan, site 13.

Plate 2.

Low woodland of *Eucalyptus loxophleba* over scrub near site 26. Very sparse dwarf scrub layer visible in right foreground.

Plate 3.

Banksia sceptrum thicket on top of dune with heath over low heath in foreground, near site 11.

Plate 4.

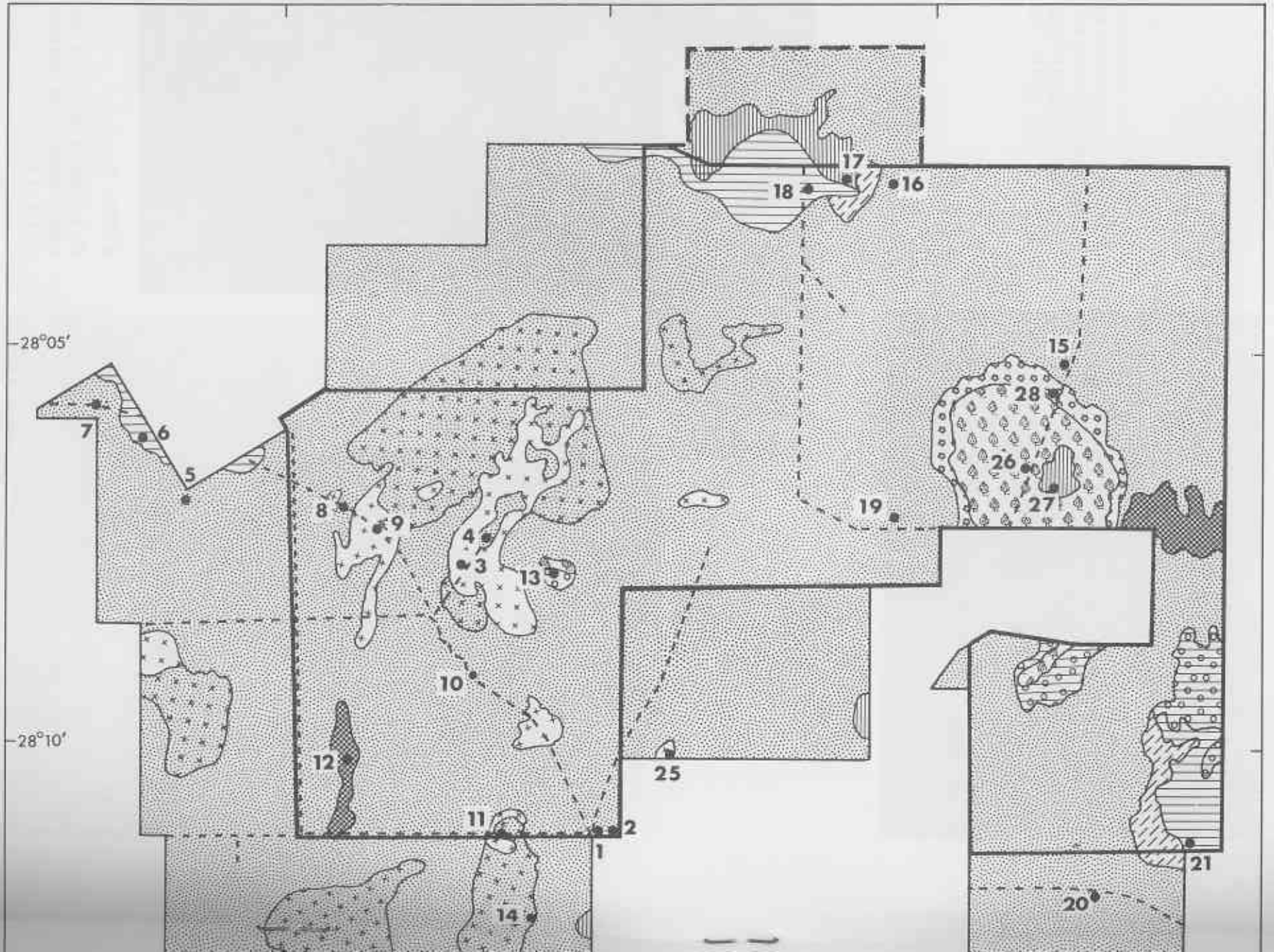
Banksia sceptrum thicket with emergent *Xylomelum angustifolium*, near site 11.

Plate 5.

Dense thicket of *Acacia acuminata/Melaleuca adnata* at site 22.

Plate 6.

Melaleuca adnata thicket over open low scrub at site 13.


28°05′
28°10′
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
25
26
27
28

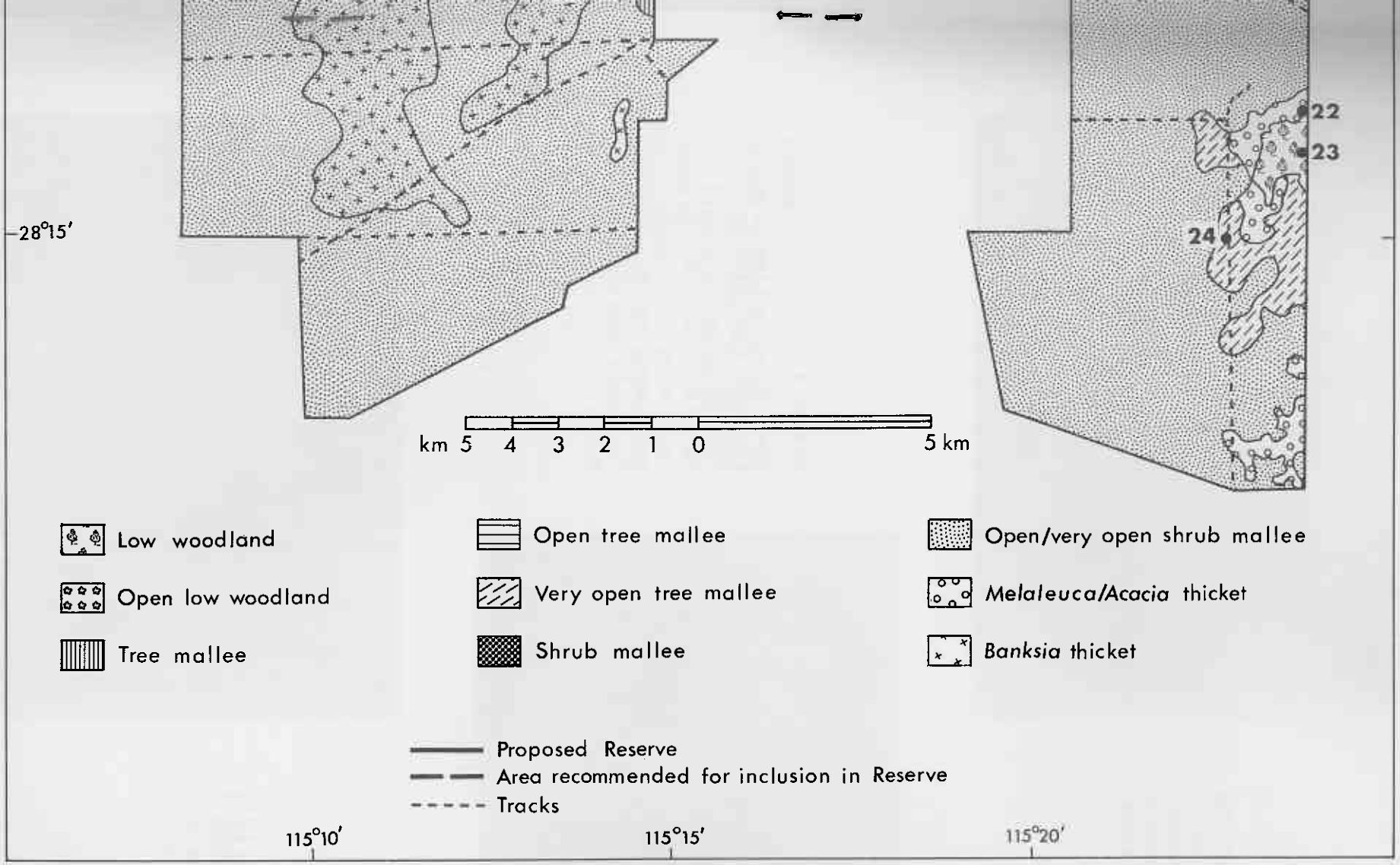


Fig. 2. Map of Wandana Area, showing vegetation, survey sites and boundaries of proposed Nature Reserve.

Plate 7.

Open tree mallee of *Eucalyptus transcontinentalis* and *E. oleosa*, over low scrub with scattered *Triodia* at site 6. Pole is 2 m high with 10 cm divisions.

Plate 8.

Open tree mallee over thicket containing *Acacia acuminata* and *Callitris columellaris*, near site 21. Some specimens of *Eucalyptus foecunda* are of tree form.

Plate 9.

Shrub mallee *(Eucalyptus oldfieldii)* over low/dwarf scrub at site 12. Note *Triodia* between mallee clumps.

Plate 10.

Recently burnt open/very open shrub mallee typical of much of yellow sandplain area (near site 15).

Plate 11.

Scrub dominated by *Actinostrobus arenarius* over heath/low heath, site 5.

Plate 12.

The Beautiful Gecko, *Diplodactylus pulcher*.

Corvidae

Corvus bennetti Little Crow

March, common, shrub mallee and low woodland; abundant on adjacent paddocks.
September, common, shrub mallee and low woodland; abundant on adjacent paddocks.

One specimen collected on 20 September but not retained.

It is likely that both the Australian Raven *(Corvus coronoides)* and the Australian Crow *(C. orru)* occur here in addition to the Little Crow.

In all 68 species of birds were recorded in the Wandana area. Of these 38 species were passerines and 30 were non-passerines.

Most species recorded have widespread distributions and could be expected in this area. Only the Bourke Parrot *(Neophema bourkii)* is at the limit of its range, its stronghold being in mulga *(Acacia aneura)* country in the Murchison and the interior.

Most of the Wandana Area consists of sandplain and dunes with shrub mallee and *Banksia* thicket vegetation. The following birds were noted only in this habitat: White-backed Swallow, Pipit, Chestnut Quail-Thrush, Splendid Wren, White-winged Wren, Redthroat, White-fronted Chat and Crimson Chat. The Redthroat, a species which has declined in the wheatbelt, was common.

Areas of low woodland and associated tree mallee and *Melaleuca/ Acacia* thicket are of limited occurrence but provide habitat for some species not seen in the shrub mallee. These include: Red-tailed Black Cockatoo, Little Corella, Bourke Parrot, Boobook Owl, Tree Martin, Chestnut-tailed Thornbill, Striated Pardalote and Grey Currawong.

Doubtless the prevailing drought conditions restricted the number of species, especially in September. Thus, five species of Honeyeater were recorded in March but only two in September. Under better conditions we would expect to record many of the following species: Little Quail *(Turnix velox)*, Bush Stone-Curlew *(Burhinus magnirostris)*, Southern Scrub-Robin *(Drymodes brunneopygia)*, Variegated Wren *(Malurus lamberti)*, Thick-billed Grass-Wren *(Amytornis taxtilis)*, Rufous Songlark *(Cinclorhamphus mathewsi)*, Brown Songlark *(C. cruralis)*, White-tailed Warbler *(Gerygone fusca)*, Spotted Scrub-Wren *(Sericornis maculatus)*, Shy Heath-Wren *(Hylacola cauta)*, Field Wren *(Calamanthus fuliginosus)*, Golden Whistler

(Pachycephala pectoralis), Black-capped Sitella *(Neositta pileata)*, Rufous Tree-Creeper *(Climacteris rufa)*, Western Silvereye *(Zosterops lateralis gouldi)*, Brown Honeyeater *(Lichmera indistincta)*, Black Honeyeater *(Certhionyx niger)*, Pied Honeyeater *(C. variegatus)*, Brown-headed Honeyeater *(Melithreptus brevirostris)* and Masked Wood-Swallow *(Artamus personatus)*.

C. REPTILES AND AMPHIBIANS

In the annotated species list data are presented in the following order: name, month collected and number of specimens, habitat, method of collection, notes. Specimens collected were lodged in the Western Australian Museum with accession numbers R56926 - 56988 and R57505 - 57590 inclusive.

ANNOTATED SPECIES LIST

REPTILES

Gekkonidae Geckoes

Crenadactylus ocellatus horni (Lucas & Frost) White-Spotted Gecko

September (4).

Open low woodland.

Burning spinifex.

Diplodactylus alboguttatus Werner Spotted-Striped Gecko

March (14), September (3); commonly observed.

Shrub mallee, widespread.

Spotlighting, headtorching.

Diplodactylus pulcher (Steindachner) Beautiful Gecko (Plate 12)

March (1), September (1).

Shrub mallee, open low woodland over *Triodia*.

Headtorching, pit trap.

Diplodactylus "vittatus Gray" Festooned Gecko

March (3), September (1).

Shrub mallee.

Headtorching, spotlighting.

This species group is being revised (G.M. Storr, pers. comm.).

Gehyra variegata (Duméril & Bibron) Dtella

March (6), September (4).

Shrub mallee and low woodland.

Headtorching, pit traps, burning *Triodia*, under litter.

Heteronotia binoei (Gray) Bynoe's Gecko

September (1).

Open tree mallee.

Under rubbish.

Nephrurus levis occidentalis Storr Western Knob-tailed Gecko

March (7), September (1); commonly observed in March.

Shrub mallee, tree mallee.

Headtorching, spotlighting, pit trap.

Rhychoedura ornata Günther Beaked Gecko

September (2)

Low woodland.

Spotlighting.

Pygopodidae Legless Lizards

Aprasia smithi Storr

September (1).

Tree mallee with *Triodia* sp.

Dug from roots of burnt spinifex.

Delma nasuta Kluge

September (2).

Low woodland and open low woodland over *Triodia*.

Burning spinifex, pit trap.

Lialis burtonis Gray Burton's Snake-Lizard

March (1).

Low woodland.

Picked up at dusk.

Pygopodus lepidopodus (Lácepède) Common Scaly-foot

September (1).

Banksia thicket.

Under leaf litter.

Agamidae

Amphibolurus inermis (De Vis)

September (1).

Low woodland.

Dug from burrow.

Amphibolurus maculatus maculatus (Gray) Spotted Dragon

March (2), September (4), commonly observed.

Shrub mallee.

Shot during daytime.

Amphibolurus minor Sternfeld Western Jew Lizard

March (1), September (2).

Shrub mallee.

Break-back trap, shot during daytime.

Amphibolurus scutulatus Stirling & Zeitz Lozenge-marked Dragon

March (6), September (2).

Shrub mallee, low woodland.

Elliott Trap, break-back trap, shot during daytime.

Moloch horridus Gray Thorny Devil

March (1), September (2), commonly observed.

Shrub mallee.

Picked up during the daytime.

Scincidae Skinks

Cryptoblepharus plagiocephalus (Cocteau) Wall Lizard

March (2), September (2).

Shrub mallee, low woodland.

Under bark and in litter.

Ctenotus alleni Storr

March (9), September (13), commonly observed.

Shrub mallee, tree mallee, low woodland.

Elliott traps, break-back traps, shot during daytime.

Ctenotus mimetes Storr

September (1).

Very open tree mallee with *Casuarina* and *Acacia*.

Shot during daytime.

Lerista nichollsi (Loveridge)

September (1)

Open low woodland over *Triodia*.

Dug from roots of burnt *Triodia*.

Lerista praepedita (Gray)

March (2), September (4).

Shrub mallee.

Dug from bulldozer spoil.

Morethia butleri (Storr)

September (1).

Very open tree mallee with *Casuarina* and *Acacia*.

Shot during daytime.

Morethia obscura Storr

March (1), September (1).

Shrub mallee.

Leaf litter, stomach of a *Denisonia monachus*.

Omolepida branchialis Günther

September (1).

Open low woodland over *Triodia*.

Burnt from *Triodia*.

Tiliqua occipitalis (Peters) Western Blue-tongue

March (2), September (2), commonly observed.

Shrub mallee.

Elliott traps, picked up.

Tiliqua rugosa (Gray) Bob-tail

September (1).

Shrub mallee.

Cage trap.

Varanidae Goannas

Varanus eremius Lucas & Frost Desert Goanna

March (1)

Low woodland.

Dug from burrow. The burrow was 55 cm deep and descended in a spiral approx. 25 cm in diameter.

Varanus gouldii (Gray) Bungarra

No specimens.

During both visits tracks and diggings were observed in shrub mallee consistent with the presence of this species.

Typhlopidae Blind Snakes

Typhlina bituberculata (Peters)

September (1).

Open low woodland over *Triodia*.

Dug from roots of burnt *Triodia*.

Elapidae Venomous Snakes

Denisonia monachus Storr

September (6).

Shrub mallee.

Dug from bulldozer spoil, under rubbish.

One specimen had a *Morethia obscura* in its stomach.

Pseudonaja modesta Günther Ringed Snake

March (1).

Low woodland.

Shot in early morning when it was active and out in the open.

Pseudonaja nuchalis Günther Gwardar

September (1).

Shrub mallee.

Dug from bulldozer spoil.

Vermicella bertholdi (Jan) Bandy Bandy

March (1).

Shrub mallee.

In leaf litter at night, headtorching.

Vermicella semifasciata (Günther) Half-ringed Snake

September (1).

Shrub mallee.

Dug from bulldozer spoil.

AMPHIBIANS

Leptodactylidae Ground Frogs

Neobatrachus sp.

September (15 tadpoles).

In an almost dried up pool in a claypan in low woodland.

Picked up.

Six additional species of reptiles have been collected within, or immediately adjacent to, the Wandana Area by G. Hitchin in 1966, *viz: Diplodactylus michaelseni* (Storr 1967), *Diplodactylus spinigerus* (WAM R26640), *Pygopus nigriceps* (R26501), *Lerista lineopunctulata* (R26500), *L. macropisthopus* (R26505) and *Vermicella fasciolata* (R26502). This means that 41 species of reptiles are known from the area.

Most of the species of reptiles recorded from the Wandana Area have widespread distributions in central and southern Western Australia and the list includes many species typical of the drier parts of the south-west or the Murchison District. Some species, however, occur here at the periphery of their known range. *Aprasia smithi* was previously known from only two localities - Kalbarri and Tamala - and ours is the first inland specimen. Other coastal species occurring here at or near their inland limit are *Amphibolurus m. maculatus, Diplodactylus alboguttatus* and *Lerista praepedita.*

Species at or near the southern or south-western periphery of their known range include *Rhychoedura ornata, Nephrurus levis occidentalis, Delma nasuta, Amphibolurus inermis, Lerista nichollsi* and *Varanus eremius.*

The skink *Ctenotus alleni* is restricted to the Ajana-Yuna area. Previously it was known from only 9 specimens and our 22 specimens add significantly to scientific collections. We found *C. alleni* to be the commonest observable diurnal reptile. It occurred in all habitats, being especially plentiful in tree mallee and low woodland on orange-red soil. Other species with a restricted range which we recorded at Wandana include *Denisonia monachus* and *Ctenotus mimetes.*

Species recorded at Wandana but not at the East Yuna and Bindoo Hill Nature Reserves are as follows: *Rhynchoedura ornata, Aprasia smithi, Cryptoblepharus plagiocephalus, Lerista nichollsi, L. praepedita, L. lineopunctulata, L. macropisthopus, Typhlina bituberculata, Denisonia monachus, Vermicella bertholdi, V. semifasciatas, V. fasciolata* and *Pseudonaja nuchalis* (J. Dell and A. Chapman pers. comm.).

The following Wandana species were collected only in the areas of low woodland or associated tree mallee and *Melaleuca/Acacia* thicket: *Crenadactylus ocellatus horni, Heteronotia binoei, Rhynchoedura ornata, Aprasia smithi, Delma nasuta, Lialis burtonis, Amphibolurus inermis, Ctenotus mimetes, Lerista nichollsi, Morethia butleri, Omolepida branchialis, Varanus eremius, Typhlina bituberculata, Pseudonaja modesta* and *Neobatrachus* sp. This shows the importance of retaining significant areas of low woodland in any reserve.

The figure of 41 reptile species is a rich one for this area. No doubt additional species will be found with further work - 16 species are represented in our collection by only one specimen.

V DISCUSSION

The proposed Wandana Nature Reserve lies near or on the boundary between the South-Western and Eremaean Botanical Provinces (Diels 1906, Gardner and Bennetts 1956). Burbidge (1960) described an "Interzone" between the two Provinces roughly corresponding to Gardner and Bennetts' Coolgardie Botanical District, but extending northwards toward Yuna. Similarly Erickson *et al.* (1973) describe an area of "Transitional Woodland", best developed in the Coolgardie District but extending northward to near Yuna. Beard (1976) places the Wandana Area in the Irwin District of the South-Western Province with the boundary of the Eremaean Province lying only 3 km to the east of the Crown land and coinciding with the Darling Fault.

Within the proposed reserve vegetation typical of both Provinces occurs. The shrub mallee and *Banksia* thicket formations predominate and contain genera typical of the South-West Province, e.g. *Banksia, Actinostrobus, Xylomelum, Calothamnus, Conospermum, Leschenaultia,* etc. However, the low woodland and tree mallee formations on red soils contain a number of species typical of the Eremaean Province, e.g. *Brachychiton gregorii, Acacia tetragonophylla, Eremophila* spp. and *Cassia nemophila.*

Similarly the fauna is a mixture of south-western (Bassian) and arid-zone (Eyrean) species. Among the mammals the Western Grey Kangaroo is a south-west species extending as far north as Shark Bay although it also occurs in the eastern Goldfields and on the Nullarbor Plain. The Red Kangaroo and the Spinifex Hopping Mouse, on the other hand, are typical Eyrean species. Similarly, some of the reptiles are typical of the south-west, e.g. *Diplodactylus alboguttatus, Delma fraseri, Amphibolurus m. maculatus, Ctenotus mimetes* and *Lerista praepedita,* while many others have a mainly Eyrean distribution, e.g. *Crenadactylus ornata, Delma nasuta, Amphibolurus inermis, A. scutulatus, Varanus eremius* and *Pseudonaja modesta.* A few are typical of

the Interzone between the South West and the Eyrean region, e.g. *Morethia butleri* and *Denisonia monachus*.

The proposed reserve is very rich in reptiles with at least 41 species occuring there. This richness is due to the Wandana Area being a region where the south-western, coastal and arid zone faunas overlap, and to the area being comparatively large and undisturbed.

Scientists and Departments involved in nature conservation have, over the years, supported the development of a series of conservation reserves along or near the boundary of the South West and Eremaean Botanical Provinces (Anon. 1965, Conservation Through Reserves Committee 1974) because:

(i) the area is of scientific interest, containing many vegetation formations, plants and animals found only in the Interzone.

(ii) there are few large reserves in the Wheatbelt and because of extensive clearing few more can be declared. Reserves placed along the interzone will protect at least a proportion of wheatbelt species, and

(iii) many south western species reach the limit of their geographical range in this region and scientific study of species in such places is of value in determining the adaptations of species to their environment and the factors which limit distribution and abundance.

Other significant existing or proposed reserves near Wandana or along the Vegetation Province boundary are:

(i) Kalbarri National Park (*ca* 186 000 ha)

(ii) the proposed Karroun Hill Nature Reserve (*ca* 300 000 ha)

(iii) the proposed Mount Manning Range Nature Reserve (*ca* 300 000 ha)

(iv) the proposed Walyahmoning Rock Nature Reserve (*ca* 20 000 ha)

(v) the proposed Yellowdine Nature Reserve (*ca* 50 000 ha)

(vi) Boorabbin National Park (26 000 ha)

(vii) Jilbadji Nature Reserve (previously known as Barker Lake Nature Reserve) (208 000 ha)

(viii) Frank Hann National Park (50 000 ha)

(ix) the proposed Peak Charles National Park (*ca* 40 000 ha)

Numbers (ii) to (vii) inclusive lie in the Coolgardie Botanical District of Gardner and Bennetts (1956) or in, or on the boundary of, the adjacent Avon and Eyre Districts of the South-Western Botanical Province. Youngson and McKenzie (1977b) discuss the differences between numbers (ii) to (v) and number (vii). Kalbarri National Park lies within the Irwin District of the South-Western Province and its vegetation is representative of the coastal Sandheaths (Conservation Through Reserves Committee 1974). Beard places it within his Kalbarri Vegetation System while the Wandana area is within his Yuna System.

Two smaller, but important, Nature Reserves are situated a short distance south of the Wandana Area - the East Yuna Nature Reserve (Reserves No. 28415 and 29231) of 1737 ha and the Bindoo Hill Nature Reserve (No. 30844) of 486 ha. These reserves have been examined by staff of the Western Australian Museum (Dell *et al.* in prep.). Although much smaller than the Wandana Area they include a greater variety of country. Both the Silurian Tumblagooda Sandstone and the Permian Nangetty Formation have significant exposures in addition to the same Pleistocene or Late Tertiary sandplain which occurs at Wandana.

Appendix II shows the mammals and reptiles which have been recorded at Kalbarri National Park (Bannister 1969), Wandana (this study), East Yuna and Bindoo Hill Nature Reserves (Dell *et al.* in prep.), Karroun Hill (Youngson and McKenzie 1977b) and Jilbadji Nature Reserve (Butler 1970). Birds for Wandana, East Yuna, Karroun Hill and Jilbadji are also listed. Bird data for Kalbarri are not available - the only published study of the area (Sedgwick 1949) concentrated on coastal, estuarine and riverine country just to the west of the Park.

There are some obvious differences between the areas although, fortunately, many species have been noted on more than one of them. Wandana is the only one of the existing or proposed conservation reserves listed to harbour the Spinifex Hopping Mouse *(Notomys alexis)*; another species, *N. mitchellii*, occurs at Kalbarri, East Yuna and Karroun Hill and probably will be found also at Jilbadji. This reflects the more northerly location of Wandana and its inland location compared with Kalbarri. Similarly, the Crimson Chat, the legless lizard *Aprasia smithi*, the skink *Lerista praepedita* and the snakes *Vermicella fasciolata* and *V. semifasciata* have only been recorded at Wandana.

Together, this series of comparatively large conservation reserves, plus a number of smaller ones, should adequately protect much of the flora and fauna of the outer wheatbelt and the transition between the South-West and the Eremaea.

Fig. 1 shows the boundaries of the proposed nature reserve at Wandana. The boundaries have been drawn to provide as regular a shape as possible while protecting significant portions of the various vegetation formations. The area of the proposed reserve is approximately 25 000 ha. The addition of a further 1 600 ha of vacant Crown land (formerly lease 3116/4421) to the north of the area designated by the EPA would add significantly to the protection of the tree mallee formation which is poorly represented in the proposed reserve.

McKenzie *et al.* (1973) discuss the requirements of a regional reserve, such as the one proposed here. They suggest that such a reserve should:

(i) have an area greater than 20 000 ha (Main and Yadav 1971);

(ii) contain a full cross section of the regional landscape with adequate areas of all soil surfaces;

(iii) contain adequate areas of all vegetation formations, and thus the fauna which inhabit them;

(iv) be of reasonable shape for efficient management.

They go on to suggest that Main and Yadav's figure of 20 000 ha, which was worked out on the basis of comparing the size of offshore islands with the diversity of their biota, is probably too small when considering mainland reserves because of the added pressures on them which are not present on islands, e.g. introduced predators and more frequent fires. Slatyer (1975) also discusses the need for large reserves.

Thus the area recommended here by us should be considered the minimum and the addition of adjoining Crown land would increase the value of the reserve and enhance the chances of the long term survival of the full range of species now occurring in an area.

There is no other large area of land available for reservation in this region.

VI RECOMMENDATIONS

We recommend that:

1. the vacant Crown land delineated in Fig. 1 and encompassing approximately 26 600 ha be declared a Class A Reserve for the Conservation of Flora and Fauna, vested in the Western Australian Wildlife Authority;

2. if adjoining Crown land is not required for agriculture it

be added to the reserve, and

3. the reserve be named "Wandana Nature Reserve".

VII ACKNOWLEDGEMENTS

We are most grateful for the field assistance of Ken Cashin, Michael Onus and Jim Rolfe. We also thank Drs D.J. Kitchener and G.M. Storr of the Western Australian Museum for identification of specimens and Mr N.L. McKenzie of the Western Australian Wildlife Research Centre for critically reading a draft of this report. Dr Kitchener, Mr A. Chapman, Mr J. Dell and Mr B.J. Muir of the W.A. Museum made available as yet unpublished data on the East Yuna and Bindoo Hill Nature Reserves.

The participation of A. McCusker in the field work was funded by the Australian Biological Resources Study and cartography was by the CSIRO Division of Land Use Research. The remainder of the work was funded by the Western Australian Department of Fisheries and Wildlife.

VIII REFERENCES

Anon. (1965). 'National Parks and Nature Reserves in Western Australia'. Report of the Western Australian sub-committee of the Australian Academy of Science Committee on National Parks (Australian Academy of Science - National Parks Board of Western Australia : Perth).

Bannister, J.L. (1969). 'Report on a biological survey of Kalbarri National Park January - February 1969 with special reference to Mammals and Reptiles'. Unpublished, W.A. Museum.

Beard, J.S. (1976). 'Explanatory Notes to Sheet 6 - Murchison. 1:1 000 000 Vegetation Series, Vegetation Survey of Western Australia'. (University of Western Australia Press : Nedlands).

Beard, J.S. and Burns, A.C. (1976). 'The vegetation of the Geraldton area, Western Australia'. Explanatory Memoir to 1:250 000 Map Sheet (Vegmap Publications : Perth).

Beard, J.S. and Webb, M.J. (1974). 'The vegetation survey of Western Australia : its aims, objects and methods'. Part I of Explanatory Notes to Sheet 2 - Great Sandy Desert. 1:1 000 000 Vegetation Series, Vegetation Survey of Western Australia. (University of Western Australia Press : Nedlands).

Burbidge, N.T. (1960). 'The phytogeography of the Australian region'. *Aust. J. Bot.* 8, 75-211.

Butler, W.H. (1970). 'Report on a survey of the vertebrate fauna of Lake Barker flora and fauna reserve, outer eastern wheatbelt, Western Australia'. Unpublished, Dept. of Fisheries and Fauna.

Conservation Through Reserves Committee (1974). 'Conservation Reserves in Western Australia'. Report of the Conservation Through Reserves Committee to the Environmental Protection Authority. Mimeographed.

Dell, J. and Johnstone, R.E. (1977). 'Birds of Cockleshell Gully Reserve and adjacent areas'. In : A vertebrate survey of Cockleshell Gully Reserve, Western Australia. *Rec. West. Aust. Mus.* Suppl. No. 4.

Dell, J., Chapman, A., Kitchener, D.J. and Muir, B.J. (in prep.) Biological survey of the Western Australian Wheatbelt, East Yuna and Bindoo Hill Nature Reserves. *Rec. West. Aust. Mus. Suppl. Ser.*

Diels, L. (1906). 'Die Pflanzenwelt von West-Australien'. In : Engler, A. and Drude, O. (Eds) *Die Vegetation der Erde*, Vol. VII. (Engelmann : Leipzig).

Environmental Protection Authority (1976). 'Conservation Reserves for Western Australia, as recommended by the Environmental Protection Authority'. Systems 1, 2, 3, 5. Mimeographed.

Erickson, R., George, A.S., Marchant, N.G. and Morcombe, M.K. (1973). *Flowers and Plants of Western Australia.* (A.H. and A.W. Reed : Sydney).

Gardner, C.A. and Bennetts, H.W. (1956). *Toxic Plants of Western Australia.* (West Australian Newspapers : Perth).

Main, A.R. and Yadav, M. (1971). 'Conservation of macropods in reserves in Western Australia'. *Biol. Cons.* 3, 123-133.

McKenzie, N.L., Burbidge, A.A. and Marchant, N.G. (1973). 'Results of a biological survey of a proposed wildlife sanctuary at Dragon Rocks, near Hyden, Western Australia'. Dept. Fish. Fauna. West. Aust. Rept. No. 12.

Muir, B.J. (1977). 'Biological Survey of the Western Australian Wheatbelt. Part 2 : Vegetation and habitat of Bendering Reserve'. *Rec. West. Aust. Mus.* Suppl. No. 3.

Northcote, K.H., Bettanay, E., Churchward, H.M. and McArthur, W.M. (1967). 'Atlas of Australian Soils : Explanatory data for Sheet 5, Perth - Albany - Esperance Area'. (C.S.I.R.O. - Melbourne University Press : Melbourne).

Playford, P.E., Horwitz, R.C., Peers, R. and Baxter, J.C. (1970). 'Explanatory notes, 1 : 250 000 Geological Series, Sheet SH/50-1. Geraldton'. (Bur. Min. Res. Geol. Geophys. : Canberra).

Sedgwick, E.H. (1949). 'Observations on the lower Murchison RAOU camp, September 1948'. *Emu* 48, 212-242.

Slatyer, R.O. (1975). 'Ecological reserves : size, structure and management'. In : Fenner, F. (Ed.) 'A National System of Ecological Reserves in Australia'. Aust. Acad. Sc. Rept. No. 19.

Specht, R.L. (1970). 'Vegetation'. In : G.W. Leeper (Ed.) *The Australian Environment*. 4th Ed., pp. 44-67. (C.S.I.R.O. - Melbourne University Press : Melbourne).

Youngson, W.K. and McKenzie, N.L. (1977a). 'An improved bat collecting technique'. *Bull. Aust. Mam. Soc.* 3(2), 20-21.

Youngson, W.K. and McKenzie, N.L. (1977b). 'The wildlife of the proposed Karroun Hill Nature Reserve, Western Australia'. Dept. Fish. Wildl. West. Aust. Rept. No. 30.

APPENDIX 1.

STRUCTURAL CLASSIFICATION OF VEGETATION AT SURVEY SITES 1-28 (Fig. 1) AND CANOPY COVER FOR EACH LAYER (%).

SITE 1.

Thicket 40%
over
Low scrub 30%

SITE 2.

Open shrub mallee 10%
over
Low scrub 10%
over
Low heath C 50%

SITE 3.

Thicket 30%
over
Low scrub 10%
over
Low heath C 40%

SITE 4.

Very open shrub mallee 5%
over
Heath A 40%
over
Dwarf scrub C 20%

SITE 5.

Scrub 20%
over
Heath A 40%
over
Low heath C 40%

SITE 6.

Open tree mallee 15%
over
Low scrub A 25%
over
Open dwarf scrub C 5%

SITE 7.

Very open shrub mallee 5%
over
Dense heath A/B 80%

SITE 8.

Open shrub mallee 10%
over
Heath B 30%
over
Low heath D 40%

SITE 9.

Scrub 25%
over
Heath A/B 35%
over
Open dwarf scrub D 5%

SITE 10.

Open shrub mallee 25%
over
Low heath D 40%

SITE 11.

Heath A 45%
over
Low heath D 30%

SITE 12.

Shrub mallee 60%
over
Low scrub B 15%
over
Dwarf scrub D 15%

SITE 13.

Thicket	35%
over	
Open low scrub A/B	2%
over	
Open dwarf scrub C/D	5%

SITE 14.

Thicket	50%
over	
Heath A/B	40%

SITE 15.

Very open shrub mallee	2%
over	
Low heath C	50%
over	
Open dwarf scrub D	5%

SITE 16.

Very open scrub mallee	2%
over	
Thicket	40%
over	
Dwarf scrub C/D	15%

SITE 17.

Tree mallee	35%
over	
Scrub	25%
over	
Open dwarf scrub D	5%

SITE 18.

Open scrub	2%
over	
Dwarf scrub C/D	10%

SITE 19.

Very open shrub mallee	5%
over	
Heath A	50%
over	
Dwarf scrub C/D	10%

SITE 20.

Dense thicket	70%
over	
Open dwarf scrub C/D	2%

SITE 21.

Very open tree mallee	5%
over	
Thicket	30%
over	
Open dwarf scrub	2%

SITE 22.

Dense thicket	70%

SITE 23.

Low woodland	20%
over	
Thicket	40%

SITE 24.

Very open tree mallee	1%
over	
Thicket/heath	50%

SITE 25.

Thicket 45%
over
Heath A
over
Low heath D

SITE 26.

Low woodland A 25%
over
Scrub 20%
over
Open dwarf scrub C/D 8%

SITE 27

Tree mallee/thicket 40%
over
Low scrub B

SITE 28.

Open low woodland A 1%
over
Thicket/heath 45%
over
Very open herbs 2%

APPENDIX II

Indiginous vertebrates known from Kalbarri National Park, the proposed Wandana Nature Reserve, the East Yuna and Bindoo Hill Nature Reserves, the proposed Karroun Hill Nature Reserve and the Jilbadji Nature Reserve.

MAMMALS

	Kalbarri	Wandana	East Yuna	Karroun Hill	Jilbadji
Megaliea rufa		X		X	X
Macropus fuliginosus	X	X	X		X
Macropus robustus	X	X	X	X	X
Petrogale penicillata	X				
Tarsipes spencerae	X				
Sminthopsis murina				X	
Sminthopsis granulipes	X				
Sminthopsis hirtipes	X				
Sminthopsis crassicaudata	X				
Notomys alexis		X			
Notomys mitchellii	X		X	X	
Pseudomys albocinereus	X		X		
Pseudomys hermannsburgensis				X	
Chalinolobus gouldii	X	X		X	X
Chalinolobus morio				X	
Eptesicus pumilis	X			X	X
Nytophilus geoffroyi		X		X	
Nycticieus greyi				X	
Tadarida australis		X		X	X
Tadarida planiceps				X	
Canis familiaris dingo					X
Tachyglossus aculeatus		X	X	X	X
Totals	11	8	5	13	8

BIRDS

	Wandana	East Yuna	Karroun Hill	Jilbadji
Emu	X	X	X	X
Little Grebe				X
White-necked Heron				X
Mountain Duck				X
Black Duck				X
Grey Teal				X
Blue-winged Shoveller				X
Pink-eared Duck				X
Wood Duck				X
Black-shouldered Kite			X	
Square-tailed Kite				X
Whistling Kite	X	X	X	X
Brown Goshawk	X	X		X
Collared Sparrowhawk	X	X	X	
Little Eagle	X	X		
Wedge-tailed Eagle	X	X	X	X
Spotted Harrier				X
Little Falcon	X		X	X
Nankeen Kestrel	X	X	X	X
Brown Falcon	X	X	X	X
Mallee Fowl	X	X		X
Brown Quail				X
Painted Quail		X		
Little Quail			X	
Black-tailed Native Hen			X	
Coot				X
Australian Bustard	X			X
Banded Plover	X	X	X	X
Black-fronted Dotterel		X		X
Australian Dotterel	X		X	
Southern Stone-Curlew				X
Common Bronzewing	X	X	X	X
Crested Pigeon	X	X	X	X
Purple-crowned Lorikeet				X
Red-tailed Cockatoo	X	X	X	
Major Mitchell Cockatoo			X	
Little Corella	X	X		
Galah	X	X	X	X
Cockatiel	X	X		
Regent Parrot			X	X
Western Rosella				X
Port Lincoln Parrot	X	X	X	X
Mulga Parrot	X	X	X	X
Bourke's Parrot	X			
Elegant Parrot				X

	Wandana	East Yuna	Karroun Hill	Jilbadji
Pallid Cuckoo	X	X		X
Black-eared Cuckoo				X
Horsfield Bronze Cuckoo	X			X
Barn Owl				X
Boobook Owl	X	X	X	X
Tawny Frogmouth	X	X	X	X
Owlet Nightjar	X	X	X	X
Spotted Nightjar	X	X	X	X
Red-backed Kingfisher		X	X	X
Sacred Kingfisher	X	X		X
Rainbow Bird	X	X	X	X
White-backed Swallow	X	X	X	X
Tree Martin	X	X		X
Australian Pipit	X	X	X	X
Magpie Lark	X	X	X	X
Ground Cuckoo-Shrike			X	X
Black-faced Cuckoo-Shrike	X	X	X	X
White-winged Triller	X			X
Southern Scrub-Robin			X	X
Chestnut Quail-Thrush	X			X
White-browed Babbler	X	X	X	X
Splendid Wren	X	X	X	
Variegated Wren		X		X
White-winged Wren	X			
Rufous Songlark				X
Weebill	X	X	X	X
Brown Thornbill		X		
Broad-tailed Thornbill	X	X	X	X
Chestnut-tailed Thornbill	X	X	X	X
Yellow-tailed Thornbill	X	X	X	X
Southern Whiteface			X	
Spotted Scrub-wren		X		X
Shy Heath-wren		X		X
Redthroat	X	X	X	X
Field Wren		X		
Brown Flycatcher			X	X
Red-capped Robin	X	X	X	X
Hooded Robin	X		X	X
Western Yellow Robin		X		X
Grey Fantail	X	X	X	X
Willie Wagtail	X	X	X	X
Restless Flycatcher			X	X
Rufous Whistler	X	X		X
Golden Whistler		X		X
Gilbert's Whistler				X
Western Shrike Thrush	X	X	X	X
Crested Bell Bird	X	X	X	X
White-fronted Chat	X	X		X
Crimson Chat	X			

	Wandana	East Yuna	Karroun Hill	Jilbadji
Black-capped Sitella			X	X
Rufous Tree Creeper		X	X	X
White-browed Tree Creeper				X
Mistletoe Bird	X	X		X
Striated Pardalote	X	X	X	X
Western Silvereye			X	X
Brown Honeyeater		X		X
White-eared Honeyeater		X		X
Singing Honeyeater	X	X	X	
Purple-gaped Honeyeater				X
Yellow-fronted Honeyeater	X			
Yellow-plumed Honeyeater			X	X
Brown-headed Honeyeater		X		X
White-fronted Honeyeater	X		X	X
Tawny-crowned Honeyeater				X
Yellow-throated Miner	X	X	X	X
Spiny-cheeked Honeyeater	X	X	X	X
Red Wattle Bird			X	X
Zebra Finch	X	X	X	X
Masked Wood-Swallow		X		X
Black-faced Wood-Swallow	X	X		X
Dusky Wood-Swallow				X
Little Wood-Swallow		X		
Pied Butcher Bird	X	X	X	X
Grey Butcher Bird	X	X	X	X
Western Magpie	X	X	X	X
Grey Currawong	X	X	X	X
Australian Raven		X	?	X
Australian Crow				X
Little Crow	X	X	?	X
Totals	68	73	63	103

REPTILES

	Kalbarri	Wandana	East Yuna	Karroun Hill	Jilbadji
Chelidae					
Chelodina steindachneri	X				
Gekkonidae					
Crenadactylus ocellatus		X	X		X
Diplodactylus alboguttatus	X	X	X		

	Kalbarri	Wandana	East Yuna	Karroun Hill	Jilbadji
Diplodactylus maini				X	X
Diplodactylus michaelseni		X	X		
Diplodactylus pulcher		X	X	X	
Diplodactylus spinigerus	X	X	X	X	
Diplodactylus "vittatus"	X	X	X	X	X
Gehyra variegata	X	X	X	X	X
Heteronotia binoei	X	X	X	X	X
Nephrurus levis occidentalis	X	X	X		
Oedura reticulata				X	X
Phyllurus milii	X				X
Rhynchoedura ornata		X		X	
Pygopodidae					
Aprasia smithi		X			
Delma australis			X		
Delma fraseri	X				X
Delma nasuta		X	X		
Lialis burtonis	X	X	X	X	
Pygopus lepidopodus	X	X	X		
Pygopus nigriceps		X	X		
Agamidae					
Amphibolurus adelaidensis	X				
Amphibolurus cristatus				X	X
Amphibolurus inermis	X	X	X		
Amphibolurus maculatus maculatus	X	X	X		
Amphibolurus maculatus griseus					X
Amphibolurus, minor	X	X	X	X	X
Amphibolurus ornatus				X	X
Amphibolurus parviceps	X				
Amphibolurus reticulatus	X		X	X	
Amphibolurus scutulatus	X	X	X	X	X
Moloch horridus	X	X	X		X
Physignathus longirostris	X		X		
Scinidae					
Cryptoblepharus carnabyi	X		X		

	Kalbarri	Wandana	East Yuna	Karroun Hill	Jilbadji
Cryptoblepharus plagiocephalus	X	X		X	X
Ctenotis alleni	X	X	X		
Ctenotis fallens	X				
Ctenotis lesuerii	X				
Ctenotis mimetes		X	X	X	
Ctenotis pantherinus					X
Ctenotis schomburgkii	X			X	
Ctenotis uber				X	X
Egernia carinata					X
Egernia inornata			X		X
Lerista elegans	X				
Lerista lineopunctulata	X	X			
Lerista macropisthopus	X	X			
Lerista muelleri	X				
Lerista nichollsi	X	X			
Lerista planiventralis	X				
Lerista praepedita		X			
Menetia greyii	X		X		
Menetia surda	X		X		
Morethia butleri	X	X	X	X	X
Morethia lineoocellata	X		X		
Morethia obscura		X	X		X
Omolepida branchialis		X	X		X
Sphenomorphus richardsonii	X				
Tiliqua occipitalis	X	X	X		
Tiliqua rugosa	X	X	X	X	X
Varanus					
Varanus eremius	X	X	X		
Varanus gouldii	X	X		X	X
Varanus tristis	X			X	
Typhlopidae					
Typhlina bituberculata		X		X	
Typhlina leptosoma	X				
Boidae					
Liasis childreni	X				

	Kalbarri	Wandana	East Yuna	Karroun Hill	Jilbadji
Elapidae					
Demansia reticulata	X				
Denisonia monachus	X	X			
Pseudechis australis	X		X	X	X
Pseudonaja modesta	X	X	X		
Pseudonaja nuchalis	X	X			X
Vermicella bertholdi		X			
Vermicella bimaculata	X				
Vermicella fasciolata		X			
Vermicella littoralis	X				
Vermicella semifasciata		X			
Totals	51	41	36	24	26