

A biological survey of Boonanarring Nature Reserve

ALLAN H. BURBIDGE¹, LOUISE J. BOSCACCI^{1,2}, JENI J. ALFORD¹ AND G.J. KEIGHERY¹

¹ Science and Information Division, Department of Conservation and Land Management, Wildlife Research Centre, PO Box 51, Wanneroo 6065, Western Australia.

² Present address: Graduate School of the Environment, Macquarie University, North Ryde 2109, New South Wales.

ABSTRACT

Boonanarring Nature Reserve (ca 9250 ha) is about 15 km north of Gingin. It extends eastward from the Gingin Scarp onto the Dandaragan Plateau, near the southern end of the plateau. It is bounded by the Swan Coastal Plain on the west. Water reserve A22602 is on the southern boundary and extends into Boonanarring Nature Reserve. This reserve was included in the present survey.

The variable surface and underlying geology and topography are reflected by a mosaic of ten distinct vegetation associations. The dominant vegetation associations within the reserve are jarrah and marri woodlands typical of the south-west (Swan Coastal Plain and Darling Range) and *Banksia* woodlands with elements of the Kwongan heaths of the lower rainfall areas to the north. Boonanarring Nature Reserve contains the best and most extensive example of the poorly conserved *Banksia* woodlands on Dandaragan soils.

A total of 573 vascular plant taxa, representing 70 families and 223 genera have been recorded on the reserve. Several large populations of the previously declared rare *Grevillea saccata* occur on the reserve and are the only ones found on conservation reserves. This find was instrumental in this species being removed from the list of declared rare flora. The vegetation mosaics and ecotones support numerous rare and uncommon plant species. Seventy-five taxa (13 per cent) of the flora recorded are of particular interest, including 18 priority species and at least 47 species recorded at the ends of their known ranges. As an indication of its richness, the reserve is known to support 9 *Eucalyptus*, 11 *Banksia* and 15 *Acacia* taxa.

Amongst the animals recorded, the fossorial Black-striped Snake (*Vermicella calonotos*) is of restricted occurrence and the Carpet Python (*Morelia imbricata*) is declared 'in need of special protection'. Gould's

Long-eared Bat (*Nyctophilus gouldi*) is at the northern limit of its range. Five frog species were found. The avian and reptilian faunas were reasonably diverse (74 and 20 species respectively), but the mammalian fauna was less diverse than expected (11 native species). Some species may be absent or severely reduced in number owing to the frequent burning which has occurred in recent years. Further survey work, particularly in spring, would be expected to considerably expand the fauna lists. The vertebrate fauna is representative of that of the general area. This fauna is becoming increasingly less common in the region with the development of the coastal plain and scarp.

Boonanarring Nature Reserve is a significant reserve, being rich in flora and vegetation types not present on any other conservation reserves and being large enough to provide some protection from degradation owing to edge effects.

INTRODUCTION

Boonanarring Nature Reserve (A41805) is an area of about 9250 ha, 15 km north of the town of Gingin (Fig. 1). The biological significance of the area was first assessed in 1971 (N. McKenzie personal communication) and on the basis of this assessment the System Six Report (Department of Conservation and Environment 1983) recommended that the then vacant Crown land be combined with several smaller reserves and an area of about 400 ha of private land along Gingin Brook, to form Boonanarring Nature Reserve. Boonanarring 'C' class Nature Reserve was finally gazetted on 9 August 1991, being vested in the National Parks and Nature Conservation Authority. Reserve A22602, for water, is on the southern boundary and extends into Boonanarring Nature Reserve.

The area is situated near the southern tip of the Dandaragan Plateau. The Gingin Scarp, which forms the western boundary of the Dandaragan Plateau, runs along the western edge of the study area. The topography of the reserve is undulating, with some areas of sandplain and other areas of exposed laterite, sometimes forming small breakaways. The study area contains the upper catchment and sections of Boonanarring Brook, a predominantly dry

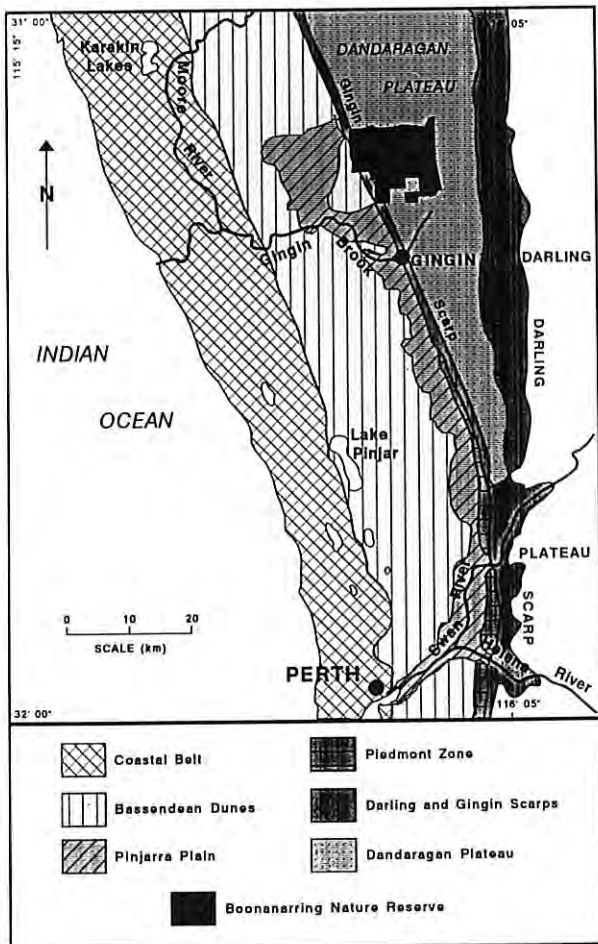


Figure 1. Location of the Boonanarring Nature Reserve in relation to significant geomorphological features of the region (after Wilde and Low 1978).

watercourse. The Brook meanders in a south-westerly direction from the southern part of the reserve (Fig. 2).

The Dandaragan Plateau consists primarily of Tertiary laterites outcropping in Pleistocene-Recent sands over flat-lying partly lateritized Cretaceous rocks. These sedimentary Cretaceous beds contrast with the hard Precambrian rocks of the Darling Plateau and the deep Pleistocene sands and alluvial soils of the eastern Swan Coastal Plain (Wilde and Low 1978).

The climate is Warm Mediterranean with 700 mm annual precipitation and 5-6 dry months per year. Mean winter temperature is about 13°C and the mean minimum temperature for the coldest month is 8°C. Mean summer temperature is about 23°C and mean maximum temperature for the hottest month is 32°C. Annual evaporation is about 1900 mm (Bureau of Meteorology 1968).

Boonanarring Nature Reserve is located within the Drummond Sub-district of the South-west Botanical Province (Beard 1980). The vegetation of this area was first mapped by Beard (1979) at a scale of 1:250 000. Physiognomy of the dominant vegetation stratum and surface geology were used to define three major vegetation components:

- (1) *Banksia* low woodlands (less than 10 m),
- (2) *Banksia* low woodlands with scattered jarrah (*Eucalyptus marginata*) and marri (*E. calophylla*) trees, and
- (3) *E. calophylla* woodlands between 10 and 30 m.

The vegetation complexes were also mapped by Hedde *et al.* (1980), again at a scale of 1:250 000, but based on Havel's (1968, 1975a, b) site-vegetation types and the landform and soil units defined by Churchward and McArthur (1980). According to this system, the Karamal landform/soil unit is predominant within the reserve, and is described as a gently undulating landscape dominated by deep, yellow sands with lateritic gravels on the ridges. Within our study area, lateritic outcrops are common. The associated vegetation, the Karamal Complex - South, is described as being dominated by an open forest of jarrah (*Eucalyptus marginata*) and marri (*E. calophylla*) with a mid-storey of bull banksia (*Banksia grandis*). In the north-east of the study area, aeolian sandplain with some low dunes supports the Cullala complex of low open forest of *Banksia attenuata* and *B. menziesii* with some *B. ilicifolia* and *E. todtiana*. On the boundary with the Karamal complex there often occurs an intermediate vegetation type of open marri (or jarrah) forest with a second storey of *Banksia* species. The western edge of the study area consists mainly of red sandy soils on the gently sloping irregular scarp (Gingin unit) and deep red and yellow brown sands in the valleys (Moondah unit). The Gingin vegetation complex on the scarp is described as an open woodland of *E. calophylla* with a second storey of *B. grandis* and *Nuytsia floribunda*. In the valleys and slopes is an open woodland of *Eucalyptus* species, and on some of the lower slopes there is a low closed to low open forest of *Banksia* species with *E. todtiana*.

Apart from the broad scale vegetation mapping referred to above, there appear to be no published biological data on the Boonanarring Nature Reserve. Surveys from nearby areas include observations on the birds of the Moore River gorge area, 25 km to the north (Whitlock 1905; Loaring and Serventy 1952), a study of the fauna of the northern Swan Coastal Plain (How 1978), the quadrat-based vegetation survey of Moore River to Jurien Sandplain (Griffin and Keighery 1989), work on fire effects in *Banksia* woodland about 10 km to the south-east at Mooliabeenee (Bamford 1985, 1986) and a general survey of Julimar Forest Block, about 40 km to the south-east on the Darling Plateau (Forests Department unpublished).

The present survey was undertaken with two aims in mind. The first was to obtain base-line data on the assemblages of plants and animals present at selected sites in the study area. Such data can be used in quantitative comparisons between these and other sites or, with resampling, comparisons over time (monitoring) (McKenzie 1988; McKenzie *et al.* 1991). The second aim was to provide an assessment of the conservation values of the area as the basis of a management program for the reserve.

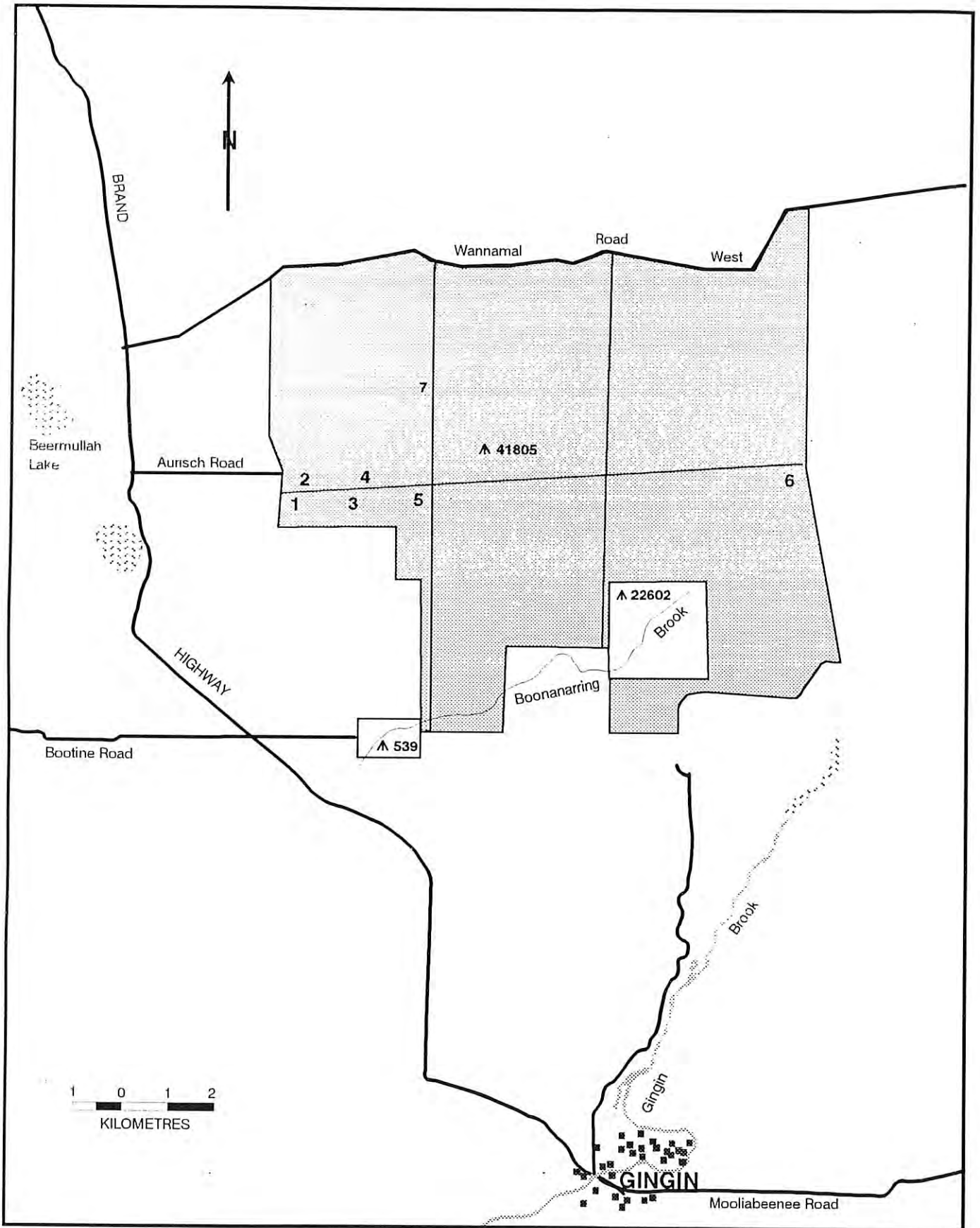


Figure 2. Locations of sample sites (quadrats) in the Boonanarring Nature Reserve

METHODS

Seven sites (quadrats) were selected for systematic sampling for assemblage data in March 1986 (Table 1 and Fig. 2). These sites were arranged to form a transect from the foot of the Gingin Scarp in the west, through the woodlands of the plateau to a dense heath on the eastern boundary, and placed so as to sample some of the major vegetation types in the study area. A detailed description of vegetation at each site is given in Appendix 1.

TABLE 1

Locations of permanent sampling sites in the Boonanarring Nature Reserve. (Elevations were estimated from the Gingin 1:100 000 map.)

SITE	LATITUDE	LONGITUDE	ELEVATION (m)
1	31°13'05"	115°50'15"	140
2	31°13'00"	115°50'30"	145
3	31°13'00"	115°51'05"	220
4	31°12'55"	115°51'15"	225
5	31°12'55"	115°52'05"	260
6	31°12'40"	115°56'55"	220
7	31°11'45"	115°52'10"	240

Sampling for assemblage data (including live-trapping for vertebrates) was carried out from 17 to 23 March 1986. Each site was sampled as exhaustively as possible for species of vascular plants, amphibians, reptiles, birds and mammals. The search area for each site was an unbounded quadrat of about 2 ha centred on the trapping lines at that site. Opportunistic observations were made at other times (mostly in February, July and August 1986) and at other places in the study area.

Vegetation at each site was described using Muir's (1977) system of vegetation classification. Voucher specimens were collected for most vascular plant species and lodged at the Western Australian Herbarium (PERTH), but a number of common, widespread species were simply recorded. Soil substrate type and topography was recorded for each site. Sites were resampled at several different times of the year to record annual or inconspicuous plant species. Opportunistic flora records for the reserve were made by several collectors. No estimates of species abundance were made.

Vegetation mapping was undertaken using monochrome 1:250 000 (1985) and colour 1:20 000 (1989) aerial photographs and the 1:50 000 Mindarra SW topographic map. Geological and soil maps were consulted to assist in vegetation interpretation. Transition zones in vegetation types were recorded along all tracks and fire breaks throughout the reserve and by extensive ground reconnaissance. Mapping from aerial photographs was made difficult by the presence of extensive fire scars of variable age.

Sampling of vertebrates was done by live-trapping and systematic searching. Bats were caught in mist nets near Site 5 and at two locations to the south of this site. Mist

nets were run for 9.5 net hours (1 net x 1 hour = 1 net hour). Small ground-dwelling vertebrates were sampled by means of pitfall (Sites 1-4, 7) and Elliott traps (Sites 5 and 6). A description of traps and trap layout is provided in Appendix 2. The total trapping effort was 300 pit trap nights and 300 Elliott trap nights (1 trap x 1 night = 1 trap night).

Spotlighting from a vehicle was conducted throughout the reserve on the existing main tracks. Spotlighting effort totalled five hours.

In order to identify recaptures, small mammals were marked using alcohol-based coloured marker pens, usually on the base of the tail or under the chin. This proved to be an effective technique since, in some cases, one application persisted for the duration of the five-night trapping period.

Fishes were sampled from the headwaters of Boonanarring Brook by means of 40 x 25 x 25 cm traps with two funnel entrances giving access to a baited pouch. Traps were baited with dry cat food ('Go Cat'). Four traps were set for a total of eight hours during daylight hours on 15 July 1992.

Identifications in the field were done with reference to a range of guides including Tyler *et al.* (1984), Storr *et al.* (1981, 1986) and Strahan (1983). Voucher fish, frog, reptile and mammal specimens were collected and have been accessed by the Western Australian Museum. Accession numbers (where known) are listed in Appendix 3.

Samples of heart, liver and kidney tissues were taken from specimens of *Sminthopsis* and frozen in liquid nitrogen for electrophoretic analyses. Analyses were run by the Evolutionary Biology Unit of the South Australian Museum. Electrophoretic determinations were used in conjunction with standard taxonomic procedures to verify our identifications.

RESULTS

Vegetation

Ten discrete vegetation associations were recognized within the Boonanarring Nature Reserve (Fig. 3). As expected, these correlated with soil type, topography and drainage. Some vegetation types had distinct boundaries while others represented ecotones, particularly where *Banksia* woodland adjoined jarrah forest and heaths. Some rare or unusual species occurred within these ecotones; for example *Eucalyptus lane-poolei* populations occur only where upland jarrah forest adjoins *Banksia* woodland.

Woodlands and Forests

There are seven woodland and forest types in the study area.

The first vegetation type occurs in valleys on Moondah soil and consists of tall forests of *Eucalyptus calophylla* over open, variable scrub. This vegetation association flanks most of the slopes running down into Boonanarring Brook.

The second vegetation type, open forest or low woodland of *Melaleuca preissiana* and *Eucalyptus rudis*, is extremely limited in occurrence within the reserve, being restricted to the watercourses and areas where the water table is close to the surface (palusplains; see Semeniuk 1987).

The third vegetation type is limited to the small areas of massive, exposed laterite rock breakaways supporting *Eucalyptus wandoo* on their western facing slopes.

Banksia woodlands on deep yellow or grey sand are the second most abundant vegetation type on the reserve, occurring on the sandier components of all major soil units present. Understorey components were highly variable, reflecting substrate depth and type. Two major sub-associations were identified.

The fourth vegetation type consists of a low open woodland of *Banksia menziesii*, *B. attenuata* and *Eucalyptus todtiana* with occasional *Nuytsia floribunda* and *Banksia ilicifolia* in wetter sites. The understorey is dominated by *Adenanthos cygnorum*, often dense scrub to 2 m. This association occurs in the lower landscape on Cullala soils or as an ecotone at the junction of Cullala and Karamal soils.

The fifth vegetation type consists of *Banksia attenuata*, *B. grandis* and *Eucalyptus todtiana* with occasional *Nuytsia floribunda* and a low, variable, often species-rich

understorey. Quadrats 2, 3 and 4 are representative of this vegetation type on the Moondah soil unit.

Most of the reserve consists of Karamal soils which support the predominant vegetation type of an open forest or woodland of jarrah and marri. This broadscale association is further defined based on vegetation structure and floristics, soil type and topography. The sixth vegetation type occurs on the shallow soils of the gravelly, lateritic uplands. At these sites jarrah is the dominant tree with some marri and occasional *Banksia grandis* in the mid-storey. *Dryandra sessilis* is found in large stands where soils are very shallow. The shrub layer is species-rich, denser and smaller than in the surrounding lower landscape. This represents a typical response of jarrah forest to soil depth (Havel 1975a). This vegetation type was recorded at permanent quadrat 5.

The seventh vegetation type occurs in the deep yellow sands in the swales between the laterite uplands. Here, the jarrah woodland becomes more open and marri is more abundant. Understorey species and cover vary considerably. Large patches and mosaics of *Petrophile ericifolia* and *Melaleuca scabra* occur with variations in soil depth and topography. Where fires have been intense or frequent the understorey appears depauperate and *Stirlingia latifolia* is dominant. This vegetation type was recorded at permanent Quadrat 7.

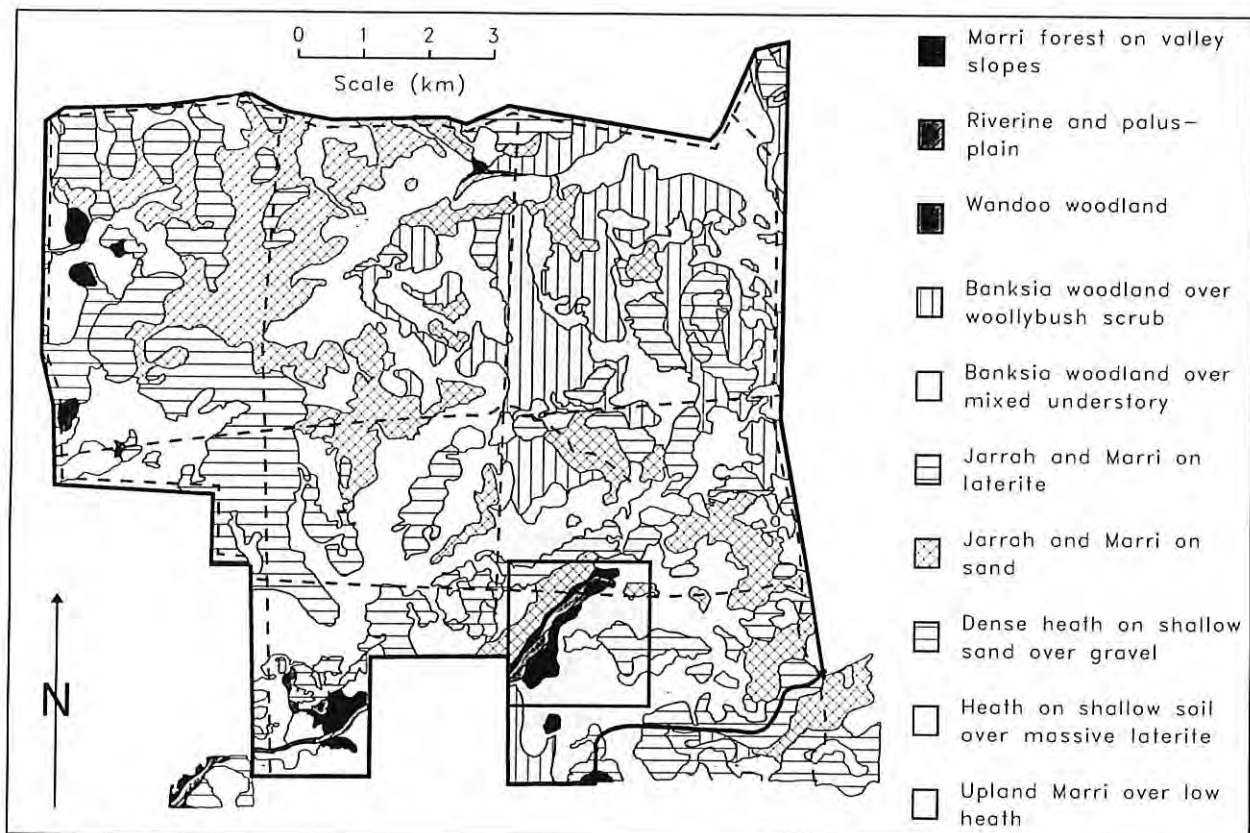


Figure 3. Vegetation unit boundaries within the Boonanarring Nature Reserve

Heaths

Three major heath associations were recognized. These occurred in patches throughout the reserve, corresponding to soil depth and aspect. The first occurs on the western scarp boundary and on breakaways where shallow, grey sand (Karamal soil) occurs over massive laterite. In this association *Dryandra sessilis* dominates with varying amounts of *Hakea ruscifolia*, *Xanthorrhoea preissii* over *Stirlingia latifolia*, *Jacksonia* spp., *Calytrix* spp., *Leucopogon* spp. and *Petrophile linearis*. The second heath consists of species-rich, dense heath to 1.5 m on shallow white to grey sandy soils over gravel, on low rises within the Cullala soil unit. The species-rich scrub heaths were highly variable in composition with *Allocasuarina humilis*, *Hakea trifurcata* and *Adenanthos cygnorum* occurring in patches, generally to 1 m with emergent *Nuytsia floribunda* and *Jacksonia* spp. Quadrat 6 provides a typical example of this vegetation type. The final vegetation type recognized occurs on rises where sands are shallow in the Karamal soil unit. This is a very sparse, low heath with open, tall *Eucalyptus calophylla*. The understorey is highly variable but usually dominated by *Dryandra echinata*, *Hakea lissocarpha*, *Petrophile serruriae*, *Macrozamia riedlei* and *Bossiaea eriocarpa*. These heaths are unusual because they are generally in the upper landscape and contain several rarely recorded plant species such as *Conospermum incurvum*.

Floristics

A total of 573 vascular plant species (from 70 families and 223 genera; see Appendix 4) have been recorded within the Boonanarring Nature Reserve. Herbs were well represented within the reserve; for example, Orchidaceae and Asteraceae were represented by 28 and 27 taxa respectively. The reserve was relatively free of introduced species, but included 27 taxa (4.7 per cent) dominated by members of the families Asteraceae (5) and Poaceae (5). Given the relatively large size of the reserve and the difficulty in traversing it on the ground, further investigations will undoubtedly result in additions to the flora list, although we believe that the majority of perennial and annual species present were recorded.

Of the total number of families recorded, the Myrtaceae (63 native species), Proteaceae (58) and Papilionaceae (44) were dominant, with Epacridaceae (31 native species) and Asteraceae (27) significant (Table 2). Important genera include *Stylidium* (19 taxa), *Acacia* (15), *Leucopogon* (15), *Hibbertia* (13), *Hakea* (13), *Banksia* (11) and *Eucalyptus* (9). A noticeable feature of the area is the low mean number of species per genus (2.1). Of the 223 genera listed, 129 (59 per cent) are represented by only one species, highlighting the level of generic richness in the reserve. Further research is needed to ascertain whether this is a general feature of species-rich reserves in south-west Western Australia.

Rare and Unusual Plant Species

Of the 573 species recorded at Boonanarring, 75 species (13 per cent) are considered to be of particular interest

(Table 3). This includes 18 priority species (Atkins 1995). Based on Marchant *et al.* (1987), current herbarium records and personal knowledge, 67 species records were considered to represent range extensions or disjunct populations.

TABLE 2

Dominant plant families in Boonanarring Nature Reserve and water reserve A22602.

FAMILY	No. of TAXA		% of TOTAL (native taxa)
	native	introduced	
Myrtaceae	63	0	11.6
Proteaceae	58	0	10.6
Papilionaceae	44	4	8.1
Epacridaceae	31	0	5.7
Orchidaceae	28	1	5.1
Asteraceae	27	5	5.0
Cyperaceae	26	0	4.8
Anthericaceae	25	0	4.4
Stylidiaceae	23	0	4.2
Goodeniaceae	18	0	3.3
Haemodoraceae	18	0	3.3
Mimosaceae	15	0	2.8
Poaceae	15	5	2.8
Restionaceae	15	0	2.8

Several populations of the previously declared rare *Grevillea saccata* occur on the Moondah soil unit within the reserve. These represent the only secure populations, as all others occur on alienated lands or road verges. The location of these populations and the subsequent declaration of the nature reserve were instrumental in removing this species from the list of declared rare flora.

Several populations of *Acacia clydonophora*, *Verticordia paludosa*, *Conostephium minus*, *Calytrix sylvana*, (all Priority 4), *Acacia cummingiana*, *Acacia pulchella* var *reflexa* (acute bracteole variant), *Leucopogon oliganthus*, *Banksia micrantha*, *Dryandra echinata*, *Haemodorum loratum*, *Olax scalariformis* (all Priority 3) and *Macarthuria apetala*, *Lysinema elegans*, *Pithocarpa achilleoides* (all Priority 2) were all recorded on the reserve. Several large populations of *Dryandra echinata* occur within areas of Vegetation type 6. These are the largest known populations on a reserve.

A population of *Banksia chamaephyton* (Priority 4) on the eastern side of the reserve represents a southerly extension of the known range of this species which until recently was declared rare and endangered. The record of *Laxmannia omnifertilis* is a southerly range extension (by about 70 km, from north of Cataby) of a species which has been relatively well surveyed.

In shallow sands over laterite at Quadrat 6, *Eucalyptus decurva* was found. This is a predominantly south-coast species recently found near Northam and near New Norcia (M. Brooker, personal communication; Brooker and Kleinig 1990). The population at Boonanarring is the farthest north-west known occurrence. Also of interest is another eucalypt, *E. lane-poolei*. Within Boonanarring Nature Reserve this species forms sparse woodlands on

laterite derived sands and near the Gingin Scarp which runs down the western edge of the study area. This is one of several disjunct populations which occur to the north of the bulk of the species' range, which is south of Perth (Brooker and Kleinig 1990). At the same site we found a subspecies of *Lomandra micrantha* (*L.m. teretifolia*) normally found only on the south coast.

The type specimen of *Stylidium carlquistii* (Priority 1) is from the reserve, and several previously unknown species were first collected from the reserve, including *Tetratheca* aff. *hirsuta* (JJA 153) and several undescribed orchid species (S.D. Hopper personal communication).

Other flora records of interest include a hybrid population between *Eucalyptus marginata* and *E. todtiana* and the presence of blue-green leaved jarrah (*E. marginata* subsp. *thalassica*) as well as trees with dark green leaves (subsp. *marginata*). This is the most northerly record for subsp. *thalassica*. Populations of *Stylidium leptocalyx* and *S. carlquistii* are the only ones found on nature reserves, making this reserve important to the conservation of these species.

TABLE 3
Biogeographically interesting, significant or unusual plant occurrences known from Boonanarring Nature Reserve.

SPECIES	COMMENT
SCHIZAEACEAE	
<i>Schizaea fistulosa</i>	northern limit, previously Muchea
POACEAE	
<i>Eriachne ovata</i>	south-western limit; closest population Bakers Hill
CYPERACEAE	
<i>Schoenus efalatus</i>	northern limit
<i>Tetaria capillaris</i>	northern limit, extension from Busselton
RESTIONACEAE	
<i>Ecdeiocolea monostachya</i>	at southern limit of range
<i>Onchisepalum laxiflorum</i>	at southern limit of range
DASYPOGONACEAE	
<i>Lomandra hastilis</i>	at southern limit of range
<i>Lomandra</i> aff. <i>micrantha</i>	population apparently referable to <i>L. micrantha</i> subsp. <i>teretifolia</i> , previously recorded from Albany to Cape Arid
ANTHERICACEAE	
<i>Borya scirpoidea</i>	only population known from north of Perth
<i>Laxmannia omnifertilis</i>	southernmost known population
<i>Laxmannia sessiliflora</i> subsp. <i>australis</i>	at or near northern limit of this subspecies
<i>Laxmannia squarrosa</i>	northern-most known population
HAEMODORACEAE	
<i>Anigozanthos pulcherrimus</i>	uncommon; southern extension of range (from Bartlett's Well)
<i>Haemodorum loratum</i>	Priority 3 species
<i>Phlebocarya filifolia</i>	rarely collected, Priority 2 species ¹
ORCHIDACEAE	
<i>Caladenia 'arenicola'</i>	north-eastern limit of range; unusual away from coastal plain
<i>Calochilus</i> aff. <i>robertsonii</i>	northern-most occurrence; range extension from near Perth
<i>Corybas abditus</i>	northern-most occurrence; range extension from Busselton-Albany region
PROTEACEAE	
<i>Banksia burdettii</i>	southern-most record
<i>Banksia chamaephyton</i>	until recently declared endangered; southern-most known population; Priority 4

Table 3 (continued)

<i>Banksia micrantha</i>	Priority 3 species; southern extension of known range
<i>Dryandra echinata</i>	Priority 3 species; extensive populations on the reserve
<i>Grevillea saccata</i>	Priority 4 species; southernmost known population; only known population not on a road verge
<i>Lambertia multiflora</i> var. <i>multiflora</i>	near southern limit of range
<i>Isopogon adenanthoides</i>	southern-most known population
<i>Isopogon linearis</i>	southern-most known population
<i>Petrophile scabriuscula</i>	furthest south record
AMARANTHACEAE	
<i>Ptilotus drummondii</i>	northern end of range
OLACACEAE	
<i>Olax scalariformis</i>	Priority 3 species
<i>Olax spartea</i>	southern-most known population
RANUNCULACEAE	
<i>Clematis pubescens</i>	northern-most record
DROSERACEAE	
<i>Drosera pulchella</i>	northern-most known population; usually Perth to Albany
MOLLUGINACEAE	
<i>Macarthuria apetala</i>	Priority 3 species
MIMOSACEAE	
<i>Acacia clydonophora</i>	Priority 4 species, at southern limit of range
<i>Acacia cummingiana</i>	Priority 3 species, at southern limit of range
<i>Acacia pulchella</i> var. <i>reflexa</i> (acuminate bracteole variant)	Priority 3 species
PAPILIONACEAE	
<i>Aotus gracillima</i>	northern-most known population
<i>Bossiaea ornata</i>	northern-most known population
<i>Daviesia striata</i>	northern-most known population
<i>Gompholobium scabrum</i>	northern-most known population
<i>Sphaerolobium vimineum</i>	northern-most known population
RUTACEAE	
<i>Boronia malloyae</i>	northern-most known population
<i>Boronia purdieana</i>	?eastern margin of range
TREMANDRACEAE	
<i>Tetratheca</i> aff. <i>hirsuta</i>	First known locality of undescribed species, proposed type locality
POLYGALACEAE	
<i>Comesperma virgatum</i>	northern-most known population
RHAMNACEAE	
<i>Cryptandra scoparia</i>	poorly collected
<i>Stenanthemum humilis</i>	southern-most known population
MYRTACEAE	
<i>Agonis linearifolia</i>	one of only nine records; northern-most population known; range extension
<i>Calytrix sylvana</i>	Priority 4 species
<i>Calytrix variabilis</i>	restricted range
<i>Eucalyptus decurva</i>	very unusual occurrence, only two other populations not on the South-Coast.
<i>Eucalyptus lane-poolae</i>	patchy occurrence along and near the Darling and Gingin Scarps; uncommon
<i>Eucalyptus marginata</i> x <i>todtiana</i>	only known hybrid between these two taxa
<i>Homalospermum firmum</i>	northern-most known population
<i>Kunzea ericifolia</i>	northern-most known population
<i>Pericalymma ellipticum</i>	near northern limit (Moore River)
<i>Verticordia paludosa</i>	Priority 4 species
APIACEAE	
<i>Platysace ramosissima</i>	rarely collected; second known population and the only one known on a Nature Reserve
EPACRIDACEAE	
<i>Astroloma macrocalyx</i>	poorly collected
<i>Conostephium minus</i>	Priority 4 species

Table 3 (continued)

SPECIES	COMMENT
<i>Leucopogon oliganthus</i>	Priority 3 species
<i>Leucopogon oxycedrus</i> / <i>nutans</i>	northern-most known population
<i>Leucopogon</i> cf. <i>verticillatus</i>	northern-most known population
<i>Lysinema elegans</i>	Priority 2 species
<i>Styphelia tenuiflora</i>	near northern limit
LENTIBULARIACEAE	
<i>Utricularia violacea</i>	northern-most known population
<i>Utricularia volubilis</i>	northern-most known population
LOBELIACEAE	
<i>Lobelia tenuior</i>	northern-most known population
STYLIDIACEAE	
<i>Styloidium albo-lilacinum</i>	rarely collected
<i>Styloidium</i> aff. <i>rhynocharpum</i>	either a new species or northern-most occurrence of <i>S. rhynocharpum</i>
<i>Styloidium carlquistii</i>	Priority 1 species, only known occurrence
ASTERACEAE	
<i>Asteridea pulverulenta</i>	northern-most known population
<i>Blennospora drummondii</i>	restricted
<i>Millotia tenuifolia</i>	poorly collected
<i>Pithocarpa achilleoides</i>	Priority 2 species; widespread throughout the Nature Reserve

¹ CALM Flora Conservation Codes (as at 14 September 1995) (Atkins 1995)

Declared Rare Flora - Extant Taxa: Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

Priority One - Poorly Known Taxa: Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Two - Poorly Known Taxa: Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Three - Poorly Known Taxa: Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

Priority Four - Rare Taxa: Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Fishes

Three individuals of the Western Pygmy Perch (*Edelia vittata*) were captured near the head of Boonanarring Brook.

Frogs and Reptiles

Three frog and 18 reptile species were detected on the reserve during the assemblage survey in March, and

another two frog and two reptile species were recorded opportunistically at other times (Table 4). Six species were detected once only at a single sample site: *Heleioporus eyrei*, *Pletholax gracilis gracilis*, *Morethia obscura*, *Tiliqua rugosa*, *Vermicella calonotos* and *Pseudonaja affinis*. However, four of these, *Heleioporus eyrei*, *Morethia obscura*, *Tiliqua rugosa* and *Pseudonaja affinis*, are common and widespread species in the south-west of the State and are likely to be more common and widespread in the study area than these data suggest.

TABLE 4

Reptile and amphibian species recorded from each sample site on Boonanarring Nature Reserve.

SPECIES	SITE							OPPORTUNISTIC RECORD
	1	2	3	4	5	6	7	
Frogs								
Hylidae								
<i>Litoria adelaidensis</i>								*
Leptodactylidae								
<i>Heleioporus eyrei</i>	X							
<i>Mnodynastes dorsalis</i>			X	X			X	
<i>Myobatrachus gouldii</i>	*		X	X				
<i>Ranidella glauerti</i>								*
Reptiles								
Gekkonidae								
<i>Crenadactylus ocellatus</i>					X			X(scarp)
Pygopodidae								
<i>Aprasia repens</i>	X	X	X		X		X	
<i>Delma fraseri</i>				*	X			X(scarp)
<i>Lialis burtonis</i>								*
<i>Pletholax gracilis gracilis</i>		X						
<i>Pygopus lepidopodus</i>								X(scarp)
Scincidae								
<i>Cryptoblepharus plagiocephalus</i>			X		X			
<i>Ctenotus fallens</i>	X			X				
<i>Lerista distinguenda</i>	X					X		
<i>Lerista praepedita</i>	X	X	X	X				
<i>Morethia obscura</i>							X	
<i>Tiliqua rugosa</i>					X			
Agamidae								
<i>Pogona minor</i>						X		X
<i>Tympanocryptis adelaidensis</i>		X	X		X			
Boidae								
<i>Morelia spilota</i>								*
Elapidae								
<i>Vermicella bimaculata</i>	X	X						
<i>Vermicella calonotos</i>	X							
<i>Vermicella semifasciata</i>	X			X				
<i>Nolechis curtus</i>	X		X					*
<i>Pseudonaja affinis</i>	X							
Number of species at each site:	11	5	7	6	5	2	4	

All records except * were made during the assemblage survey in March. 'Scarp' refers to lateritic breakaway surfaces of the Gingin Scarp, between Sites 2 and 3.

Table 5 shows the number of individuals of each species captured in pitfall traps and during diurnal searches. Pitfall captures equate with the total number of individuals captured since there were no recaptures. Only eight species (three frog and five reptile species) were pit-trapped. Twelve species of reptiles were detected only by active searching techniques.

TABLE 5

Total numbers of each frog and reptile species recorded from pitfall traps and diurnal searches at sample sites on Boonanarring Nature Reserve, 17-23 March 1986.

SPECIES	METHOD		SAMPLE SITE
	Pitfall traps	Diurnal searches	
Frogs			
<i>Heleioporus eyrei</i>	1		1
<i>Limnodynastes dorsalis</i>	5		3,4,7
<i>Myobatrachus gouldii</i>	5		3,4
Reptiles			
<i>Crenadactylus ocellatus</i>		1	5
<i>Aprasia repens</i>		8	1,2,3,5,7
<i>Delma fraseri</i>		3	5
<i>Pletholax gracilis gracilis</i>	1		2
<i>Pygopus lepidopodus</i>		1	
<i>Cryptoblepharus plagiocephalus</i>	1	1	3,5
<i>Ctenotus fallens</i>		2	1,4
<i>Lerista distinguenda</i>		2	1,6
<i>Lerista praepedita</i>		8	1,2,3,4
<i>Morethia obscura</i>		1	7
<i>Tiliqua rugosa</i>		1	6
<i>Tympanocryptis adelaidensis</i>	3	2	2,3,5
<i>Pogona minor</i>	2		7
<i>Vermicella bimaculata</i>		4	1,2
<i>Vermicella calanotos</i>		1	1
<i>Vermicella semifasciata</i>		2	1,4
<i>Notechis curtus</i>	1	1	1,3
<i>Pseudonaja affinis</i>		1	2
Number of species:	8	16	

Birds

In the March survey, 47 species of birds were recorded in the reserve (Table 6). A further 27 species were recorded on other occasions, sometimes opportunistically, providing a total of 74 species known for the study area. A chestnut-shouldered fairy-wren (possibly *Malurus lamberti*) was also seen, but not well enough to distinguish it reliably from the two other species which could occur. In any case, the occurrence is of interest, being outside the normal range of these species. The Laughing Kookaburra was the only introduced species recorded. All species were within their known ranges (Storr 1991). A total of 30 families were represented (taxonomic groupings used were those of Christidis and Boles 1994). Prominent families included Meliphagidae (honeyeaters, 11 species), Accipitridae (hawks and eagles, 6) and Pardalotidae (pardalotes, thornbills and allies, 6).

Mammals

Eleven native and four introduced mammal species were recorded on the reserve (Table 7). Seven native and one introduced species were recorded at sample sites and, opportunistically, an additional four native (all bats) and three introduced species were recorded away from the permanent sampling sites (quadrats) (Table 7). A species account is presented in Appendix 5. The list of native species comprised three small ground mammals, five bats, two macropods and the echidna. All are within their known geographic ranges.

Three native and one introduced small mammal species were trapped (Table 7). Appendix 6 lists the total number of individuals captured from individual traplines at each site. Honey Possums (*Tarsipes rostratus*) had pouch young at the time of the survey (March) and several *Mus* were in breeding condition (one female was pregnant). One male *Pseudomys albocinereus* was in breeding condition, suggesting that limited breeding may have been occurring at the time of survey. Captures of juveniles and an adult female *Sminthopsis griseoventer* indicated that the species had successfully bred on the reserve before March. Males of three bat species, *Nyctophilus gouldi*, *N. geoffroyi* and *Vespadelus regulus* showed breeding condition, although we have no reproductive information from females to confirm breeding activity in March. (See Appendix 5 for further details.)

DISCUSSION

Floristics and Vegetation

Boonanarring Nature Reserve is of considerable botanical significance as it represents the transition zone of vegetation associations of the Swan Coastal Plain, Darling Scarp and the Dandaragan Plateau. These are primarily the woodlands of the Muchea-Gingin area and the heaths (kwongan) of the Mogumber area.

This transition is reflected in the floristics of the area. Griffin (1994) utilised the quadrats established for this study, and others he established in the reserve, in his analysis of the floristics of the sandplains between Perth and Geraldton. Sites from Boonanarring fell into four woodland and heath groups (20-5, 20-6 (heaths), 20-7 and 20-9 (woodlands)). The heath groups had northern affinities with those in Boonanarring near their southern limits. The woodland group 20-7 also was a northern group, while 20-9 was essentially a group allied to the Dandaragan scarp extending from Wannamal to Bullsbrook. Gibson and Keighery (personal communication) using Griffin's sites, those from the Swan Coastal Plain survey (Gibson *et al.* 1994) and from the Department of Environmental Protection's System Six update study (1996), have also found that floristic sites from Boonanarring have affinities to heaths and woodlands north and south of the reserve, rather than the adjacent coastal plain. These data are currently being prepared for publication elsewhere.

TABLE 6

Bird species recorded at each sample site on the Boonanarring Nature Reserve.

COMMON NAME	SCIENTIFIC NAME	SITE							Opp.
		1	2	3	4	5	6	7	
Emu	<i>Dromaius novaehollandiae</i>			+	+		+	+	
Australian Shelduck	<i>Tadorna tadornoides</i>								+
Pacific Black Duck	<i>Anas superciliosa</i>								N
Black-shouldered Kite	<i>Elanus axillaris</i>								+
Whistling Kite	<i>Haliastur sphenurus</i>								+
Brown Goshawk	<i>Accipiter fasciatus</i>								R
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>								+
Wedge-tailed Eagle	<i>Aquila audax</i>								+
Little Eagle	<i>Hieraaetus morphnoides</i>								+
Brown Falcon	<i>Falco berigora</i>	+	+	+					+
Australian Hobby	<i>Falco longipennis</i>								+
Australian Kestrel	<i>Falco cenchroides</i>								+
Painted Button-quail	<i>Turnix varia</i>			?					
Common Bronzewing	<i>Phaps chalcoptera</i>								+
Crested Pigeon	<i>Ocyphaps lophotes</i>								+
Short-billed Black-Cockatoo	<i>Calyptorhynchus latirostris</i>				+				+
Galah	<i>Cacatua roseicapilla</i>								+
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>							+	+
Australian Ringneck	<i>Barnardius zonarius</i>			+	+			+	+
Red-capped Parrot	<i>Purpureicephalus spurius</i>								+
Pallid Cuckoo	<i>Cuculus pallidus</i>								+
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>								+
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>	+							
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>								+
Southern Boobook	<i>Ninox novaeseelandiae</i>					+			+
Barn Owl	<i>Tyto alba</i>								N
Tawny Frogmouth	<i>Podargus strigoides</i>								+
Australian Owllet-nightjar	<i>Aegotheles cristatus</i>								+
Laughing Kookaburra	<i>Dacelo novaeguineae</i>					+		+	+
Sacred Kingfisher	<i>Todiramphus sanctus</i>							+	+
Rainbow Bee-eater	<i>Merops ornatus</i>								+
Splendid Fairy-wren	<i>Malurus splendens</i>					+		+	+
White-winged Fairy-wren	<i>Malurus leucopterus</i>	+	+				+		+
Striated Pardalote	<i>Pardalotus striatus</i>							+	+
Weebill	<i>Smicromis brevirostris</i>							+	+
Western Gerygone	<i>Gerygone fusca</i>	+		+	+	+		+	+
Inland Thornbill	<i>Acanthiza apicalis</i>								+
Western Thornbill	<i>Acanthiza inornata</i>				+	+	+	+	+
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>				+			+	+
Red Wattlebird	<i>Anthochaera carunculata</i>				+	+	+	+	+
Little Wattlebird	<i>Anthochaera chrysoptera</i>			+	+	+	+		+
Yellow-throated Miner	<i>Manorina flavigula</i>								+
Singing Honeyeater	<i>Lichenostomus virescens</i>	+	+	+	+			+	
Yellow-plumed Honeyeater	<i>Lichenostomus ornatus</i>								N
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>					+		+	
Brown Honeyeater	<i>Lichmera indistincta</i>	+	+	+	+	+	+	+	+
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>								+
Tawny-crowned Honeyeater	<i>Phylidonyris melanops</i>	+	+	+	+		+		+
Western Spinebill	<i>Acanthorhynchus superciliosus</i>			+	+	+	+	+	+
White-fronted Chat	<i>Ephthianura albilfrons</i>						+		
Scarlet Robin	<i>Petroica multicolor</i>				+	+		+	+
Red-capped Robin	<i>Petroica goodenovii</i>								+
Hooded Robin	<i>Melanodryas cucullata</i>			+					
Varied Sittella	<i>Daphoenositta chrysoptera</i>					+		+	+
Golden Whistler	<i>Pachycephala pectoralis</i>								R
Rufous Whistler	<i>Pachycephala rufiventris</i>			+	+	+		+	+
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	+				+		+	+
Magpie-lark	<i>Grallina cyanoleuca</i>								+
Grey Fantail	<i>Rhipidura fuliginosa</i>	+		+	+	+		+	+
Willie Wagtail	<i>Rhipidura leucophrys</i>								+
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>			+	+	+	+	+	+
White-winged Triller	<i>Lalage sueunii</i>								N

Table 6 (continued)

COMMON NAME	SCIENTIFIC NAME	SITE							Opp.
		1	2	3	4	5	6	7	
Black-faced Woodswallow	<i>Artamus cinereus</i>	+				+			+
Dusky Woodswallow	<i>Artamus cyanopterus</i>								+
Grey Butcherbird	<i>Cracticus torquatus</i>			+	+			+	+
Australian Magpie	<i>Gymnorhina tibicen</i>				+				+
Australian Raven	<i>Corvus coronoides</i>			+					+
Richard's Pipit	<i>Anthus novaeseelandiae</i>								+
Mistletoebird	<i>Dicaeum hirundinaceum</i>								+
White-backed Swallow	<i>Cheramoeca leucosternus</i>						+		+
Welcome Swallow	<i>Hirundo neoxena</i>	+							+
Tree Martin	<i>Cecropis nigricans</i>	+	+	+	+	+			+
Rufous Songlark	<i>Cinclorhampus mathewsi</i>								+
Silvereye	<i>Zosterops lateralis</i>	+	+	+		+		+	+
Number of species		13	10	19	17	19	9	24	
Total number of species recorded = 74									

R = species recorded during an RAOU excursion in June 1989 (R. van Delft, personal communication) and N = recorded during Western Australian Naturalists Club excursions in October 1992 (H. and K. Frederiksen, personal communication) and August and October 1995 (R. Roe, personal communication), but not during earlier sampling.
Opp. = opportunistic sightings, away from detailed sampling quadrats.
Nomenclature and order follows Christidis and Boles (1994).

The topographic complexities of the area are reflected by the soil patterning and hence patterns in the species-rich vegetation. Although there are few comparable studies, the list of 573 species recorded at Boonanarring is similar to that recorded from John Forrest National Park (590+ species) (Mattiske and Associates 1991; Armstrong and Muir 1994; Foulds and Parsons 1996), although the latter is a rather smaller area (ca 2550 ha) but more intensively studied. The list from Boonanarring is also comparable with the 624 species recorded in and around 93 quadrats (each 10 x 10 m, across a study area of about 2400 km²) in the Moore River to Jurien Sandplain Survey (Griffin and Keighery 1989).

The records of *Laxmannia omnifertilis*, *Ecdeiocola monostachya*, *Banksia chamaephyton*, *Grevillea saccata*, *Isopogon adenanthoides*, *Isopogon linearis* and *Pileanthus filiformis* are the southern most for these taxa and are further evidence of the influence of the kwongan vegetation boundary. Conversely, the northern-most records of *Schizaea fistulosa*, *Eriachne ovata*, *Borya scirpoidea*, *Laxmannia squarrosa*, *Gompholobium scabrum*, *Agonis linearifolia*, *Eucalyptus marginata* ssp. *thalassica*, *Homalospermum firmum*, *Kunzea ericifolia* and *Pericalymma ellipticum* indicate the influence of the Darling Province flora. The number of vascular plant species recorded for Boonanarring Nature Reserve will undoubtedly increase with further sampling during other times of year and when less accessible parts of the reserve are studied.

A unique feature of the reserve is the large number of taxa of *Eucalyptus* (9, including two subspecies), *Banksia* (11), and *Acacia* (15). Reasons for this are unknown but can be attributed in part to the mosaic of soil and vegetation associations. Many of the more unusual species such as *Eucalyptus lane-poolei* were found in transitional zones or ecotones, particularly where Karamal and Moondah soils adjoin.

TABLE 7

Mammal species recorded at each sample site on Boonanarring Nature Reserve, February to August 1986.

SPECIES	SITE							RECORDED OPPORTUNISTICALLY
	1	2	3	4	5	6	7	
<i>Tachyglossus aculeatus</i>				D	D			D
<i>Sminthopsis griseoventer</i>	X	X						*
<i>Tarsipes rostratus</i>	X	X	X	X				
<i>Macropus fuliginosus</i>	S	S	X	X	S	S	S	X
<i>Macropus irma</i>	X			X				X
<i>Nyctinomys australis</i>								X
<i>Nyctophilus geoffroyi</i>								X
<i>Nyctophilus gouldi</i>								X
<i>Chalinolobus gouldii</i>								X
<i>Vespadelus regulus</i>					X			X
<i>Pseudomys albocinereus</i>	X	X	X	X	X	X		
<i>Mus musculus</i>	X	X	X	X	X	X		
<i>Vulpes vulpes</i>								X
<i>Felis catus</i>								X
<i>Oryctolagus cuniculus</i>								X
<i>Canis familiaris</i>								S

X = capture or sight record

S = scats, tracks

D = diggings

* = *Sminthopsis* sp.

Opportunistic records were made away from the seven sample sites. A description of the vegetation at each site is given in Appendix 1. Taxonomic order of native species follows Strahan (1995).

The reserve contains the most extensive example of the poorly conserved *Banksia* woodlands on Dandaragan soils (the Cullala complex). Nearby, on the Swan Coastal Plain, Moore River National Park also supports large areas of *Banksia* woodland, but these occur on Bassendean dunes of deep grey sand. The rest of the national park consists of subdued swales supporting primarily wet heaths. It has been estimated (Beard and Sprenger 1984) that *Banksia* woodlands in Western Australia originally covered 6229 km² of which 61 per cent is now alienated land where the vegetation is presumed cleared. All of an estimated 680 km² of *Banksia* woodland with scattered *Eucalyptus* is now on alienated land. Approximately one third of all *Banksia* woodlands were found on the Dandaragan Plateau, reaching an optimum on the Swan Coastal Plain between Muchea and Cataby and extending northward along the Dandaragan Plateau to the middle of Watheroo National Park (Beard 1989). Hopper and Burbidge (1989) estimated that only 7 per cent of the original 281 000 ha of *Banksia* woodland on the Swan Coastal Plain south of Lancelin were on conservation reserves. *Banksia* woodlands in general are under threat from rapid urban and rural development and degradation owing to weed invasions and recreational usage.

Boonanarring Nature Reserve contains extensive areas of *Banksia* woodland with *Eucalyptus todtiana* and *E. lane-poolei*. With further survey utilizing quadrat-based data, the two *Banksia* woodland associations described could be redefined based on the understorey species composition. A quantitative analysis of the vegetation using quadrats would be expected to confirm analyses elsewhere (Havel 1968; Dodd and Griffin 1989) that soil leaching and moisture availability are the major determinants of variability within the *Banksia* woodlands. The species richness of unbounded sampling sites within our study site ranged from 68 at site 2 to 108 at site 1 (mean = 92). These cannot be directly compared with bounded sites but indicate that *Banksia* woodlands within Boonanarring Nature Reserve may be more species-rich than those reported in other studies. In 83 quadrats, each 400 m², in *Banksia* woodland in the Perth region (Dodd and Griffin 1989) perennial species richness varied from 16 to 53 species per site. Dominant woody families found within the *Banksia* woodlands were Myrtaceae, Proteaceae, Papilionaceae and Epacridaceae, indicative of the influence of Kwongan flora species. *Allocasuarina fraseriana*, usually a co-dominant in *Banksia* woodlands south of Yanchep National Park (Beard 1989), is apparently absent from Boonanarring Nature Reserve.

Jarrah forest on Boonanarring Nature Reserve is extensive and basically similar to that on the Swan Coastal Plain and Darling Scarp in being rich in species. Jarrah forest is relatively well represented on conservation reserves, being the predominant vegetation association within John Forrest National Park, Moondyne Nature Reserve and Walyunga National Park. It is also widespread in State forest. The jarrah forest types found in the reserve correlate strongly with soil type and landform, in the manner described by Havel (1975a). The best developed, taller jarrah forest on the gravelly uplands has

been heavily exploited for timber at unknown times in the past. Stands of *Banksia grandis* and *Dryandra sessilis* often occur nearby, depending on soil depth and slope. On the deep, sandy plains and swales between laterite breakaways the slower growing, straggly jarrah open mixed woodland (vegetation Type 7) appears to have been affected in some areas by severe wildfires. In burnt vegetation east of site 7 the understorey is dominated by *Stirlingia latifolia* in stark contrast to the more species rich unburnt site. The establishment of permanent monitoring quadrats within areas that are to be prescription burnt may indicate whether species diversity is affected in the long term. Although Bell and Koch (1980) suggest that richness and diversity are not reduced by fire in jarrah forest, their study was carried out in different vegetation types in higher rainfall areas to the south, and the effect of site to site variation is not clear from their data. There is still a need to follow individual sites through time.

The distribution of wandoo woodland is limited within the reserve, being restricted to areas where the Gingin Scarp adjoins the Moondah soils unit. At these junctions massive exposed consolidated laterites with heavy textured soils occur over clays which remain wet in winter and bake over summer. Although limited in size, the wandoo woodlands may prove, with further sampling, to be habitat for a number of flora and fauna species not occurring in other parts of the reserve.

Fishes

The one species collected (*Edelia vittata*) is within its known range, which is from the Phillips River on the south coast to the Moore River, a little to the north of our study area (Allen 1982). More extensive sampling, using a broader range of techniques to detect secretive and nocturnal fish, would probably reveal the presence of other species.

Frogs and Reptiles

A reasonably diverse herpetofauna, comprising five frog and 20 reptile species, was detected in the study area. Data from the Swan Coastal Plain and Darling Range near Perth (How and Dell 1994) suggest that further work at Boonanarring would reveal the presence of additional species. All species detected at Boonanarring are within their known geographic ranges. However, two records are of particular significance. Until recently, *Vermicella calonotos* was declared endangered. It still has only an extremely restricted geographic distribution in the south-west, from Lancelin to Mandurah (Storr *et al.* 1986; Bush *et al.* 1995). Within this range, the species has previously been recorded only rarely outside the coastal belt (Quindalup and Spearwood Dune Systems of McArthur and Bettenay (1960)). These records are from the coastal plain at Bullsbrook, Caversham and Riverton, and in *Banksia* woodland at Mooliabeenee on the Dandaragan Plateau (Bamford 1985, 1986; Storr *et al.* 1986). Our record from sands at the base of the Gingin Scarp is an additional inland record. The second record of particular interest is the Carpet Python, *Morelia spilota imbricata*,

which is declared 'in need of special protection'.

Several other records are also of some interest. Three species of *Vermicella* (small fossorial snakes) were detected at one site (Site 1) at the base of the Gingin Scarp. No microhabitat differences were apparent, suggesting that the three are syntopic. A total of five species of *Vermicella* are known to occur sympatrically on the coastal plain from Perth to the Moore River (Storr *et al.* 1978); interestingly, all five occur in a relatively small area at Bold Park in the western suburbs of Perth (How and Dell 1994).

Our list is clearly not exhaustive since the herpetofaunal survey was brief and trapping was restricted to one season. There was also a difference in sampling effort between sandy and lateritic sites (no pit-trapping) and overall, capture rates were low; for example, seven species were represented by one specimen recorded at one sample site only. Thus apparent absence from a site may not be real. Further sampling in warmer weather would have resulted in more species being detected, and at more sites.

Nevertheless, several broad trends were indicated. Seven species were detected only on deep sands at the base of the Gingin Scarp and on the Dandaragan Plateau: *Heleioporus eyrei*, *Pletholax gracilis*, *Vermicella bimaculata*, *V. calonotos*, *V. semifasciata*, *Notechis curtus* and *Pseudonaja affinis*. The first five are burrowing species typically associated with sandy surfaces on the coastal plain between the Swan and Moore Rivers (Storr *et al.* 1978; How and Dell 1994; Tyler *et al.* 1994), while the last two are non-burrowing snakes.

Four of these species were absent from our sites on the Dandaragan Plateau: *Heleioporus eyrei*, *Pletholax gracilis*, *Vermicella calonotos* and *Pseudonaja affinis*. However, the first three have been previously recorded in *Banksia* woodland about 10 km away at Mooliabeenee (Bamford 1985). *P. affinis* has been recorded some 10 km south-east of there, near Bindoon (Western Australian Museum records).

Four species were detected only at sites on laterite or lateritic sands in gullies between lateritic ridges: *Crenadactylus ocellatus*, *Morethia obscura*, *Tiliqua rugosa* and *Pogona minor*. However, all are known from the adjacent northern Swan Coastal Plain (Swan River to Moore River), where with the exception of *C. ocellatus*, they are common (Storr *et al.* 1978). *C. ocellatus* is scarce on the Swan Coastal Plain because of the paucity of suitable rocky habitat; the species is considered to be more common on the adjacent Darling Scarp and Plateau (Storr *et al.* 1978). Dell (1983) recorded it from 'woodland' and 'granite' on the Darling Scarp near Perth.

The list of species includes four reptile species endemic to the west coastal sandplains from Geographe Bay to North West Cape: *Pletholax gracilis gracilis*, *Lerista praepedita*, *Tympanocryptis adelaidensis adelaidensis* and *Vermicella calonotos*.

A much richer herpetofauna than that detected by our survey is predicted to occur on the reserve. How and Dell (1994) have demonstrated strong patterning of reptiles across landscape gradients near Perth, and so one would

expect significant differences between the lateritic upland, scarp deep sand sites within Boonanarring, resulting in a rich reptile fauna. Records from a three-year pitfall trap study near Mooliabeenee (Bamford 1985), 10 km south-east of the reserve, provide a comparison with our list (Appendix 7). From *Banksia* woodland alone, Bamford (1985) recorded an additional four frog and 16 reptile species. On current knowledge of the geographic distribution, habitat associations and status of each of these species, all could occur on the reserve. The four frogs are most easily detected after winter rains when breeding, and our failure to detect any of these species on the reserve is probably related to our survey work being restricted to autumn. Two points should be made, however. The frog *Crinia georgiana* has not been collected north of Gingin (Tyler *et al.* 1994), but the Mooliabeenee record indicates that the species occurs inland in this region. *Lerista christinae* is an uncommon species and hence, if present at Boonanarring, may be sparsely distributed. Prior to the Mooliabeenee records, it was known only from sandplains near Badgingarra and near Eneabba (Storr *et al.* 1981).

We recorded four species on the reserve that are additional to Bamford's (1985) list from near Mooliabeenee: *Crenadactylus ocellatus*, *Lerista distinguenda*, *Vermicella bimaculata* and *Pseudonaja affinis*. The presence of *C. ocellatus* in the study area appears to be related to the presence of suitable rocky habitat, and the presence of *R. glauerti* related to the availability of surface water in Boonanarring Brook.

A search of unpublished Western Australian Museum records (to August 1986) from the area within a 25 km radius of Gingin yielded records of an additional two frog and nine reptile species. These are listed in Appendix 8, and are possible additions to the list for Boonanarring. Of note is that the reserve is very close to the known northern limit of *Leiopisma trilineatum* at Gingin Brook (Storr *et al.* 1981) which has its head-waters adjacent to the southern boundary of the study area.

Birds

We detected over 60 per cent of the 120 terrestrial species recorded in the surrounding 1° x 1° block during the RAOU Atlas of Australian birds survey (Blakers *et al.* 1984). The RAOU survey was of a much larger area than our study site, extended over five years, involved many observers in all seasons and covered a much greater range of habitat types. The number of species detected in our study site suggests that its avifauna is reasonably rich for this general area.

Most (65 per cent) of the species we recorded are of widespread occurrence, 28 per cent are Bassian (southern) species and 7 per cent are Eyrean (arid zone) species.

Few site specific data exist with which to make meaningful comparisons of community structure. However, in terms of species composition, the avian communities of the eucalypt woodland sites at Boonanarring appear more similar to those of eucalypt woodlands in the Yanchep area on the Swan Coastal Plain

(Burbidge *et al.* unpublished data) than to those of the Darling Range jarrah forests (Wykes 1985; Worsley Alumina Pty Ltd 1985). Not surprisingly, there are numerous bird species in common between each of these sites, but there are also a number of differences. For example, Golden Whistlers were common in the Darling Range sites, but they were absent from the Yanchep and Boonanarring sites (although there is one opportunistic record of this species in eucalypt woodland at Boonanarring, they were probably once at Yanchep (Storr and Johnstone 1988) and may have once been more common at Boonanarring). On the other hand, Rufous Whistlers were commonly recorded at Yanchep and Boonanarring but only rarely recorded in the Darling Range sites. Similarly, Red-capped Parrots were more common in the Darling Range sites than at Yanchep or Boonanarring, whereas the opposite was true of the Australian (Port Lincoln) Ringneck. Brown-headed Honeyeaters were absent from the Darling Range sites whereas White-naped Honeyeaters were rarely recorded at Yanchep or Boonanarring. Yellow Robins, White-browed Scrubwrens, Red-winged Fairy-wrens and Western Rosellas were recorded only at some of the Darling Range sites; on the other hand, some species preferring more open habitats (e.g. Singing Honeyeater) were not recorded in the Darling Range sites, although this species is known to occur elsewhere in the Darling Range, particularly around towns (I. Abbott personal communication).

In *Banksia* woodland about 10 km south-east at Mooliabeenee, Bamford (1985, 1986) recorded about twice as many species per site as we did in *Banksia* woodland. However, his was a detailed study carried out over all seasons over three years, and his sample areas were much larger than ours. All species recorded in *Banksia* woodland by us were also recorded at Mooliabeenee. Boonanarring *Banksia* woodland sites are, however, very similar in bird species richness and composition to those at Yanchep National Park (Burbidge *et al.* unpublished data). The most noticeable differences between these two areas are that both Splendid Fairy-wrens and New Holland Honeyeaters were absent from the *Banksia* sites at Boonanarring, presumably because of the sparser shrub layer and absence of stands of *Calothamnus*.

Heathland sites at Yanchep (Burbidge *et al.* unpublished data) are richer in bird species than are heathland sites at the Southern Beekeepers Reserve (Burbidge and Boscacci 1989) or those in the Boonanarring Nature Reserve. Most of the bird species in the Boonanarring heaths were also recorded in heaths in the other two areas.

Red-tailed Black-Cockatoos occurred in the area in the past, and as occasional visitors in recent times (Storr 1991). We did not record this species, but there seems no reason that it could not occur, unless suitable nest sites have been destroyed.

Mammals

Our record of *Nyctophilus gouldi* is of biogeographical interest. It is the first from the Dandaragan Plateau and indicates the species' presence at the northern extremity of

the Darling Range. There is a single record of the species from the Wheatbelt (Jibberding, 1982 - Western Australian Museum records) and an old record (1949) from the northern Swan Coastal Plain at Muchea (Kitchener and Vicker 1981), 40 km south of Gingin. However, all other Western Australian records are from the forests and woodlands of the mesic south-western corner, from the Darling Scarp near Perth (Kalamunda, 1970) south to Pemberton (1980) (Kitchener and Vicker 1981; Western Australian Museum records). The species has been recorded as far east as Frankland (Christensen *et al.* 1985) on the edge of the south-west forest block.

An additional four native ground mammals have recently been recorded near Mooliabeenee, approximately 10 km south-east of the reserve. These are *Cercartetus concinnus*, *Sminthopsis dolichura*, *Sminthopsis granulipes* and *Isoodon obesulus* (diggings only) (Bamford 1985). All were recorded in *Banksia* woodland in the period 1983 to 1985; the first three were pit-trapped (Bamford 1985). On current knowledge of the geographical distribution and habitat associations of each species, the first three may occur on the reserve and further pit-trapping, particularly in spring, is required to clarify this. The presence of *I. obesulus* is less likely. On the Darling Scarp near Perth this species prefers dense heath understorey at the breakaway edge (Dell and How 1988) but there is little of this habitat at Boonanarring. Some further discussion is given below.

The effects on populations of small mammals of the extensive burning that has occurred on the reserve in recent years are unknown, but may be relevant to the apparent absence of at least one species, *Cercartetus concinnus*. Bamford (1985, 1986) found that small mammals in *Banksia* woodland at Mooliabeenee were more severely affected by fire than either reptiles or birds. Response to fire (susceptibility) was found to vary considerably between different species and of the five species monitored, *Cercartetus concinnus* was most adversely affected. It, along with *Pseudomys albocinereus*, was not recorded at all immediately following fire and took the longest time to reappear in samples after fire (three years). Effects of fire on a range of species near Perth are described in Harris (1995).

It should also be noted, however, that our survey was conducted in autumn when few plant species were flowering. *C. concinnus* is nectarivorous and insectivorous (Strahan 1983) and although little is known of the species' population biology, it is possible that the species is more easily detected in spring and early summer, corresponding with peaks in food sources. Kitchener and Vicker (1981) list a 1962 specimen of *C. concinnus* from Bindoon Creek. Kitchener *et al.* (1978) concluded that the species appeared to be uncommon on the northern Swan Coastal Plain. Dell (1983) listed *C. concinnus* as moderately common on the Darling Scarp, occurring mainly in the heath understorey of wandoo and jarrah woodlands.

Sminthopsis dolichura is predicted to occur on the reserve. In addition to the Mooliabeenee records (two specimens pit-trapped in 1985), there is also one specimen (1979) from *Banksia* woodland near Gingin (Kitchener

et al. 1984; Western Australian Museum records). At Mooliabeenee, the species was recorded infrequently and was less abundant than *S. griseoventer* (Bamford 1985). However, unlike *S. griseoventer*, *S. dolichura* was also pit-trapped in jarrah forest on laterite (M.J. Bamford, personal communication 1986) and this vegetation type is extensively represented in the reserve.

Compared with *S. dolichura*, the local distribution and status of *S. granulipes* in the region of the reserve is less easily assessed. Most records of *S. granulipes* since 1920 have been from the Western Australian wheatbelt and Eastern Goldfields where characteristic habitat is low shrubland and surfaces of sand and sandy loam are preferred (Kitchener and Vicker 1981; Kitchener in Strahan 1983). However, Boonanarring Nature Reserve is close to several known capture sites for the species: *Banksia* woodland at Mooliabeenee (Bamford 1986), heathland communities in Badgingarra National Park (1979; Kitchener and Vicker 1981), heathland near Cataby (1993; M.J. Bamford personal communication) and at Eneabba (1981; Western Australian Museum records). It is noteworthy, however, that the Mooliabeenee record is of a single juvenile from a three-year program of monthly pit-trapping (M.J. Bamford personal communication) which suggests that the species is currently common locally, at least in *Banksia* woodland. The only other record from the vicinity of the reserve is an old (1934) record from nearby Gingin (Kitchener and Vicker 1981) for which habitat information is unavailable. Of interest also is that the species has previously been recorded at one locality on the coastal plain north of Perth, in low heath on sandy soils in the coastal belt at Cockleshell Gully Reserve (1973, 1974; Chapman *et al.* 1977). However, it was not recorded in more southerly (Kitchener *et al.* 1978) or more recent (Burbidge and Boscacci 1989) surveys on the coastal plain, although pit-trapping was not deployed in the former study. The most likely habitat for the species on the Boonanarring Nature Reserve would appear to be the dense heathlands on sandy soils in the eastern section, although it may also be sparsely distributed in *Banksia* woodland. If *S. granulipes* is present, the reserve would provide additional unalienated habitat in the westernmost part of the species' geographic range.

Bamford's (1985) record of *Isoodon obesulus* near Mooliabeenee, on available data, is the northernmost record of this species in the south-west, although sub-fossil records extend further north (Strahan 1995). Shortridge (1909) in Kitchener *et al.* (1978) stated that *I. obesulus* extended as far north as the Moore River, although it was scarce in that area. More recently, the species was recorded on the northern Swan Coastal Plain as far north as Wanneroo and Yanchep National Park in 1977/1978 and 1988; here, it was found to inhabit predominantly thickly vegetated damp situations, typically dense shrubland of *Melaleuca* and *Kunzea ericifolia* over low heath and sedgeland (Kitchener *et al.* 1978; Burbidge *et al.* unpublished). On the Darling Range near Perth, the species was reported to inhabit dense riparian vegetation (Dell 1971; Dell and How 1988). There appears to be very limited suitable habitat on the reserve to support

I. obesulus and thus its occurrence seems unlikely. However, a permanently moist area supporting *Melaleuca* woodland and sedgeland in the upper reaches of Boonanarring Brook warrants further inspection.

An interesting absence from our list is *Rattus fuscipes*. Similarly, the species was not detected near Mooliabeenee by Bamford (1985, 1986) and within Yanchep National Park it is now restricted in occurrence (Burbidge *et al.* unpublished) despite its having once been common at this latter site (How 1978). Another recent survey (Ninox Wildlife Consulting 1991) failed to detect this species in John Forrest National Park on the Darling Scarp near Perth. Previously, we have found the species to be readily trappable in pit-traps near Cervantes (Burbidge and Boscacci 1989). Its absence, specifically from our sites at the base of the Gingin Scarp, suggests that immediately north of Perth the species may be restricted to the Coastal Plain and possibly declining.

Management Issues

In recent years, two major activities causing deterioration of the conservation values of the reserve have been gravel mining and wood cutting.

Gravel has been removed from several parts of the reserve on several occasions during recent years. Gravel mining and construction of roads within the reserve for the extraction of gravel has left problems of rehabilitation. Gravel has been extracted from the reserve with little apparent regard for hygiene precautions to prevent the spread of dieback (*Phytophthora*) and with little apparent regard for the conservation status of the land. Some such areas need to be rehabilitated to CALM and Main Roads Department standards.

Wood cutting for housing, fencing, etc., has occurred in the area since early this century (R. Roe, personal communication). However, wood cutting has continued into recent times, resulting in the creation of numerous tracks with no regard whatsoever to conservation values. Most recent wood cutting appears to have been for firewood and occurred in winter, when the risk of the introduction and spread of dieback is greatest.

Management will need to address the issue of rationalizing the track system which has become excessive as a result of gravel mining and wood cutting activities. It may be appropriate to mechanically rip some tracks to aid in revegetation and reduce internal fragmentation in the reserve.

A major management problem on this reserve relates to the control of fire. Given the very high conservation values of the reserve, particularly for flora, fire management must be a high priority (Harris 1995). In relatively recent times, large segments of the reserve have been burnt with little apparent regard for possible implications concerning the conservation values of the area. For the area to be managed adequately with regard to fire, planning needs to take into account the need to contain fires to a manageable area and to ensure that entire habitat types are not burnt at the one time. From studies at

nearby Mooliabeenee and near Cataby, some small ground mammals (*Sminthopsis*, *Tarsipes*) have been shown to prefer long (> 10 years) unburnt vegetation (M. J. Bamford personal communication), and it is possible that populations of small mammals might not be maintained in the long term in the face of more frequent burning. Recently burnt areas can be colonized, but only if there is a population in a nearby long unburnt area.

Management needs to continue to take into account the presence of the declared endangered and priority flora and fauna species present. Much research needs to be done on the effects of fire on rare species and communities, but for a number of species, sufficient knowledge is already available to guide management. For example, *Grevillea saccata* is known to be killed by fire, and therefore areas containing this species need to be managed accordingly. Such occurrences should also be taken into account in any review of the track system (and therefore fire breaks/access), to minimize the risk of unnecessary burning of *G. saccata* populations. Research needs to be undertaken on the appropriate fire regime for this species.

It is unknown to what extent feral animals may be a problem, but they are unlikely to be a problem for the restricted *Vermicella calanotos*, as this species is fossorial. Foxes may well be a problem for small ground mammals in particular, and fox baiting could be considered as a management option in the future, as a reserve of this size should be capable of maintaining viable populations of small mammals in the absence of foxes. While some weed species were detected during our survey, none appears to be a serious problem at present, and virtually all are confined to tracks and edges except in the Boonanarring Brook head-waters, where weeds were apparently introduced by marijuana cultivators. The situation should be monitored, and action taken if weed invasion increases.

Some areas, particularly along Boonanarring Brook, may be susceptible to invasion by *Phytophthora*, as many susceptible species are present in the area and the climate is suitable for dieback disease.

Consideration of the issues discussed above highlights the need for a management plan for this highly significant reserve.

RECOMMENDATIONS

1. Because of the very high conservation value of the reserve, particularly with regard to flora, it is strongly recommended that it be reclassified from 'C' Class to 'A' Class Nature Reserve. Water reserve A22602 and the area around the head of Gingin Brook should be included in the nature reserve.
2. Rationalization of the system of roads and tracks and rehabilitation of some tracks is required.
3. A fire management plan, which takes into account the known high conservation values of the reserve, is required. Such a plan should include some areas in which burns are not planned. Further research is needed on species such as

Grevillea saccata which are killed by fire, to determine appropriate fire regimes.

4. Areas mined for gravel require adequate rehabilitation.
5. Permanent vegetation quadrats (10 m x 10 m) should be established within each vegetation type to assess the effects of long-term change, including the effectiveness of management practices.
6. A management plan, taking into account the high conservation values, should be prepared for the reserve.

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APPENDIX 1

Descriptions of vegetation and soils at each sample site on Boonanarring Nature Reserve.

Quadrat 1

Open woodland A of *Eucalyptus calophylla* and *Nuytsia floribunda* with occasional *E. todtiana* over open scrub of *Allocasuarina humilis*, *Jacksonia sternbergiana*, *Hakea trifurcata*, *Xanthorrhoea preissii* and *Adenanthos cygnorum* over low heath C of mainly *Calothamnus sanguineus* and *Banksia candolleana* over low sedges and herbs.

Light grey sand over brown sand on western facing gentle slope.

Quadrat 2

Open low woodland B of *Banksia menziesii*, *B. attenuata*, *B. prionotes*, *Eucalyptus todtiana* and occasional *E. lane-poolei* over low heath C of *Acacia lasiocarpa*, *Conospermum stoechadis*, *Calothamnus sanguineus* and *Xanthorrhoea preissii* over low sedges and herbs with occasional emergent *Jacksonia sternbergiana* and *Allocasuarina humilis*.

Dark red-brown sand over laterite on western facing slope.

Quadrat 3

Low woodland A/B of *Banksia menziesii* and *B. attenuata* with occasional *B. grandis*, *Eucalyptus todtiana* and *Nuytsia floribunda* over low heath C of *Xanthorrhoea preissii*, *Stirlingia latifolia*, *Banksia candolleana*, *Allocasuarina humilis* with emergent *Adenanthos cygnorum* and *Jacksonia floribunda* over low sedges and herbs with patches of bare ground.

Yellow sand over dark brown coarse sand in gently undulating topography.

Quadrat 4

Open low woodland B of *Banksia menziesii* and *B. attenuata* with occasional *Eucalyptus todtiana* over low heath C of *Hibbertia hypericoides*, *Eriostemon spicatus*, *Petrophile ericifolia* and *Xanthorrhoea preissii* over low sedges and herbs.

Yellow-grey sand over laterite in gently undulating topography.

Quadrat 5

Low woodland A dominated by *Eucalyptus marginata* with occasional *E. calophylla*, *E. todtiana* and *Banksia grandis* over open low scrub A of *Xanthorrhoea preissii* and *Acacia* sp. over low heath C/D.

Brown sandy loam over laterite and laterite over black rich sand in very gently undulating topography.

Quadrat 6

Scrub of *Allocasuarina humilis*, *Adenanthos cygnorum* and *Hakea trifurcata* with emergent low, *Eucalyptus decurva* and *E. todtiana* over low heath C of *Xanthorrhoea preissii*, *Calothamnus sanguineus*, *Petrophile* spp., *Hakea* spp. and *Allocasuarina humilis* over low sedges and herbs.

Grey sand over laterite on the crest of a hill.

Quadrat 7

Low woodland A of *Eucalyptus marginata* and *E. calophylla* over dwarf scrub C of *Petrophile ericifolia*, *Xanthorrhoea preissii* and *Acacia pulchella* over low heath D of *Hibbertia* spp., *Hakea* spp., and very open low sedges and herbs.

Deep yellow loamy sand over ? laterite on gentle easterly slope.

APPENDIX 2

Description of trap layout used in the assemblage survey at the Boonanarring Nature Reserve, March 1986.

Pitfall traps (12.5 x 60 cm PVC tubing) were arranged 10 m apart in lines. A flywire drift fence (30 cm high) was placed between all pits and across the top of every pit in the line. At each of Sites 1 to 4 a line of 6 pits and 2 lines of 3 pits were laid out. The lines of 3 pits were about 50 m apart and these lines were 100-150 m from the line of 6 pits at each site. Site 7 had 2 lines of 6 pits, 150 m apart.

Sites 5 and 6 (hard lateritic surfaces) had three lines of medium Elliott traps (32 x 10 x 8 cm, Elliott Scientific Company, Upwey, Victoria) with a space of 10 m between trap locations in a line. At each site, one line had a drift fence (identical to those used for the pits) placed on a 30 cm wide scrape that had been made through the vegetation with a 'Rakho' (a hand implement with features of a rake and a hoe). Traps were placed at each end of this fence and, at 10 m intervals along the fence, traps were placed on alternate sides of the fence, facing in opposite directions. The fenced line therefore had ten traps at six locations along the fence. The second line had ten traps placed at 10 m intervals along a scrape similar to that at the first line, but without the fence. The third line consisted simply of ten traps placed at 15 m intervals. All Elliott traps were baited with a standard mixture of peanut butter, honey and rolled oats.

APPENDIX 3

Western Australian Museum accession numbers of reptiles and mammals collected on the Boonanarring Nature Reserve.

Frogs

<i>Myobatrachus gouldii</i>	R 1694647
<i>Heleioporus eyrei</i>	R 494651

Reptiles

<i>Crenadactylus ocellatus</i>	R 594640
<i>Aprasia repens</i>	R 994645, 1194638
<i>Delma fraseri</i>	R 194634, 794635 1594641, 1494642, 1994639
<i>Pletholax gracilis</i>	R 894649
<i>Pygopus lepidopodus</i>	R 694636
<i>Cryptoblepharus plagiocephalus</i>	R 1294646
<i>Ctenotus fallens</i>	R 1894643, 2094654
<i>Lerista distinguenda</i>	R 394650
<i>Lerista praepedita</i>	R 1094655
<i>Morethia obscura</i>	R 1394637
<i>Tympanocryptis adalaidensis</i>	R 294648
<i>Vermicella bimaculata</i>	R 2294653
<i>Vermicella calonotos</i>	R 2394652
<i>Vermicella semifasciata</i>	R 2194644
<i>Notechis curtus</i>	R 1794656

Mammals

<i>Sminthopsis griseoventer</i>	M 25676, M 25677, 25678, 25679
<i>Tarsipes rostratus</i>	M 25697, 25698
<i>Pseudomys albocinereus</i>	M 25699
<i>Mus domesticus</i>	M 25700 (5 specimens)
<i>Nyctophilus gouldi</i>	M 25680
<i>Nyctophilus geoffroyi</i>	M 25675

APPENDIX 4

List of vascular plants found on Boonanarring Nature Reserve and water reserve A22602, showing occurrence at each sample site or as opportunistic collections. Order and nomenclature follows Green (1985). Introduced/naturalized species are denoted by an asterisk (*). Initials denote collectors: AB = A.H. Burbidge, ASG = A.S. George, BM = W. Muir, EAG = E.A. Griffin floristic site records (Griffin 1994 and E.A. Griffin personal communication), GK = G.J. Keighery, JA = J.J. Alford, LR = J.L. Robson, MB = M. Brooker, RR = R. Roe and WA Naturalists Club, SH = S.D. Hopper. Records with initials only represent sight records. For descriptions of sites see Appendix 1.

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
LYCOPODIACEAE									
<i>Phylloglossum drummondii</i> Kunze	GK13274							+	
SELAGINELLACEAE									
<i>Selaginella gracillima</i> (Kunze) Alston	GK14317								+
SCHIZAEACEAE									
<i>Schizaea fistulosa</i> Labill.	GK10254						+	+	+
ADIANTACEAE									
<i>Cheilanthes australenuifolia</i> H. Quirk & T.C. Chambers	JA								+
DENNSTAEDTIACEAE									
<i>Peridium esculentum</i> (G. Forster) Cockayne	JA								+
ZAMIAACEAE									
<i>Macrozamia riedlei</i> (Fischer ex Gaudich.) C. Gardner	JA	+				+			
JUNCAGINACEAE									
<i>Triglochin calcitrapa</i> Hook.	JA								+
<i>Triglochin centrocarpa</i> Hook.	JA								+
<i>Triglochin minutissima</i> F. Muell.	JA								+
POACEAE									
* <i>Aira caryophylla</i> L.	JA742							+	
<i>Amphibromus neesii</i> Steud.	GK14318								+
<i>Amphipogon amphipogonoides</i> (Steud.) Vick.	GK14319								+
<i>Amphipogon laguroides</i> R. Br.	GK14320								+
<i>Amphipogon turbinatus</i> R. Br.	AB/GK				+				
* <i>Briza maxima</i> L.	JA	+							
* <i>Briza minor</i> L.	JA								+
<i>Danthonia occidentalis</i> Vick.	GK10266						+		
<i>Ehrharta longiflora</i> Smith	RR								+
<i>Eriachne ovata</i> Nees	GK10269								+
<i>Microlaena stipoides</i> (Labill.) R. Br.	GK11068						+		
<i>Neurachne alopecuroidea</i> R. Br.	GK11065	+	+	+		+		+	
* <i>Pentaschistus airoides</i> (Nees) Stapf	GK10278							+	
<i>Poa drummondiana</i> Nees	JA752								+
<i>Polypogon tenellus</i> R. Br.	GK10277					+			
<i>Stipa elegantissima</i> Labill.	JA								+
<i>Stipa macalpinei</i> Reader	JA720		+						+
<i>Stipa pycnostachya</i> Benth.	GK11097						+		
<i>Stipa trichophylla</i> Benth.	JA							+	
* <i>Vulpia myuros</i> (L.) C. Gmelin	JA						+		
CYPERACEAE									
<i>Baumea articulata</i> (R. Br.) S.T. Blake	SH								+
<i>Caustis dioica</i> R. Br.	JA368,382,738	+		+	+				
<i>Chorizandra enodis</i> Nees	JA						+		
<i>Cyathochaeta avenacea</i> Benth.	EAG								+
<i>Cyperus tenellus</i> L. f.	GK14321								+
<i>Gahnia ?lanigera</i> (R. Br.) Benth.	GK14322								+
<i>Isolepis marginata</i> (Thunb.) A. Diel.	GK10267								+
<i>Isolepis stellata</i> (C.B. Clarke) K.L. Wilson	GK11094						+		
<i>Lepidosperma angustatum</i> R. Br.	JA177,244,499	+		+		+	+	+	
	312,362								
<i>Lepidosperma longitudinale</i> Labill.	EAG								+
<i>Lepidosperma scabrum</i> Nees	EAG								+
<i>Lepidosperma ?squomatum</i> Labill.	JA266,378			+		+	+		
<i>Lepidosperma tenue</i> Benth.	JA258,355,383	+				+	+	+	
<i>Mesomelaena pseudostygia</i> (Kuek.) K.L. Wilson	JA384,298				+	+	+		+
<i>Mesomelaena graciliceps</i> (C.B. Clarke) K.L. Wilson	GK10044								+
<i>Mesomelaena tetragona</i> (R. Br.) Benth.	JA225, 358	+	+			+	+		

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Schoenus caespitius</i> W. Fitzg.	JA315,GJK	+	+	+		+	+	+	
<i>Schoenus clandestinus</i> S.T. Blake	AB/GK				+				+
<i>Schoenus curvifolius</i> (R. Br.) Benth.	JA314,315			+					+
	GK10246								
<i>Schoenus efoliatus</i> R. Br.	GK11064				+				
<i>Schoenus pedicellatus</i> (R. Br.) Benth.	GK14323								+
<i>Schoenus pleiostemoneus</i> F. Muell.	JA219,347	+		+	+				
<i>Schoenus rigens</i> S.T. Blake	GK		+						+
<i>Schoenus subflavus</i> Kuek.	JA								+
<i>Tetralia capillaris</i> (F. Muell.) J. Black	GK11091								+
<i>Tetralia octandra</i> (Nees) Kuek.	GK		+		+	+			
RESTIONACEAE									
<i>Alexgeorgea nitens</i> (Nees) Johnson & Briggs	JA215			+	+		+	+	
<i>Ecdiocola monostachya</i> F. Muell.	GK								+
<i>Harperia lateriflora</i> W. Fitzg.	EAG								+
<i>Hypolaena exsulca</i> R. Br.	JA218,371			+	+				
<i>Lepidobolus preissianus</i> Nees	JA399	+			+			+	
<i>Leptocarpus ?coangustus</i> Nees	AB4060				+				
<i>Lepyrodia muirii</i> F. Muell.	JA		+						
<i>Loxocarya 'aspera'</i> Johnson & Briggs	JA215,350,368	+							
<i>Loxocarya cinerea</i> R. Br.	JA								+
<i>Loxocarya fasciculata</i> (R. Br.) Benth.	GK								+
<i>Loxocarya 'lateritica'</i> Johnson & Briggs	EAG								+
<i>Lyginia barbata</i> R. Br.	JA,GK	+		+	+				
<i>Ornithosepalum laxiflorum</i> Steud.	EAG								+
<i>Restio 'microcodon'</i> Johnson & Briggs	AB			+	+				
<i>Restio 'sinuosus'</i> Johnson & Briggs	EAG								+
CENTROLEPIDACEAE									
<i>Aphelia cyperoides</i> R. Br.	JA							+	
<i>Centrolepis aristata</i> (R. Br.) Roemer	GK								+
<i>Centrolepis pilosa</i> Hieron.	GK11142								+
<i>Centrolepis polygyna</i> (R. Br.) Hieron.	GK11892						+		
PHILYDRACEAE									
<i>Philydrella pygmaea</i> (R. Br.) Carvel	EAG								+
DASYPOGONACEAE									
<i>Acanthocarpus preissii</i> Lehm.	JA							+	
<i>Calectasia cyanea</i> R. Br.	JA268			+	+		+		
<i>Dasyogon obliquifolius</i> Lehm. ex Nees							+		
<i>Lomandra caespitosa</i> (Benth.) Ewart	JA181,163				+			+	
<i>Lomandra hastilis</i> (R. Br.) Ewart	EAG								+
<i>Lomandra hermaphrodita</i> (C.R.P. Andrews) C. Gardner	GK	+		+	+		+	+	
<i>Lomandra</i> aff. <i>micrantha</i> (Endl.) Ewart	GK						+		
<i>Lomandra preissii</i> (Endl.) Ewart	GK10052, JA180	+			+		+	+	+
<i>Lomandra sericea</i> (Endl.) Ewart	JA163	+				+	+	+	+
<i>Lomandra suaveolens</i> (Endl.) Ewart	EAG								+
XANTHORRHOACEAE									
<i>Xanthorrhoea drummondii</i> Harvey	JA,GK	+	+	+	+	+	+	+	
<i>Xanthorrhoea preissii</i> Endl.	JA								+
PHORMIACEAE									
<i>Dianella revoluta</i> R. Br.	JA							+	
<i>Typania imbricata</i> R. Br.	JA332					+			
ANTHERICACEAE									
<i>Amocrinum preissii</i> Lehm.	GK								+
<i>Arthropodium capillipes</i> Endl.	GK								+
<i>Arthropodium preissii</i> Endl.	GK								+
<i>Borya constricta</i> Churchill	AB4269	+							
<i>Borya scirpoidea</i> Lindl.	JA								+
<i>Borya sphaerocephala</i> R. Br.	AB 4040								+
<i>Chamaescilla corymbosa</i> (R. Br.) F. Muell. ex Benth.	JA714				+				+
<i>Caesia micrantha</i> Lindl.	JA								+
<i>Caesia occidentalis</i> R. Br.	GK10030								+
<i>Corynotheca micrantha</i> (Lindl.) MacBride	EAG								+
<i>Johnsonia pubescens</i> Lindl.	JA216,310	+		+	+				
<i>Laxmannia omnifertilis</i> G.J. Keighery	JA395	+							+
<i>Laxmannia ramosa</i> Lindl.	GK8044								+
<i>Laxmannia sessiliflora</i> Decne. subsp. <i>australis</i> Keighery	JA285	+					+	+	
<i>Laxmannia squarrosa</i> Lindl.	GK, JA	+					+		

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Sowerbaea laxiflora</i> Lindl.	JA								+
<i>Thysanotus anceps</i> Lindl.	EAG								+
<i>Thysanotus asper</i> Lindl.	GK11970								+
<i>Thysanotus patersonii</i> R. Br.	JA								+
<i>Thysanotus rectantherus</i> N.H. Britton	GK11971,SH5828								+
<i>Thysanotus sparteus</i> R. Br.	JA			+					
<i>Thysanotus thyrsoides</i> Baker f.	EAG								+
<i>Thysanotus triandrus</i> (Labill.) R. Br.	EAG								+
<i>Thysanotus</i> sp. (EAG2511)	EAG								+
<i>Tricoryne elatior</i> R. Br.	GK10293							+	+
COLCHICACEAE									
<i>Burchardia multiflora</i> Lindl.	SH								+
<i>Burchardia umbellata</i> R. Br.	JA392,739	+		+	+	+	+	+	
<i>Wumbea dioica</i> (R. Br.) F. Muell	JA767								+
HAEMODORACEAE									
<i>Anigozanthos humilis</i> Lindl.	JA338	+	+	+	+	+		+	
<i>Anigozanthos manglesii</i> D. Don	JA								+
<i>Anigozanthos pulcherrimus</i> Hook.	BM								+
<i>Blancoa canescens</i> Lindl.	JA						+		
<i>Conostylis aculeata</i> R. Br. subsp. <i>aculeata</i>	JA151	+							+
<i>Conostylis aurea</i> Lindl.	JA151,179,376			+	+			+	
<i>Conostylis festuacea</i> Endl.	EAG								+
<i>Conostylis setigera</i> R. Br.	EAG								+
<i>Conostylis juncea</i> Endl.	AB 4062					+		+	
	JA159,389								
<i>Conostylis teretifolia</i> J.W. Green subsp. <i>planescens</i> Hopper	JA 226,322								
	JA147,300	+	+	+	+	+	+	+	
<i>Haemodorum laxum</i> R. Br.	EAG								+
<i>Haemodorum loratum</i> T.D. Macfarl.	JA	+	+	+	+	+	+	+	
<i>Haemodorum spicatum</i> R. Br.	JA501			+					
<i>Haemodorum venosum</i> T.D. Macfarl.	EAG								+
<i>Phlebocarya ciliata</i> R. Br.	JA753								+
<i>Phlebocarya filifolia</i> (F. Muell.) Benth.	JA754,SH5823			+	+				+
<i>Tribonanthes australis</i> Endl.	GK								+
<i>Tribonanthes violacea</i> Endl.	JA								+
HYPOXIDACEAE									
<i>Hypoxis occidentalis</i> Benth	JA								+
IRIDACEAE									
* <i>Gladiolus caryophyllaceus</i> (Burm. f.) Poiret	JA,AB4265				+				+
<i>Orthrosanthus loxus</i> (Endl.) Benth.	AB4222,JA239					+			
<i>Patersonia juncea</i> Lindl.	AB,JA145							+	
<i>Patersonia occidentalis</i> R. Br.	JA149,345,	+		+				+	+
<i>Patersonia</i> cf. <i>occidentalis</i> R. Br.	SH5810								+
* <i>Romulea rosea</i> (L.) Ecklon	GK								+
ORCHIDACEAE									
<i>Caladenia 'arenicola'</i> Hopper & Brown	SH5496								+
<i>Caladenia 'arenicola'</i> Hopper & Brown x ' <i>paludosa</i> ' Hopper & Brown	SH5497								+
<i>Caladenia deformis</i> R. Br.	RR								+
<i>Caladenia denticulata</i> Lindl.	SH								+
<i>Caladenia flava</i> R. Br. subsp. <i>flava</i>	JA158,SH5486							+	+
<i>Caladenia gemmata</i> Lindl.	SH								+
<i>Caladenia ixiooides</i> Lindl.	RR								+
<i>Caladenia 'paludosa'</i> Hopper & Brown	SH5497								+
<i>Caladenia sericea</i> Lindl.	JA247					+			+
<i>Caladenia 'splendens'</i>	SH 5494								+
<i>Calochilus</i> cf. <i>robertsonii</i> Benth.	SH								+
<i>Corybas abditus</i> D.L. Jones	SH								+
<i>Diuris corymbosa</i> Lindl.	SH,JA235					+			+
<i>Drakaea glyptodon</i> W. Fitzg.	SH5821								+
<i>Drakaea livida</i> J. Drumm.	RR								+
<i>Elythranthera brunonis</i> (Endl.) A.S. George	SH5927								+
<i>Elythranthera emarginata</i> (Lindl.) A.S. George	AB4065						+	+	
<i>Eriochilus dilatatus</i> Lindl. subsp. ' <i>multiflorus</i> ' (Lindl.) Hopper & Brown	SH								+
<i>Leporella fimbriata</i> (Lindl.) A.S. George	SH,GK		+	+	+	+		+	+
<i>Leptoceras menziesii</i> (R. Br.) Lindl.	SH,GK								+
<i>Lyperanthus nigricans</i> R. Br.	JA154			+	+			+	
<i>Microtis media</i> R. Br.	RR								+
* <i>Monadenia bracteata</i> (SVW.) T. Dur. & Schinz	GK11628							+	+

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Paracaleana nigrita</i> (Lindl.) Blaxell	GK								+
<i>Pterostylis</i> aff. <i>nana</i> R. Br.	SH								+
<i>Pterostylis recurva</i> Benth.	JA321,SH								+
<i>Pterostylis vittata</i> Lindl.	JA318			+					
<i>Thelymitra ontenniferia</i> (Lindl.) Hook. f.	RR								+
<i>Thelymitra benthamiana</i> H.G. Reichenbach	SH								+
<i>Thelymitra stellata</i> Lindl.	R.Roe and M.Hancock							+	
CASUARINACEAE									
<i>Allocasuarina humilis</i> (Otto & Dietr.) L. Johnson	JA273, 503	+	+	+			+	+	
<i>Allocasuarina microstachya</i> (Miq.) L. Johnson	EAG								+
PROTEACEAE									
<i>Adenanthos cygnorum</i> Diels	JA215	+		+			+		+
<i>Banksia attenuata</i> R. Br.	JA		+	+	+				
<i>Banksia burdettii</i> Bake f.r	BM								+
<i>Banksia chamaephyton</i> A.S. George	JA						+		
<i>Banksia grandis</i> Willd.	JA			+		+		+	
<i>Banksia ilicifolia</i> R. Br.	JA	+							+
<i>Banksia littoralis</i> R. Br.	JA249,BM						+		
<i>Banksia menziesii</i> R. Br.	JA		+	+	+				
<i>Banksia micrantha</i> A.S. George	JA249,BM						+		
<i>Banksia prionotes</i> Lindl.	JA		+						
<i>Banksia sphaerocarpa</i> R. Br.	EAG								+
<i>Conospermum acerosum</i> Lindl.	JA718, GK10241								+
<i>Conospermum glumaceum</i> Lindl.	AB4039								+
<i>Conospermum incurvum</i> Lindl.	GK10237								+
<i>Conospermum stoechadis</i> Endl.	JA172, 743		+						
<i>Dryandra bipinnatifida</i> R. Br.	JA232						+		
<i>Dryandra carlinoides</i> Meisn.	EAG								+
<i>Dryandra echinata</i> A.S. George	JA294						+		
<i>Dryandra kippistiana</i> Meisn.	JA224	+							
<i>Dryandra lindleyana</i> Meisn. subsp. <i>lindleyana</i>	JA265,292	+	+	+		+	+	+	
<i>Dryandra sessilis</i> (Knight) Domin	JA								+
<i>Dryandra shuttleworthiana</i> Meisn.	EAG								+
<i>Grevillea saccata</i> Benth.	AB4069								+
<i>Grevillea synapheae</i> R. Br.	JA160					+	+	+	
<i>Grevillea vestita</i> (Endl.) Meisn.	JA299								+
<i>Hakea conchifolia</i> Hook.	BM,JA								+
<i>Hakea costata</i> Meisn.	JA169,291,346	+	+				+		
<i>Hakea erinacea</i> Meisn.	JA282		+						
<i>Hakea gilbertii</i> Kipp. ex Meisn.	JA								+
<i>Hakea incassata</i> R. Br.	JA222,270	+	+				+		
<i>Hakea lissocarpa</i> R. Br.	JA336					+	+	+	
<i>Hakea obliqua</i> R. Br.	GK								+
<i>Hakea prostrata</i> R. Br.	JA176,271		+			+		+	
<i>Hakea ruscifolia</i> Labill.	JA253	+	+	+	+	+	+	+	
<i>Hakea smilacifolia</i> Meisn.	JA233	+				+	+		
<i>Hakea stenocarpa</i> R. Br.	JA325	+				+	+		
<i>Hakea trifurcata</i> (Smith) R. Br.	JA250, 282	+	+				+	+	
<i>Hakea varia</i> R. Br.	EAG								+
<i>Isopogon adenanthoides</i> Meisn.	GK10251								+
<i>Isopogon divergens</i> R. Br.	JA773								+
<i>Isopogon linearis</i> Meisn.	AB4227, JA446	+					+		
<i>Lambertia multiflora</i> Lindl. var. <i>multiflora</i>	JA226						+		+
<i>Persoonia comata</i> Meisn.	GK								+
<i>Persoonia elliptica</i> R. Br.	EAG								+
<i>Petrophile brevifolia</i> Lindl.	JA394, GK11627						+		
<i>Petrophile linearis</i> R. Br.	JA146,349	+		+	+	+	+	+	
<i>Petrophile macrostachya</i> R. Br.	JA342								+
<i>Petrophile media</i> R. Br.	JA230, 394								+
<i>Petrophile rigida</i> R. Br.	EAG								+
<i>Petrophile scabriuscula</i> Meisn.	GK/JA80,	+	+	+	+			+	+
	JA166,372, AB4278								
<i>Petrophile seminuda</i> Lindl.	GK10925				+				
<i>Petrophile serruriae</i> R. Br.	JA262,385	+				+	+		
<i>Petrophile striata</i> R. Br.	JA342,387,506	+		+	+			+	
<i>Petrophile trifida</i> R. Br.	JA381								+
<i>Stirlingia latifolia</i> (R. Br.) Steud.	JA354	+		+	+		+	+	
<i>Synaphea petiolaris</i> R. Br.	JA352	+	+	+	+	+			
<i>Synaphea spinulosa</i> (Burm. f.) Merr.	JA178,231,280,502	+	+	+	+	+	+		

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
SANTALACEAE									
<i>Leptomeria empetriformis</i> Miq.	GK								+
<i>Leptomeria spinosa</i> (Miq.) A. DC.	GK, JA984								+
OLACACEAE									
<i>Olax scalariformis</i> A.S. George	GK10926								+
LORANTHACEAE									
<i>Amyema miquelii</i> (Lehm.ex Miq.) Tieghem	JA							+	
<i>Nuytsia floribunda</i> (Labill.) R. Br.	JA	+		+					+
POLYGONACEAE									
<i>Muehlenbeckia adpressa</i> (Labill.) Meisn.	GK, JA								+
AMARANTHACEAE									
<i>Ptilotus drummondii</i> (Moq.) F. Muell.	GK								+
<i>Ptilotus manglesii</i> (Lindley) F. Muell.	AB,JA					+			
<i>Ptilotus polystachyus</i> (Gaudich.) F. Muell.	AB								+
GYROSTEMONACEAE									
<i>Gyrostemon subnudus</i> (Nees) Baillon	JA363		+						
MOLLUGINACEAE									
<i>Macarthuria apetala</i> Harvey	EAG								+
<i>Macarthuria australis</i> Huegel ex Endl.	GK,JA AB4125								+
PORTULACACEAE									
<i>Calandrinia corrigioloides</i> F. Muell.ex Benth.	GK14324								+
<i>Calandrinia granulifera</i> Benth.	GK14325								+
<i>Calandrinia liniflora</i> Fenzl	GK14326								+
CARYOPHYLLACEAE									
* <i>Cerastium glomeratum</i> Thuill.	GK,JA								+
* <i>Petrohragia velutina</i> (Guss.) P. Ball et Heyw.	GK10294								+
* <i>Silene gallica</i> L.	AB4041								+
RANUNCULACEAE									
<i>Clematis pubescens</i> Huegel ex Endl.	JA758								+
LAURACEAE									
<i>Cassytha flava</i> Nees	GK								+
<i>Cassytha glabella</i> R. Br.	EAG								+
<i>Cassytha pomiformis</i> Nees	JA508	+		+			+		
<i>Cassytha racemosa</i> Nees	JA357	+							+
BRASSICACEAE									
<i>Brassica toumefortii</i> Gouan	GK11095								+
<i>Stenopetalum robustum</i> Endl.	AB4049								+
DROSERACEAE									
<i>Drosera erythrorhiza</i> Lindl.	JA	+	+	+	+	+	+	+	+
<i>Drosera gigantea</i> Lindl.	JA								+
<i>Drosera leucoblasta</i> Benth.	JA380, AB4047	+		+	+			+	
<i>Drosera macrantha</i> Endl.	JA390, AB4270	+	+	+	+	+	+	+	
<i>Drosera menziesii</i> R. Br. subsp. <i>penicillaris</i> (Diels) N.G. Marchant & A. Lowrie	GK14327					+			+
<i>Drosera neesii</i> Lehm.	GK								+
<i>Drosera pulchella</i> Lehm.	SH5809								+
<i>Drosera stolonifera</i> Endl.	GK								+
CRASSULACEAE									
<i>Crassula colorata</i> (Nees) Ostenf.	GK, JA								+
<i>Crassula exserta</i> (Reader) Ostenf.	GK								+
* <i>Crassula natans</i> Thunb.	GK/JA87								+
PITOSPORACEAE									
<i>Billardiera</i> sp.	JA								+
MIMOSACEAE									
<i>Acacia alata</i> R.Br. var. <i>tetrantha</i> Maslin	GK								+
<i>Acacia opplanata</i> Maslin	JA157, 161					+		+	
<i>Acacia barbinervis</i> Benth. subsp. <i>borealis</i> Maslin	GK, JA								+
<i>Acacia clydonophora</i> Maslin	JA236, 369			+		+			+
<i>Acacia colletioides</i> Benth.	GK, JA	+	+						
<i>Acacia cummingiana</i> Maslin	EAG								+
<i>Acacia drummondii</i> Lindl. subsp. <i>elegans</i> Maslin	JA246					+			
<i>Acacia lasiocarpa</i> Benth. var. <i>lasiocarpa</i>	JA278			+					
<i>Acacia pulchella</i> R. Br. var. <i>pulchella</i>	JA148, 242	+				+		+	

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Acacia pulchella</i> R. Br. var. <i>reflexa</i> Maslin	JA238,337					+		+	
<i>Acacia saligna</i> (Labill.) H.L. Wendl.	GK10263, JA								+
<i>Acacia sphacelata</i> Benth.	EAG								+
<i>Acacia stenoptera</i> Benth.	GK10037	+	+						+
<i>Acacia tetragonocarpa</i> Meisn.	GK10029					+			+
<i>Acacia willdenowiana</i> H.L. Wendl.	JA182,391					+			+
PAPILIONACEAE									
<i>Aotus gracillima</i> Meisn.	JA784								+
<i>Aotus procumbens</i> Meisn.	JA769								+
<i>Bossiaea eriocarpa</i> Benth.	JA284	+	+	+	+	+			
	AB4226, 4229								
<i>Bossiaea ornata</i> (Lindl.) Benth.	JA,AB4273	+	+						+
<i>Daviesia angulata</i> Benth.	JA255, 807							+	
<i>Daviesia decurrens</i> Meisn.	JA174		+			+			
<i>Daviesia divaricata</i> Benth.	JA183, AB4274				+	+			
<i>Daviesia gracilis</i> M.D. Crisp	JA257		+					+	
<i>Daviesia incrassata</i> Smith	JA319	+							
<i>Daviesia inflata</i> M.D. Crisp	JA	+	+						
<i>Daviesia nudiflora</i> Meisn.	JA237, 398		+	+		+			+
<i>Daviesia physodes</i> A. Cunn. ex Don	JA, EAG					+			+
<i>Daviesia</i> ? <i>preissii</i> Meisn.	JA225							+	
<i>Daviesia</i> ? <i>striata</i> Turcz.	GK		+						
<i>Daviesia trillora</i> M.D. Crisp	JA334	+		+	+				+
<i>Gastrolobium spinosum</i> Benth.	AB								+
<i>Gompholobium aristatum</i> Benth.	GK			+					+
<i>Gompholobium confertum</i> (DC.) M.D. Crisp	JA304,AB4277			+	+				+
<i>Gompholobium knightianum</i> Lindl.	JA240,AB4225		+	+	+	+	+	+	+
<i>Gompholobium marginatum</i> R. Br.	JA496								+
<i>Gompholobium polymorphum</i> R. Br.	EAG								+
<i>Gompholobium preissii</i> Meisn.	GK								+
<i>Gompholobium scabrum</i> Smith	AB4224					+			
<i>Gompholobium tomentosum</i> Labill.	JA370					+			
<i>Hovea stricta</i> Benth.	JA328	+							
<i>Hovea trisperma</i> Benth.	JA309	+		+			+	+	
<i>Isotropis cuneifolia</i> (Smith) Benth.	AB4275					+			
<i>Jacksonia decumbens</i> E. Pritzel	EAG								+
<i>Jacksonia densiflora</i> Benth.	JA406			+					
<i>Jacksonia stembergiana</i> Huegel.	JA272,344	+	+		+				
<i>Jacksonia ulicina</i> Meisn.	JA								+
<i>Jacksonia restioides</i> Meisn.	EAG								+
<i>Jacksonia</i> sp.	AB							+	
<i>Kennedia prostrata</i> R. Br.	JA152,323					+		+	
<i>Mirbelia dilatata</i> R. Br.	GK								+
<i>Mirbelia</i> aff. <i>microphylla</i> (Turcz.) Benth.	AB4223	+	+						
<i>Mirbelia trichocalyx</i> Domin.	JA221, 283	+							
<i>Nemcia capitatum</i> (Benth.) M.D. Crisp	GK, JA780	+		+	+				+
<i>Nemcia parviflorum</i> (Benth.) M.D. Crisp	GK								+
<i>Nemcia reticulatum</i> (Meisn.) M.D. Crisp	JA295,301,311	+		+	+	+			+
<i>Sphaerolobium macranthum</i> Meisn.	GK10511							+	
<i>Sphaerolobium medium</i> R. Br.	AB4272, 4276	+						+	
<i>Sphaerolobium</i> ? <i>vimineum</i> Smith	SH5807								+
<i>Templetonia biloba</i> (Benth.) Polh.	GK								+
* <i>Trifolium angustifolium</i> L.	GK11069								+
* <i>Trifolium campestre</i> Schreber	GK							+	
* <i>Trifolium cernuum</i> Brot.	GK10295								+
* <i>Trifolium dubium</i> Sibth.	GK11090								+
<i>Viminaria juncea</i> (Schrader & Wendl.) Hoffsgg.	JA								+
GERANIACEAE									
* <i>Erodium cicutarium</i> (L.) L'Her.	GK10291								+
<i>Erodium cygnorum</i> Nees	GK								+
<i>Pelargonium littorale</i> Huegel	GK11093					+			
OXALIDACEAE									
<i>Oxalis perennans</i> Haw.	RR								+
RUTACEAE									
<i>Boronia molloyae</i> J. Drumm.	JA164							+	+
<i>Boronia purdieana</i> Diels	BM								+
<i>Boronia ramosa</i> (Lindl.) Benth.	JA287,164	+						+	
subsp. <i>anethifolia</i> (Bartling) Paul G. Wilson									
<i>Boronia scabra</i> Lindl.	EAG								+
<i>Eriostemon spicatus</i> A. Rich.	JA305,AB4271	+		+	+	+	+	+	+

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.	
		1	2	3	4	5	6	7		
TREMANDRACEAE										
<i>Tetralochea aff. hirsuta</i> Lindl.	JA153								+	
POLYGALACEAE										
<i>Comesperma acerosum</i> Steetz.	EAG									+
<i>Comesperma ciliatum</i> Steetz	JA,AB4212					+				
<i>Comesperma flavum</i> DC.	GK									+
<i>Comesperma virgatum</i> Labill.	GK,SH5816									+
EUPHORBIACEAE										
<i>Monotaxis grandiflora</i> Endl.	GK									+
<i>Phyllanthus calycinus</i> Labill.	JA245					+				
STACKHOUSIACEAE										
<i>Stackhousia pubescens</i> A. Rich.	JA223, 708	+	+			+			+	
<i>Tripterococcus brunonis</i> Endl.	GK									+
SAPINDACEAE										
<i>Diplopellis huegelii</i> Endl.	AB									+
RHAMNACEAE										
<i>Cryptandra glabriflora</i> Benth.	JA,GK10035									+
<i>Cryptandra pungens</i> Steud.	JA168,281			+						
<i>Cryptandra scoparia</i> Reissek	GK10042									+
<i>Stenanthemum humilis</i> Benth.	GK									+
<i>Stenanthemum tridentatum</i> Steud.	EAG									+
<i>Trymalium angustifolium</i> Reissek	GK10290		+	+				+	+	+
<i>Trymalium ledifolium</i> Fenzl	GK									+
STERCULIACEAE										
<i>Guichenotia sarotes</i> Benth.	SH									+
<i>Thomasia foliosa</i> Gay	JA765									+
<i>Thomasia glutinosa</i> Lindl.	JA,SH									+
DILLENIACEAE										
<i>Hibbertia acerosa</i> (R. Br. ex DC.) Benth.	JA709,AB4266				+	+			+	+
<i>Hibbertia aurea</i> Steud.	JA331									+
<i>Hibbertia crassifolia</i> (Turcz.) Benth.	JA264							+		
<i>Hibbertia desmophylla</i> (Benth.) F. Muell.	EAG									+
<i>Hibbertia cf. glaberrima</i> F. Muell.	JA	+								
<i>Hibbertia glomerata</i> Benth.	EAG									+
<i>Hibbertia aff. helianthemoides</i> (Turcz.) F. Muell.	JA497								+	
<i>Hibbertia huegelii</i> (Endl.) F. Muell.	JA227,290,302,316				+	+				
<i>Hibbertia hypericoides</i> (DC.) Benth.	JA289,263,326	+	+	+	+	+	+	+	+	
<i>Hibbertia cf. rhadinopoda</i> F. Muell.	AB4219	+		+	+		+	+	+	
<i>Hibbertia subvaginata</i> (Steudel) F. Muell.	JA306,317				+	+				
<i>Hibbertia stellaris</i> Endl.	EAG									+
<i>Hibbertia vaginata</i> (Benth.) F. Muell.	JA717									+
VIOLACEAE										
<i>Hybanthus calycinus</i> (DC. ex Ging.) F. Muell.	AB,JA									+
THYMELAEACEAE										
<i>Pimelea angustifolia</i> R. Br.	JA,AB4218								+	
<i>Pimelea suaveolens</i> Meisn.	EAG									+
<i>Pimelea sulphurea</i> Meisn.	GK, JA324, 173			+		+		+		
MYRTACEAE										
<i>Agonis linearifolia</i> (DC.) Schauer	JA,SH5806									+
<i>Astartea fascicularis</i> (Labill.) DC.	GK,SH5822									+
<i>Baeckea camphorosmae</i> Endl.	JA296	+				+				+
<i>Baeckea elegans</i> Schau.	EAG									+
<i>Baeckea grandiflora</i> Benth.	EAG									+
<i>Beaulortia squarrosa</i> Schauer	JA748									+
<i>Calothamnus lateralis</i> Lindl.	GK									+
<i>Calothamnus quadrifidus</i> R. Br.	JA175									+
<i>Calothamnus sanguineus</i> Labill.	JA155,276,327	+	+	+		+	+	+		+
<i>Calytrix angulata</i> Lindl.	JA	+								+
<i>Calytrix flavescens</i> A. Cunn.	JA379			+						+
<i>Calytrix fraseri</i> A. Cunn.	JA373			+						+
<i>Calytrix leschenaultii</i> (Schauer) Benth.	JA719									+
<i>Calytrix oldfieldii</i> Benth.	EAG									+
<i>Calytrix strigosa</i> A. Cunn.	EAG									+
<i>Calytrix sylvana</i> Craven	LR101									+
<i>Calytrix variabilis</i> Lindl.	LR426, JA303	+		+	+	+				+
<i>Calytrix</i> sp.	JA171,333,241	+				+		+		+

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Darwinia</i> aff. <i>nieldiana</i> F. Muell.	GK								+
<i>Eremaea asterocarpa</i> Hnatiuk	AB4063						+		+
<i>Eremaea pauciflora</i> (Endl.) Druce	JA509, AB4120			+					+
<i>Eremaea purpurea</i> (Endl.) Benth.	GK						+		+
<i>Eucalyptus calophylla</i> Lindl.	JA	+				+		+	+
<i>Eucalyptus decurva</i> F. Muell.	JA267, MB9391						+		+
<i>Eucalyptus drummondii</i> Benth.	SH								+
<i>Eucalyptus lane-poollei</i> Maiden	JA269		+						+
<i>Eucalyptus marginata</i> Donn ex Smith subsp. <i>marginata</i>	JA					+	+		+
<i>Eucalyptus marginata</i> Donn ex Smith subsp. <i>thalassica</i> Brooker & Hopper	JA							+	+
<i>Eucalyptus marginata</i> x <i>todiana</i>	SH								+
<i>Eucalyptus rudis</i> Endl.	JA, SH								+
<i>Eucalyptus todiana</i> F. Muell.	JA353	+	+	+	+	+	+		+
<i>Eucalyptus wandoo</i> Blokely	JA								+
<i>Homalospermum firmum</i> Schauer	SH5805, JA751								+
<i>Hypocalymma angustifolium</i> Endl.	JA, SH5808								+
<i>Hypocalymma linifolium</i> Turcz	JA162, 234						+	+	
<i>Hypocalymma xanthopetalum</i> F. Muell.	JA307, 367	+		+	+			+	
<i>Kunzea 'glabrescens'</i> Toelken	JA756								+
<i>Kunzea 'glabrescens'</i> Toelken x <i>recurva</i> Schauer	SH5826								+
<i>Kunzea 'litticola'</i> Toelken	GK11092								+
<i>Kunzea recurva</i> Schauer	SH5825								+
<i>Leptospermum erubescens</i> Schauer	AB4038							+	+
<i>Leptospermum spinescens</i> Endl.	JA261, 308	+		+	+	+	+		+
<i>Melaleuca acerosa</i> Schauer	JA744								+
<i>Melaleuca ciliosa</i> Turcz.	EAG								+
<i>Melaleuca preissiana</i> Schauer	SH								+
<i>Melaleuca radula</i> Lindl.	EAG								+
<i>Melaleuca raphiophylla</i> Schauer	GK								+
<i>Melaleuca</i> aff. <i>scabra</i> R. Br.	SH								+
<i>Melaleuca seriata</i> Lindl.	GK								+
<i>Melaleuca trichophylla</i> Lindl.	AB/GK				+				+
<i>Melaleuca</i> aff. <i>urceolaris</i> F. Muell. ex Benth.	JA397, AB4216	+					+	+	+
<i>Pericalymma ellipticum</i> (Endl.) Schauer	GK								+
<i>Pileanthus filifolius</i> Meisn.	GK								+
<i>Regelia ciliata</i> Schauer	JA757								+
<i>Scholtzia involucrata</i> (Endl.) Druce	JA, BM								+
<i>Verticordia acerosa</i> Lindl.	AB4215		+						+
<i>Verticordia blepharophylla</i> A.S. George	EAG								+
<i>Verticordia densiflora</i> Lindl.	BM								+
<i>Verticordia drummondii</i> Schau.	EAG								+
<i>Verticordia nitens</i> (Lindley) Endl.	JA774						+		+
<i>Verticordia nabilis</i> Meisn.	GK, SH, IR500, JA745							+	+
<i>Verticordia paludosa</i> A.S. George	JA399						+		+
<i>Verticordia plumosa</i> (Desf.) Druce	GK								+
<i>Verticordia pennigera</i> Endl.	EAG								+
HALORAGACEAE									
<i>Glischrocaryon aureum</i> (Lindl.) Orch.	GK								+
<i>Gonocarpus pthyoides</i> Nees	JA762, GK								+
APIACEAE									
<i>Eryngium pinnatifidum</i> Bunge	GK								+
<i>Homalosciadium homalocarpum</i> (F. Muell.) H. Eichler	GK							+	+
<i>Hydrocotyle callicarpa</i> Bunge	AB4267								+
<i>Hydrocotyle diantha</i> DC.	GK								+
<i>Hydrocotyle pilifera</i> Turcz.	GK								+
<i>Platysace ramosissima</i> (Benth.) C. Norman	GK11143	+							+
<i>Trachymene ornata</i> (Endl.) Druce	GK								+
<i>Trachymene pilosa</i> Smith	JA, AB4118	+	+					+	+
<i>Xanthosia ciliata</i> Hook.	GK10286								+
<i>Xanthosia huegelii</i> (Benth.) Steud.	JA, AB4214	+	+	+	+	+	+	+	+
EPACRIDACEAE									
<i>Andersonia heterophylla</i> Sond.	JA								+
<i>Andersonia lehmanniana</i> Sond.	JA217, 254, 275	+	+	+	+		+		+
<i>Astroloma</i> ? <i>ciliatum</i> (Lindl.) Druce	JA, SH	+							+
<i>Astroloma glaucescens</i> Sond.	JA165, 170, 386	+	+	+		+		+	+
	GK8041								
<i>Astroloma macrocalyx</i> Sond.	GK								+
<i>Astroloma microdonta</i> F. Muell. ex Benth.	EAG								+

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Astroloma pallidum</i> R. Br.	JA,AB4213		+	+		+		+	
<i>Astroloma stomarrhena</i> Sond.	GK10050	+		+	+		+		
<i>Astroloma xerophyllum</i> (DC.) Sond.	GK								+
<i>Astroloma</i> sp. (red flower, hairy leaves)	GK						+		
<i>Conostephium minus</i> Lindl.	GK10256								+
<i>Conostephium pendulum</i> Benth.	JA377,256	+		+	+	+	+	+	
<i>Conostephium preissii</i> Sond.	GK8045				+			+	+
<i>Leucopogon allittii</i> F. Muell.	JA348	+		+					
<i>Leucopogon australis</i> R. Br.	SH5813, JA761								+
	AB4119								
<i>Leucopogon conostephioides</i> DC.	GK10047				+				+
<i>Leucopogon gracillimus</i> DC.	JA243,772					+			
<i>Leucopogon leptanthus</i> Benth.	EAG								+
<i>Leucopogon nutans</i> E. Pritzel	GK10041								+
<i>Leucopogon oldfieldii</i> Benth.	JA150,184	+	+		+	+	+	+	
	228,274,396								
<i>Leucopogon oliganthus</i> E. Pritzel	GK10034								+
<i>Leucopogon oxycedrus</i> Sond.	EAG								+
<i>Leucopogon</i> aff. <i>pendulus</i> R. Br.	JA								+
<i>Leucopogon polymorphus</i> Sond.	JA		+	+	+				
<i>Leucopogon propinquus</i> R. Br.	EAG								+
<i>Leucopogon racemulosus</i> DC.	EAG								+
<i>Leucopogon sprengelioides</i> Sond.	GK10032,10033				+	+	+	+	+
	JA396								
<i>Leucopogon</i> sp.	JA288	+							
<i>Lysinema ciliatum</i> R. Br.	JA252,356	+		+	+		+		
<i>Lysinema elegans</i> Sond.	EAG								+
<i>Styphelia tenuiflora</i> Lindl.	GK10039			+	+		+		+
PRIMULACEAE									
* <i>Anagallis arvensis</i> L. var. <i>caerulea</i> Gouan	JA,AB								+
LOGANIACEAE									
<i>Logania serpyllifolia</i> R. Br.	GK11047						+		
<i>Mitrasacme paradoxa</i> R. Br.	AB			+	+				
CHLOANTHACEAE									
<i>Pityrodia barlingii</i> (Lehm.) Benth.	JA							+	
LAMIACEAE									
<i>Hemiandra pungens</i> R. Br.	GK								+
SOLANACEAE									
* <i>Solanum nigrum</i> L.	JA,AB								+
OROBANCHACEAE									
* <i>Orobanche minor</i> Smith	JA,GK								+
LENTIBULARIACEAE									
<i>Polypompholyx multifida</i> (R. Br.) F. Muell.	AB4058, JA								+
<i>Polypompholyx tenella</i> (R. Br.) Lehm.	AB4059								+
<i>Utricularia violacea</i> R. Br.	GK								+
<i>Utricularia volubilis</i> R. Br.	GK								+
RUBIACEAE									
* <i>Galium divaricalum</i> Pourret ex. Lam.	GK11645						+		+
<i>Opercularia vaginata</i> Labill.	EAG								+
CAMPANULACEAE									
* <i>Wahlenbergia capensis</i> (L.) A. DC.	JA								+
<i>Wahlenbergia preissii</i> Vriese	GK								+
LOBELIACEAE									
<i>Isoloma hypocrateriformis</i> (R. Br.) Druce	GK								+
<i>Lobelia rhombifolia</i> Vriese	GK11046								+
<i>Lobelia tenuior</i> R. Br.	GK						+		+
GOODENIACEAE									
<i>Dampiera alata</i> Lindl.	GK10236								+
<i>Dampiera carinata</i> Benth.	EAG								+
<i>Dampiera linearis</i> R. Br.	GK								+
<i>Dampiera oligophylla</i> Benth.	GK11096						+		+
<i>Goodenia caerulea</i> R. Br.	EAG								+
<i>Goodenia convexa</i> Carolin	GK11897								+
<i>Goodenia micrantha</i> Hemsley ex Carolin	GK								+
<i>Goodenia mooreana</i> Krause	GK						+		

Appendix 4 (continued)

NAME	COLLECTION NUMBER	SITE							OPP. COLL.
		1	2	3	4	5	6	7	
<i>Goodenia pulchella</i> Benth.	GK11575								+
<i>Lechenaultia biloba</i> Lindl.	JA286,779	+				+	+	+	
<i>Lechenaultia floribunda</i> Benth.	EAG								+
<i>Lechenaultia stenosepala</i> E. Pritzel	GK11967								+
<i>Scaevola calliptera</i> Benth.	AB		+		+	+			
<i>Scaevola canescens</i> Benth.	GKJA335,364		+	+	+			+	
<i>Scaevola glandulifera</i> DC	GK11969								+
<i>Scaevola repens</i> Vriese var. <i>repens</i>	JA350	+							
<i>Scaevola striata</i> R. Br.	JA21								+
<i>Verrauxia reinwardtii</i> (Vriese) Carolin	GK								+
STYLIDIACEAE									
<i>Levenhookia dubia</i> Sond.	EAG								+
<i>Levenhookia pauciflora</i> Benth.	AB4051						+		
<i>Levenhookia pusilla</i> R. Br.	AB4124								+
<i>Levenhookia</i> sp.	AB4125								+
<i>Stylidium adpressum</i> Benth.	AB4046,4123			+	+				+
<i>Stylidium albo-lilacinum</i> (Erickson & Willis) lowrie & Carlquist	AB4064					+	+		
<i>Stylidium breviscapum</i> R. Br.	JA405	+	+	+			+		
<i>Stylidium brunonianam</i> Benth.	AB4033,JA156	+	+	+	+		+	+	
<i>Stylidium bulbiferum</i> Benth.	JA								+
<i>Stylidium calcaratum</i> R. Br.	AB								+
<i>Stylidium carlquistii</i> lowrie	AB4126,4037		+			+			
	JA248,279								
<i>Stylidium ? dichotomum</i> DC.	ABJA359,366	+	+	+			+	+	+
<i>Stylidium diuroides</i> Lindl.	AB4045,4121								+
<i>Stylidium cf. diuroides</i> Lindl.	AB4052						+		
<i>Stylidium junceum</i> R. Br.	AB4029								+
<i>Stylidium leptocalyx</i> Sond.	AB4032								+
<i>Stylidium leptophyllum</i> DC.	EAG								+
<i>Stylidium miniatum</i> Mildbr.	AB4042,4044		+	+	+		+	+	
<i>Stylidium piliferum</i> R. Br.	EAG								+
<i>Stylidium pycnostachyum</i> Lindl.	EAG								+
<i>Stylidium repens</i> R. Br.	JA726	+		+	+		+		
<i>Stylidium</i> aff. <i>rhynocharpum</i> Sond.	AB4228								+
<i>Stylidium schoenoides</i> DC.	AB4050	+							
ASTERACEAE									
* <i>Arctotheca calendula</i> (L.) Levyns	JA								+
<i>Asteridea pulverulenta</i> Lindl.	GK								+
<i>Blennospora drummondii</i> A. Gray	JA734								+
<i>Brachycome iberidifolia</i> Benth.	JA730,AB4048						+		+
<i>Catula coronopifolia</i> L.	AB4122								+
<i>Gnephosis pusilla</i> (Benth.) Endl.	GK								+
<i>Gnephosis tenuissima</i> Cass.	JA735								+
<i>Gnephosis trifida</i> (Short) Short	EAG								+
<i>Helipterum manglesii</i> (Lindley) F. Muell ex Benth.	AB4034								+
<i>Hyalosperma catula</i> (Benth.) Paul G. Wilson	AB4030,4035							+	
	JA710								
* <i>Hypochaeris glabra</i> L.	JA804,737								+
<i>Lagenifera huegelii</i> Benth.	AB4057,SH5819					+		+	+
	JA711								
<i>Millotia myosotidifolia</i> (Benth.) Steetz.	AB4043					+		+	
<i>Millotia tenuifolia</i> Cass.	JA733								+
<i>Olearia elaeophila</i> (DC.) F. Muell. ex Benth.	GK								+
<i>Olearia paucidentata</i> (Steetz) F. Muell.	JA								+
<i>Olearia rudis</i> (Benth.) F. Muell. ex Benth.	JA330,402								+
<i>Pithocarpa achilleoides</i> P. Lewis & Summerh.	JA343,507	+					+		+
<i>Podolepis gracilis</i> (Lehm.) R.A. Graham	AB4066					+			
<i>Podotrochea angustifolia</i> (Labill.) Less.	JA722	+							
<i>Podotrochea chrysantha</i> (Steetz) Benth.	GK11067,10454								+
<i>Podotrochea gnaphalioides</i> R.A. Graham	JA736,AB4036	+	+		+				
<i>Pseudognaphalium luteo-album</i> (L.) Hilliard & B.L. Burt	GK								+
<i>Pterochaeta paniculata</i> Steetz.	JA393,732,AB4061		+			+	+	+	
<i>Quinetia urvillei</i> Cass.	JA731,GK								+
<i>Senecio hispidulus</i> A. Rich.	GK								+
<i>Siloxerus humifusus</i> Labill.	EAG								+
* <i>Sonchus asper</i> Hill	JA760								+
* <i>Tolpis barbata</i> (L.) Gaertner	GK10268								+
* <i>Ursinia anthemoides</i> (L.) Poiret	JA713,723								+
	AB4031								
<i>Waitzia citrina</i> (Benth.) Steetz	AB4217							+	
<i>Waitzia suaevolens</i> (Benth.) Druce	JA721	+							

APPENDIX 5

Notes on individual mammal species recorded on Boonanarring Nature Reserve.

Small mammals, other native ground mammals, bats and introduced mammals are discussed separately. Within each grouping taxonomic ordering and nomenclature follows Strahan (1995).

Small Mammals

Three native and one introduced small mammal species were trapped. Appendix 6 lists the total numbers of individuals of each species captured from individual traplines at each sample site.

Sminthopsis griseoventer Grey-bellied Dunnart

This species was captured only at Sites 1 and 2, at the base of the Gingin Scarp.

No animals were reproductively active. One adult female (13.5 g) had a stained pouch and slightly distended teats suggesting she had reared pouch young some time prior to capture. The other female (9.5 g) appeared to be a sub-adult with an undeveloped pouch and minute teats.

Males ranged in weight from 9.5 to 11.5 g. An examination of the skulls extracted from 4 specimens (listed in Appendix 3) confirmed that these were all sub-adults.

Tarsipes rostratus Honey Possum

Honey possums were captured only on sandy substrates in the study area, at Sites 1 and 2 (Low Heath) and at Sites 3 and 4 (*Banksia* woodland) (Table 7).

Six females (with a mean body weight of 11.3 g) had pouch young. Another two (7.5 g) each had distended teats and relaxed pouches indicative of having recently carried pouch young. Eight females (ranging in weight from 6.0 to 9.7 g) showed no pouch development. We assume these to include non-parous sub-adults and possibly animals in early stages of pregnancy.

Each female carrying young had at least 2 pouch young. When a pouch was checked for the presence of young, only those young which were visible after stretching the pouch open were counted. Young were not removed from the pouch because it has been found previously that they are difficult to replace and this procedure is time-costly when trap success is high. It has also been observed from holding females for short periods after capture, that on occasions when young have been removed, counted and replaced, they were found outside the pouch again shortly afterwards. It seems likely that this would cause increased mortality of pouch young if females were released immediately in the field.

All pouch young were hairless and ranged in size from 0.4 cm to approximately 1.5 cm (crown-rump measurement).

Males ranged in weight from 5.3 to 7.0 g. Scrotal length measurements suggested at least eight were adults (sexually mature) (see Renfree *et al.* 1984; Burbidge and Boscacci 1989).

Pseudomys albocinereus Ash-grey Mouse

Pseudomys albocinereus was widespread on the reserve, with captures at all sites except Site 7 (Table 7). It was the only native species captured at Site 6 (Dense Heath on shallow sands over laterite).

The species was trapped in both Elliott and pitfall traps (Table 7) but insufficient numbers were captured to allow statistical comparisons between sites. However, pooling of pitfall captures from replicate sites 1 and 2 (9 captures) and Sites 3 and 4 (8 captures) showed there was negligible difference in trap returns from Dense Low Heath on sand and *Banksia* woodland. The species was present but apparently uncommon in jarrah (with marri) forest over Low Heath on laterite (Site 5).

The thirteen females captured (Appendix 6) ranged in weight from 15.5 to 28.0 g. A proportion (7 of the 13) were classed as sub-adults, with a weight range of 15.5 to 19.5 g. Six were in a heavier weight range (22.0 to 28.0 g). None were lactating, palpably pregnant or had enlarged teats. These were classed as non-breeding adults, although females in early stages of pregnancy may also have been present (e.g. at Cockleshell Gully Reserve, Chapman *et al.* 1977 recorded pregnant females ranging in weight from 20.0 to 44.6 g). However, we did not collect specimens and cannot confirm this.

The ten males captured (Appendix 6) ranged in weight from 16.5 to 32.0 g. Only one (32.0 g) showed breeding condition (descended testes and epididymes). The remainder were classed as sub-adults (5, ranging in weight from 16.5 to 20.0 g) and non-breeding adults (4, ranging in weight from 22.0 to 26.5 g).

Mus musculus House Mouse

This species was widespread in the study area, being detected at all sites except Site 7 (Table 7).

Only four individuals were captured at Sites 1 to 4 (deep sands) compared with 10 from Sites 5 and 6 (shallow soils on laterite, with laterite outcropping in places). However, this difference may in part reflect a different response to the two trap types used - pitfall traps (at Sites 1 to 4) and Elliott traps (at Sites 5 and 6). For example, significantly higher trap returns of *Mus musculus* from Elliott traps were recorded in a vertebrate survey of the Great Sandy Desert in which some simultaneous Elliott and pit trapping was undertaken in similar habitats (McKenzie and Youngson 1983).

Five females were captured (Appendix 6) and ranged in weight from 8.5 to 14.5 g. Internal examination of two specimens showed that one (11.7 g) was pregnant and one was non-parous. One juvenile was captured.

The nine males captured (Appendix 6) ranged in weight from 8.0 to 17.5 g. Five showed breeding condition (descended testes).

Other Ground Mammals

Tachyglossus aculeatus Short-beaked Echidna

Fresh diggings were found at Sites 3 and 4 (*Banksia* woodland) in August. Diggings were also found in a stand of *Eucalyptus lane-poolei* in the north-western corner of the reserve in July (M.J. Bamford, personal communication 1986).

Appendix 5 (continued)

Macropus fuliginosus

Western Grey Kangaroo

Grey Kangaroos were widespread throughout the reserve. Sightings were made on Sites 3 and 4 (*Banksia* woodland) and fresh scats were seen at all sites. In addition, 18 sightings (comprising 31 individual kangaroos) were recorded opportunistically in February and during the assemblage survey in March. The largest group seen was three. Most sightings were of one or two individuals. Sightings were recorded in four broad vegetation types: *Banksia* woodland over low heath on deep sands, jarrah/marri forest on lateritic sands in gullies between lateritic ridges, jarrah/marri forest on lateritic ridges, and in low heath (with scattered *Banksia* spp.) on deep sands. Sightings were made in both recently burnt (March 1985) and unburnt portions of the study area.

Macropus irma

Western Brush Wallaby

Brush Wallabies were sighted on the reserve on five separate occasions during February and March. All sightings were of individual animals. Individuals were observed on Sites 1 (Low Dense Heath) and 4 (*Banksia* woodland). Opportunistic sightings were from the following vegetation types: open jarrah forest with an understorey of low open heath, open jarrah (with marri) forest with an understorey of low heath which had been burnt in March 1985, and jarrah/marri forest with a tall dense understorey of *Dryandra sessilis* on laterite.

In addition to these records, two were sighted on land adjoining the south-western boundary, in dense vegetation along Boonanarring Brook.

Bats

Nyctinomus australis

White-striped Freetail-bat

The characteristic vocalizations of this species were heard near Site 5 and near the Gingin townsite in March.

Nyctophilus geoffroyi

Lesser Long-eared Bat

Three males (6.0, 6.0 and 6.5 g) were mist-netted in March. One had scrotal testes. They were captured at two localities south of Site 5. One of these capture sites is described below for *N. gouldi*, where the two species were taken from the same net. The other site was in *Melaleuca preissii* and marri woodland fringing Boonanarring Brook, approximately 4.5 km south-east of Site 5.

Nyctophilus gouldi

Gould's Long-eared Bat

One, a male (8.0 g) with scrotal testes, was captured in a mist-net 2 km south of Site 5. Vegetation comprised open jarrah/marri forest with a tall dense understorey of *Dryandra sessilis* on a lateritic ridge.

Chalinolobus gouldii

Gould's Wattled Bat

One female was flushed from the upper trunk of a large burnt marri (8-12 m) in February, approximately 300 m north of Boonanarring Brook. The bat was recovered from where it landed on the ground. Surrounding vegetation comprised low Heath (burnt in March 1985) with scattered marri trees.

Vespadelus regulus

Southern Forest Bat

Three individuals (two males and one female) were mist-netted in March. The males weighed 5.0 g each. One had scrotal testes. The female, also 5.0 g, was not lactating. Captures came from Site 5 and from 2 km south of Site 5. Vegetation at the latter site comprised open jarrah/marri forest with a tall dense understorey of *Dryandra sessilis* on laterite.

Introduced Mammals

Vulpes vulpes

Fox

One was spotlighted in a cleared paddock adjacent to the southern boundary of the reserve.

Felis catus

Cat

One was spotlighted in the north-eastern section of the reserve. The vegetation comprised *Banksia* woodland with a tall dense heath understorey, dominated by *Adenanthos cygnorum*. Fresh cat tracks were also seen on the vehicle track between Sites 4 and 5.

Oryctolagus cuniculus

Rabbit

Two were seen in August on the north-western corner of the reserve, approximately 200 m inside the northern boundary. Rabbits were also seen on farm paddocks on the northern side of the reserve and nearby in dense roadside vegetation.

APPENDIX 6

Total captures of small mammals at each sample site on the Boonanarring Nature Reserve, 17-23 March 1986.

SPECIES	SEX	SITE																					TOTAL No. OF INDIV.		
		1			2			3			4			5			6			7					
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
<i>Sminthopsis griseoventer</i>	F	2																					7		
	M	2		1	2																				
<i>Tarsipes rostratus</i>	F	5	2	1	1	1	2																	30	
	M	2	2		5	1	2	2																	
<i>Pseudomys albocinerus</i>	F	3		2	1		1		1	2														23	
	M		1	1		1		1	1	2															
<i>Mus musculus</i>	F																							14	
	M	1																							
No. pit trap nights		30	15	15	30	15	15	30	15	15	30	15	15	15	15	15	50	50	50	50	50	50			
No. Elliott trap nights																									

F = females, M = males
A, B and C refer to individual traplines

APPENDIX 7

Comparative list of frogs and reptiles recorded in *Banksia* woodland near Mooliabeenee (Bamford 1985) and on Boonanarring Nature Reserve.

* = record from unpublished VWA Museum records.

FAMILY	SPECIES	MOOLIABEENE	BOONANARRING
Hylidae	<i>Litoria adelaidensis</i>	X	X
Leptodactylidae	<i>Crinia georgiana</i>	X	
	<i>Heleioporus eyrei</i>	X	X
	<i>Limnodynastes dorsalis</i>	X	X
	<i>Myobatrachus gouldii</i>	X	X
	<i>Pseudophryne guentheri</i>	X	
	<i>Ranidella glauerti</i>	X	X
	<i>Ranidella insignifera</i>	X	
Gekkonidae	<i>Crenadactylus ocellatus</i>	X	
	<i>Diplodactylus polyophthalmus</i>	X	
	<i>Diplodactylus spinigerus</i>	X	
Pygopodidae	<i>Aprasia repens</i>	X	X
	<i>Delma fraseri</i>	X	X
	<i>Delma grayii</i>	X	
	<i>Lialis burtonis</i>	X	X
	<i>Pletholax gracilis gracilis</i>	X	X
	<i>Pygopus lepidopodus</i>	X	X
Scincidae	<i>Cryptoblepharus plagiocephalus</i>	X	X
	<i>Ctenotus fallens</i>	X	X
	* <i>Ctenotus impar</i>	X	
	<i>Ctenotus lesueurii</i>	X	
	<i>Ctenotus schomburgkii</i>	X	
	<i>Egernia multiscutata bos</i>	X	
	<i>Lerista christinae</i>	X	
	<i>Lerista distinguenda</i>		X
	<i>Lerista elegans</i>		
	<i>Lerista praepedita</i>	X	X
	<i>Menetia greyii</i>		
	<i>Morethia lineocellata</i>	X	
	<i>Morethia obscura</i>	X	X
	<i>Tiliqua rugosa</i>	X	X
Agamidae	<i>Pogona minor minor</i>	X	X
	<i>Tympanacryptis adelaidensis</i>	X	X
Varanidae	<i>Varanus gouldii</i>		X
	<i>Varanus tristis</i>		X
Typhlopidae	<i>Ramphotyphlops australis</i>	X	
Boidae	<i>Morelia spilota imbricata</i>		X
Elapidae	<i>Demansia psammophis reticulata</i>	X	
	<i>Notechis curtus</i>	X	X
	<i>Pseudonaja affinis</i>		X
	<i>Pseudonaja nuchalis</i>	X	
	<i>Rhinoplocephalus gouldii</i>	X	
	<i>Vermicella bertholdii</i>	X	
	<i>Vermicella bimaculata</i>		X
	<i>Vermicella calonotus</i>	X	X
	<i>Vermicella semifasciata</i>	X	X

APPENDIX 8

Additional frog and reptile species recorded from localities within a 25 km radius of Gingin that were not detected on Boonanarring Nature Reserve. Collecting localities were: Gingin, 7 km north of Gingin, Bindoon, Red Hill and Wannamal (unpublished WA Museum records to August 1986).

SPECIES	COLLECTION DATE	No. OF SPECIMENS
<i>Litoria moorei</i>	(no date)	1
<i>Neobatrachus pelobatooides</i>	1954	1
<i>Diplodactylus pulcher</i>	(no date)	1
<i>Gehyra variegata</i>	1963	1
<i>Oedura reticulata</i>	1960	1
<i>Phyllurus millii</i>	1955	4
<i>Egernia kingii</i>	(no date)	1
<i>Leiopisma trilineatum</i>	1959	2
<i>Ramphotyphlops pinguis</i>	1970	2
<i>Notechis scutatus</i>	1965, 1971	2
<i>Rhinoplocephalus nigriceps</i>	(no date)	1