IV Vertebrate Fauna

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Background

The philosophies underlying our approach to this vertebrate survey, the sampling strategy adopted, and the actual methods we employed are described in Biological Surveys Committee of Western Australia (1984).

Appendix I cross-references the vertebrate and vegetation quadrat codes, and provides the location, vegetation, floristics and substrate of each vertebrate quadrat sampled in the Kurnalpi-Kalgoorlie (KK) Study Area.

Specimens representing the array of mammal and reptile species encountered in the Study Area during our study have been lodged in the Western Australian Museum with the following register numbers: R70122-70135, 70170, 70879-70912, 73201-73225, 73241-73328, 78483-78544, 78609. M20324-20390, 20393, 20397; M20403, 20436, 20437, 20441-20445, 20455, 20456, 20459, 20460, 20470, 20472, 20473; M20501-20503, 20507, 20508, 20510, 20512-20539, 20544-20551, 20558, 20561-20565, 20580-20584; M20683, 20688; M20847-20851, 20855, 20863, 20868-20873, 20875-20882, 20887-20895; M20929. Species nomenclature in this report follows that of the Western Australian Museum.

Tables 1 and 2 list surficial stratigraphy and associated "vegetation types" known from the Kurnalpi-Kalgoorlie Study Area, and indicate those that were sampled for vertebrates. The main vegetation types on several landforms were surveyed for vertebrate fauna (Granite Exposures, Salt Lake Features, Sandplains and Broad Valleys). Breakaways and Hills were not surveyed although one quadrat was transitional to these landforms, being a relatively steep-sided, flat topped feature on Undulating Plains. Dunefields were inadequately surveyed although this landform covers only a small part of the Study Area and one quadrat was located on sandy soil immediately adjacent to a dune. The most widespread types of vegetation on the heterogeneous landform Undulating Plains were not adequately surveyed. Northern Broad Valleys were not surveyed for fauna but these are adequately covered in the adjacent Edjudina-Menzies Study Area (see Dell & How 1988). Five of the nine landforms and 10 of the 45 vegetation types present in the Study Area were surveyed intensively for vertebrate fauna, while the faunal survey team spent time opportunistically in a further 3 vegetation types in two landforms. Several of the remaining vegetation types occupy small areas and were rarely encountered during field work by either the botanical or faunal workers.

Table 2 shows how poorly the vertebrate sampling addressed the environmental heterogeneity of the Study Area; less than half of the stratigraphic surface-types were sampled. Even so, we encountered a surprisingly high percentage of its vertebrates (Table 3), especially since much of the floristic diversity of these surface-types was remote from our quadrats (see Figures 2 and 3).

This coverage was achieved because most vertebrates occur on more than one surface-type. For instance, Table 2 in McKenzie (1984) showed that the "average" passerine bird occurred in a mean of 3.8 (S.D. = 2.6, n = 42) of the nine distinct

Table 2 Distribution of vegetation types by landforms and adequacy of vertebrate sampling in the Kurnalpi-Kalgoorlie Study Area.

Three attributes are coded for each vegetation type:

a Extent within the Study Area (0 = absent, 1 = rare, 2 = scattered, 3 = frequent, 4 = common)
b General size of patches (0 = absent, 1 = <1 ha, 2 = 1-5 ha, 3 = 6-50 ha, 4 = 75 ha)
c Representation in vertebrate survey sites (- = absent, X = present)

Vegetation types (by landforms)	Attributes a	b	c	Vegetation Sites (Appendix I)
BREAKAWAYS (B)				
Breakaways Complex	2	1	-	-
Acacia aneura Tall Shrubland	2	1	-	-
DRAINAGE LINES (C) DOES NOT OCCUR				
DUNEFIELDS (D)				
Acacia aneura Low Woodland	2	1	-	-
Casuarina cristata Low Woodland	2	1	-	-
Callitris columelaris Low Woodland	2	1	-	-
GRANITE EXPOSURES (G)				
Eucalyptus spp. Mallee	2	1	-	-
Eucalyptus spp. Mallee over *Triodia scariosa* Hummock Grass	2	1	-	-
Acacia spp. Tall Shrubland	3	1	X	KK53
Acacia spp. Tall Shrubland over *Atriplex* spp. Low Shrubland	1	1	-	KK64
Granite Exposures Complex	3	1	-	-
HILLS (H)				
Casuarina cristata-Acacia aneura Low Woodland	3	3	-	KK71
Acacia acuminata Tall Shrubland	2	3	-	-
Acacia quadrimarginea Tall Shrubland	2	2	-	-
SALT LAKE FEATURES (L)				
Casuarina cristata Low Woodland	2	4	X	KK4
Eucalyptus lesouefii-Eucalyptus clelandii Low wodland	2	2	-	KK14
Eucalyptus oleosa Mallee over *Triodia scariosa* Hummock Grass	2	2	X	KK12
Halosarcia spp. Low Shrubland	4	2	X	KK5,KK67
Cratystylis subspinescens Low Shrubland	1	2	X	KK6
Atriplex spp. Low Shrubland	2	3	-	KK70
CALCAREOUS PLAINS (P)				
Eucalyptus salmonophloia Woodland over *Maireana sedifolia* Low Shrubland	1	2	-	KK76
Eucalyptus longicornis-Eucalyptus salmonophloia Woodland	1	2	-	-
Eucalyptus lesouefii-Casuarina cristata Low Woodland	1	2	-	-
Eucalyptus longicornis Low Woodland	1	2	-	-
Eucalyptus salubris Low Woodland	1	2	-	-

Table 2 (cont).

Vegetation types (by landforms)	Attributes a	b	c	Vegetation Sites (Appendix I)
SANDPLAINS (S)				
Eucalyptus transcontinentalis Low Woodland	2	2	X	KK57
Eucalyptus oldfieldii Mallee over *Triodia scariosa* Hummock Grass	2	2	X	KK52
Eucalyptus leptopoda-Acacia spp. Tall Shrubland	3	3	X	KK54,KK55
Allocasuarina spp. Tall Shrubland	2	2	-	-
UNDULATING PLAINS (U)				
Eucalyptus salmonophloia Woodland over *Maireana sedifolia* Low Shrubland	2	2	-	-
Eucalyptus salubris Low Woodland over *Atriplex* spp. Low Shrubland	1	1	-	KK7
Eucalyptus oleosa-Casuarina cristata Low Woodland	4	3	X	KK9
Eucalyptus clelandii-Eucalyptus lesouefii Low Woodland	2	2	X	KK11
Casuarina cristata-Acacia aneura Low Woodland	3	3	-	KK66
Eucalyptus lesouefii-Casuarina cristata Low Woodland over *Maireana sedifolia* Low Shrubland	2	2	-	KK74
Eucalyptus torquata-Eucaluptus lesouefii Low Woodland	1	2	-	-
Acacia spp. Tall Shrubland	1	1	-	KK68
Acacia aneura-Acacia brachystrachya Tall Shrubland	1	2	-	-
Maireana pyramidata Low Shrubland	1	1	-	-
BROAD VALLEYS (V)				
Eucalyptus salmonophloia Woodland over *Maireana sedifolia* Low Shrubland	2	2	X	KK1
Eucalyptus longicornis Woodland	2	2	-	-
Eucalyptus salubris Low Woodland	2	3	X	KK2
Eucalyptus concinna-Eucalyptus oleosa Low Woodland	2	3	X	KK51
Eucalyptus oleosa-Casuarina cristata Low Woodland	2	3	X	KK56
Acacia aneura Low Woodland	3	3	-	KK58
Eucalyptus transcontinentalis-Eucalyptus flocktoniae Low Woodland	1	2	-	-

stratigraphic surface-types sampled, an "average" reptile in 2.9 (1.6, 41) and an "average" small ground mammal in 5.4 (2.5, 8).

Accumulation curves of species recorded versus days of sampling, were used to investigate whether further effort at the quadrats sampled would have led to the detection of a significant proportion of additional species. Separate curves were compiled for birds, reptiles and mammals:

1. At the two survey areas (= campsites) in the Study Area (Black Flag and Kurnalpi).
2. At each vertebrate quadrat.
3. For each surface type.

Table 3 Coverage of the known Kurnalpi-Kalgoorlie native vertebrate fauna achieved by the study (modified from McKenzie 1984).

	Number of species		
	Mammals	Birds	Reptiles
Total known from cell[1]	34	161	66
Extant fauna[2]	23	150	66
Extant fauna recorded (%)	87	65(69[3])	68(70[4])

[1] Sources include R.A.O.U. atlas; published distribution maps; records from the Western Australian Museum.

[2] Excludes species that have become extinct or very much rarer since settlement. Sources include museum records and R.A.O.U. historical atlas.

[3] Excludes waterbirds — we didn't sample lakes etc.

[4] Excludes snakes.

These curves were presented and discussed in McKenzie (1984). Although the curves for survey areas are clearly beyond a final deflection point, additional sampling should have been undertaken for birds at three of the ten quadrats (6E-02, 6E-04 and 6W-01), for reptiles at two of the eleven quadrats (6E-01 and 6E-04) and for mammals at two of the eleven quadrats (6E-06 and 6E-03).

The seasonally tiered pattern general to the curves (Fig. 4 in McKenzie 1984) indicates the importance of sampling during several seasons and implies that a session in autumn may have added species. Nevertheless, the levels of sampling were sufficient to show that quadrats on surfaces derived from the same stratigraphy were more similar in their species composition than quadrats on different surfaces (see both Fig. 5 and Table 3 in McKenzie 1984).

Mammals

Twenty species of native mammal were recorded in the Kurnalpi-Kalgoorlie Study Area during the survey (Table 4). These comprised three species of kangaroo, seven small ground-dwelling mammal species (3 dasyurids, 1 pygmy possum and 3 rodents), the Echidna, the Dingo, and eight species of insectivorous bat. Seven species of introduced mammal were also encountered although feral or domestic stock, such as horses and sheep, are not listed in Table 4.

Western Australian Museum records include 16 indigenous and four introduced mammals from the Kurnalpi-Kalgoorlie Study Area. Four of them were not recorded during our field work: *Macrotis lagotis* (M1127 Kanowna 1929; M0565 Kalgoorlie 1922; M14370 Kalgoorlie 1973), *Myrmecobius fasciatus* (M0929 Kalgoorlie 1927), *Camelus dromedarius* (M5882) and *Felis catus* (M1068). In addition, *Antechinomys laniger, Sminthopsis hirtipes* and *Nyctophilus major* are almost certainly present. These three species were recorded in surrounding Study Areas during the Goldfields survey, and apparently suitable habitats are widespread in parts of the Study Area.

At least another eight native species might be expected on the basis of their known

distributions (Table 5) as well as sub-fossil records from exposed, superficial sub-fossil deposits (Appendices 12 and 13 in Henry-Hall 1990), although many of these are known to have become extinct or very much rarer throughout mainland Australia since European settlement (see Burbidge & McKenzie 1989). The sub-fossil deposits mentioned above include bones from a further eight mammal species; these are not listed herein.

The extant native mammal fauna of the Kurnalpi-Kalgoorlie Study Area comprises an almost equal proportion of Bassian and Eyrean species. Bassian species include *Macropus fuliginosus, Cercartetus concinnus, Notomys mitchellii, Mormopterus* sp.1 (cf *planiceps*) and *Eptesicus regulus*. Eyrean species recorded include *Macropus rufus, M. robustus, Ningaui ridei, Pseudomys hermannsburgensis, P. bolami* and *Scotorepens balstoni*. This is consistent with the phytogeographic position of the Study Area; as discussed in Keighery *et al.* (this publication), the Study Area straddles the "mulga-eucalypt line" that is usually taken to mark the transition between the Austin Botanical District of the Eremaean Province and the Coolgardie Botanical District of the South-west Province.

In Table 4, the Echidna, fox, goat, rabbit and macropod records were sightings. Bat quadrats were sampled for one evening during each seasonal visit using mist nets and spotlight shooting. These quadrats were almost always on pools, places where bats congregate to drink; no data on bat foraging habitats can be inferred. Bats recorded (Table 4) from "Qpv" surfaces were collected either at Crown Dam (30°35'S 121°13'E), Four-in-Hand-Dam (30°34'S 121°14"E) or Spud Flat Well (30°32'S 122°15'E). Those from "Qqs" were captured at Leaky Dam (30°36'S 121°04'E) or Odour Dam (30°33'S 122°15'E), and bats from "Qqz" were recorded over an ephemeral pool (30°24'S 122°22'E) on the track north from Yowie Rockhole.

Data on small ground mammals collected during the trapping program is summarised in Table 6. The trap-effort values at the top of this table provide a measure of sampling effort because all small ground mammals recorded on quadrats were trapped. Individual accumulation curves for small mammal species at the vertebrate quadrats are presented in McKenzie (1984 Fig. 4C); further sampling at 6E-03 and 6E-06 may have added species even though the latter quadrat was one of the richest for mammals, and the former was no poorer in mammals than a similar quadrat (6E-01).

Quadrats with sandy soil profiles were richest in small ground mammals — 6W-04, 6E-02, 6E-04, 6E-05 and 6E-06 (Table 6). They had a mean of 5.2 ± 0.45 (S.D.) species. The only other quadrat with a sandy profile was 6E-01 (4 species of small ground mammal), but its profile was relatively shallow and loamy; much of the quadrat was underlain by massive sheet kankar at a depth of less than 30 cm (see Appendix I). A subsequent visit revealed that 6E-01 was also adjacent to a previously unsuspected granite (Agb) outcrop, an observation that also explained the consistent clustering of 6E-01 (Qqz_1) with 6E-03 (Agb) rather than its 'pseudo-replicate' 6E-06 (Qqz_2) (see Fig. 5 in McKenzie 1984).

Table 4 List of mammals recorded from the Kurnalpi-Kalgoorlie Study Area indicating number recorded on each surface type, reproductive state and age classes for the three survey periods (October 1979, August 1980 and February 1981).

Landform Code[1]	L	L	V	U	V	V	G	S	S	S	Month		
Stratigraphy[1]	Qra	Qas	Qpv	As	Qqs	Qqz	Agb	Qps	Ts	Tg	Oct	Aug	Feb
TACHYGLOSSIDAE													
Tachyglossus aculeatus						1							1
DASYURIDAE													
*Sminthopsis ?dolichura**		7	+1	**2+2**	1+2	(7)+**1**	1+3	(2)	1	6	4	(15)	**8**
Sminthopsis crassicaudata	(**9**)	**1**	+2	**1**	(**5**)	**2**	1	**1**		**1**	(**13**)	1	**7**
Ningaui ridei						1		(**11**)	**5**	4	4	9	(**8**)
PHALANGERIDAE													
Cercartetus concinnus		(2)		(1)	(**8**)						(**11**)		
MACROPODIDAE													
Macropus fuliginosus		8		6	2	(7)	(1)	2		1	(**8**)	(**16**)	3
Macropus rufus			1	8	15	3					12	12	3
Macropus robustus				2			(4)				2	(**1**)	(**3**)
MOLOSSIDAE													
Tadarida australis			5	1	(**17**)	6			2	3	(13)	12	(**9**)
Mormopterus planiceps (2spp)**			**11**		**8**						**13**		**6**
VESPERTILIONIDAE													
Nyctophilus geoffroyi			1		2	1					2		2
Chalinolobus gouldii			(10)		(**42**)	4					(35)	(10)	**11**
Chalinolobus morio			1		3	(3)					(2)	(3)	2

Table 4 (cont).

Landform Code[1]	L	L	V	U	V	V	G	S	S	S	Month		
Stratigraphy[1]	Qra	Qas	Qpv	As	Qqs	Qqz	Agb	Qps	Ts	Tg	Oct	Aug	Feb
Scotorepens balstoni			2		**(11)**						(7)		**(6)**
Eptesicus regulus			**1**		(5)						**(4)**	1	1
MURIDAE													
Notomys mitchellii						2		**3**	(7)		(3)	5	**4**
Pseudomys hermannsburgensis						2	1	**6**	**2**	2	2	2	**9**
Pseudomys bolami	**(4)**	**(9)**	**2**								(9)	**3**	**3**
Mus musculus	**(4)**	**1**		**4**	**(13)**	**(11)**	**(8)**	**8**	**4**	**(15)**	**(18)**	**7**	**(43)**
CANIDAE													
Canis familiaris dingo	1										1		
Vulpes vulpes				1		1					2		
BOVIDAE													
Capra hircus							2				2		
LEPORIDAE													
Oryctolagus cuniculus	7										7w	7w	

[1] From Table 1.
( ) sample includes post-partum, lactating or pregnant individuals
8 sample includes sub-adults
8 sample includes only adults
+2 indicates two mummified specimens
w rabbit warrens
* Herein *Sminthopsis ?dolichura* may include *S. ooldea*
** Sympatric populations of *Mormopterus* from Kurnalpi-Kalgoorlie Study Area can be consistently separated in two groups on the basis of electrophoretic techniques, morphometrics and penis morphology (author's data in prep.)

Table 5 Additional species predicted in the Kurnalpi-Kalgoorlie Study Area on the basis of early reports from adjacent areas of the Goldfields.

Species	Source
Onychogalea lunata	Clarkson *et al.* (1864 p.336 as "Worrong"), Hunt (1864 p.377), Forrest (1875 p.55).
Lagorchestes hirsutus	Hunt (1864 p.377 as "Worrup").
Bettongia lesueur	Strahan (1983).
Trichosurus vulpecula	Clarkson *et al.* (1864 as "oppossum").
Perameles bougainville (eremiana)	Clarkson *et al.* (1864 as "marla").
Chaeropus ecaudatus	Dempster (1861 p.34).
Dasyurus geoffroyi	Photograph taken 1973 at Lake Lefroy, road kill at Ghooli in 1989*
Phascogale calura	Interpolated from museum records.
Leporillus apicalis	Dempster (1861 pp.32, 34).

* near Yellowdine (K.D. Morris, pers. comm.)

The remaining five vertebrate quadrats in Table 6 were on elluvial surfaces of rocky outcrops or on alluvial soils of plains and valleys (6W-01, 6W-02, 6W-03, 6W-05 and 6E-03). Without exception these quadrats were poorer in species of small ground mammals (3.8 ± 0.45 S.D.) than quadrats on sandy surfaces.

Keighery *et al.* (this publication) pointed out that quadrats on sandy surfaces were relatively poor in plant species, the difference being the species-rich component of ephemeral species found on elluvial and alluvial soils associated with their higher soil nutrient levels. From the viewpoint of small ground mammals, the relative richness, density and persistence of perennial grasses and other low-level strata (such as sub-shrubs) of the sandy surfaces may prove to be more significant. However no significant correlation coefficients were found between mammal and floristic richness at quadrats (even when ephemeral and perennial plants were treated separately), and between mammal richness and number of vegetation strata present (from Appendix I).

Ningaui ridei, Pseudomys hermannsburgensis and *Notomys mitchellii* were almost confined to sandy surfaces high in the landscape. In contrast, *Cercartetus concinnus* and *Pseudomys bolami* were species of surfaces low in the landscape (Table 6).

Sminthopsis crassicaudata was most common on saltlake (Qra) and alluvial plain (Qqs) surfaces low in the landscape, where the only breeding records were obtained. Data in Table 4 suggests that the scarce records of this species from quadrats on most of the other surface-types that we trapped represent a spring/summer dispersal phase of sub-adult *S. crassicaudata* that follows the restricted, springtime breeding season.

Reptiles and Amphibians

Three frogs and 45 reptile species were recorded in the Kurnalpi-Kalgoorlie Study Area during our survey. The reptile species comprised 11 geckos, 3 legless lizards, 8 dragons, 16 skinks, 2 goannas and 5 elapid snakes. These are listed in Table 7 (except for a *Gehyra purpurascens* captured in a habitat that was only opportunistically sampled).

Table 6 Species of small ground mammals recorded in the Kurnalpi-Kalgoorlie Study Area, indicating number trapped at each vertebrate quadrat during each survey period[1]. The three survey periods — Spring (October 1979), Winter (August 1980) and Summer (February 1981) are indicated as columns 1, 2 and 3 respectively for each sample site[2].

Stratigraphy[3]	Qqz(Agb)			Qqz			Qps			Agb			Tg			Ts			Qqs			Qqs			As			Qas			Qra		
Vegetation Quadrat	KK51			KK56			KK52			KK53			KK54			KK55			KK1			KK2			KK11			KK4+12			KK5		
Vertebrate Quadrat	6E-01			6E-06			6E-02			6E-03			6E-04			6E-05			6W-01			6W-02			6W-03			6W-04			6W-05		
Drift-fence Nights	9	10	10	10	10	10	9	10	10	5	5	9	10	10	10	10	10	10	9	10	10	9	5	5	10	5	5	10	10	10	16	10	10
Cercartetus concinnus																			5	–	–	3	–	–	1	–	–	2	–	–			
*Sminthopsis ?dolichura**	1	2	1	–	3	–	–	2	–	–	1		2	2	2	–	1	–	–	1	–	–	–	**	–	–	2	1	4	2			
Sminthopsis crassicaudata	1	–	–	–	–	1	1	–	–	–	–	1	1	–	–				2	1	1	–	–	1	–	–	1	1	–	–	7	–	2
Ningaui ridei				–	1	–	2	5	4				1	–	3	1	3	1															
Notomys mitchellii				–	1	1	1	1	1							2	3	2															
Pseudomys hermannsburgensis	1	–	–				–	–	5	–	–	1	–	1	1	–	–	2															
Pseudomys bolami																												4	3	2	4	–	–
Mus musculus	–	–	9	1	–	1	1	1	5	1	2	5	7	4	4	–	–	4	1	–	7	1	–	4	2	–	2	–	–	1	4	–	–
Species Richness			4			5			6			4			5			5			4			4			4			5			3

[1] Results from quadrat 6E-07 (Ts-Qqz ectotone) and 6W-06 (Qqr) are omitted because trap effort was very low (2 5 5 and 4 5 5 respectively). Quadrat 6E-07 yielded one *Notomys mitchellii* and one *Pseudomys hermannsburgensis*, both in October; 6W-06 yielded one *Pseudomys bolami* in October and another in February, a mummified *Sminthopsis ?dolichura* in February and a mummified *S. crassicaudata* in August.

[2] Codes are defined in Appendix 1

[3] From Table 1

* Herein *Sminthopsis ?dolichura* may include *S. ooldea*

** Mummified specimen taken from a pit that had lost its lid between sampling periods

Table 7 List of reptiles and amphibians recorded from the Kurnalpi-Kalgoorlie Study Area indicating number recorded in each stratigraphic surface-type during each survey period. The three survey periods — Spring (October 1979), Winter (August 1980) and Summer (February 1981) — are indicated in columns 1, 2 and 3 respectively for each surface-type.

Landform Code*	L	V	V	L	U	G	V	S	S	S
Surface Code*	Qra	Qpv	Qqs	Qas	As	Agb	Qqz	Qps	Ts	Tg
Neobatrachus ?sutor or centralis		- - 8		- 1 -		1 - -				- 1 -
N. wilsmorei				- 1 -						
Pseudophryne occidentalis		- 1 1								
Diplodactylus elderi				- 1 2						
D. granariensis		- 1 -	- - 2		2 - 2					
D. maini			1 - 2		1 - 4					
D. pulcher			- - 2	- - 1			2 - -			
Gehyra variegata			2 - 1	1 - -	1 - 1	2 - 1	- 3 3		- 1 -	
Heteronotia binoei		1 1 -	1 - 5	- 1 -	1 1 4	- 2 1		- 1 -		
Nephrurus vertebralis				1 - -						
Oedura reticulata			1 - -							
Phyllurus milii	- - 1				- - 2		2 1 2			
Rhynchoedura ornata				- - 2			- - 1			
Delma australis					1 - -					
D. nasuta								- 1 3		- 1 -
Lialis burtonis				- 1 1			- - 1			
Caimanops amphiboluroides							1 - -		- - 1	
Ctenophorus cristatus			1 - 2				1 - 3			
C. fordi				2 - 2		- - 1	3 1 -	1 2 2	- - 4	1 - -
C. reticulatus			4 - 1	- - 3		3 4 -	3 3 2			2 2 -
C. salinarum	7 1 4									
C. scutulatus				1 1 6			5 - 4			

Table 7 (cont).

Landform Code*	L	V	V	L	U	G	V	S	S	S
Surface Code*	Qra	Qpv	Qqs	Qas	As	Agb	Qqz	Qps	Ts	Tg
Moloch horridus				1 - -			1 1 -	1 - -	3 - -	2 - -
Pogona minor					- - 1	- - 1	- - 2	2 1 1	- 1 -	- - 2
Cryptoblepharus plagiocephalus				1 1 2			1 - -			
Ctenotus atlas				3 - 3			1 - 1	4 - 8	- - 6	
C. leonhardii	3 - 2					- - 1				
C. schomburgkii				- - 1			5 - 1		- 1 -	
C. uber uber			3 - 4			- - 2				
Egernia depressa						- - x	2 - 2			
E. formosa			- - 1			1 - -	1 - 2			
E. inornata		- - 1	1 - -	- 1 -			- - 1			
Lerista muelleri			1 - 2	1 - 1	1 - 1		- - 1			
L. picturata picturata			- - 2		- - 1					
Menetia greyii					- - 1					- - 1
Morethia adelaidensis	- 1 8		- 1 -							
M. butleri					1 - 1		1 - -			- - 1
Omolepida branchialis				- 1 -						- 1 -
Tiliqua occipitalis										2 - 1
T. rugosa			- - 2	1 - 2	- 3 4		2 1 2	- - 2		1 1 -
Varanus caudolineatus				- - 1		3 - -	1 1 2			
V. gouldii			1 - 1	1 - -			1 - -		1 - -	1 - -
Pseudonaja modesta			- - 1				1 - 1		- - 1	
P. nuchalis					- - x					
Rhinoplocephalus gouldii		- 1 -								
R. monachus	1 - -	- 1 -					- 1 -			
Vermicella bertholdi				- - 1						

* From Table 1

x indicates a record in October 1987

A review of the literature, and a preliminary search of the W.A. Museum collection yielded records of another 18 species from the Study Area during the period of European settlement (Table 8). At least another four species might be expected on the basis of their known distributions, even though no records are available from within the Study Area itself: *Nephrurus laevissimus* from Comet Vale, near Randalls Station (31°05'S 122° 10'E) and from 16 km south of Queen Victoria Spring; *Diporiphora reginae* from Kalin Rock (30°41'S 123°17'E) and Fraser Range (32°02'S 122°48'E); *Varanus giganteus* from 10 km ENE of Comet Vale and *Aspidites ramsayi* from 19km south of Menzies (29°42'S 121°02'E).

Thus, a minimum of 66 species were extant in the Kurnalpi-Kalgoorlie Study Area at the time of European settlement. The geographical location of the Study Area, straddling a biogeographic interzone, probably explains why 12 of the 48 species we recorded were near the limits of their known range. Near their southernmost limit were: *Neobatrachus wilsmorei, Diplodactylus pulcher, Gehyra purpurascens, Nephrurus vertebralis, Rhynchoedura ornata, Caimanops amphiboluroides, Egernia depressa* and *Varanus caudolineatus. Rhinoplocephalus gouldii* is at its northern limit, while *Oedura reticulata* its north-eastern and *Lerista picturata picturata* and *Morethia adelaidensis* their western limits.

Outlying or marginal populations of the following species may be found in the Study Area during future field work or by a more exhaustive search of the W.A. Museum collection: *Diplodactylus ciliaris, Delma fraseri, Ctenophorus isolepis citrinus, Ctenotus b. brooksi, Cryptoblepherus carnabyi, Lerista desertorum, Liasis perthensis* and *Pseudonaja nuchalis.*

Although our survey recorded most of the species of gecko, skink, dragon and goanna previously known from the Study Area, we encountered only five of more than 13 species of snake recorded there since European settlement. Similar biases in reptile sampling results have been discussed by McKenzie *et al.* (1987).

More than 30 of the 48 species we recorded are predominantly Eyrean in their geographic range. In comparison, the Bassian component of the reptile fauna is small, comprising only five species (*Diplodactylus granariensis, Oedura reticulata, Phyllurus milii, Denisonia gouldii* and *Tiliqua rugosa*). This is consistent with phytogeographic patterns. The Study Area lies entirely within the Eremaean Phytogeographic Province, and straddles the boundary between the Austin Botanical District and the South-western Interzone (see Fig. 1 in Beard 1980). This Interzone includes a component of plant species with Bassian affinites.

Reptiles collected from quadrats are listed in Table 9. Results from 6E-07 (Ts-Qqz ecotone) and 6W-06 (Qpv) are omitted from this table because collecting effort was very low on these quadrats (see footnotes to Table 6). Quadrat 6E-07 yielded *Ctenophorus cristatus, C. fordi, Moloch horridus, Ctenotus atlas, C. schomburgkii, Egernia inornata* and *Varanus caudolineatus.* Quadrat 6W-06 yielded *Diplodactylus granariensis, Heteronotia binoei, Egernia inornata, Rhinoplocephalus gouldii* and *R. monachus.*

Table 8 Reptiles from the Kurnalpi-Kalgoorlie Study Area not recorded during the survey.

Species	Specimen*	Source Location
Diplodactylus intermedius	WAM R ?	9 km NW of Kalgoorlie
D. damaeus	WAM R 12231	30 km W of Randalls Stn
D. conspicillatus	AM R 7240-1	Kalgoorlie
Pygopus lepidopodus	AMNH 20880	Kalgoorlie
P. nigriceps	WAM R 2783	Karonie
Tympanocryptus cephala	WAM R 4329	Kalgoorlie
Ctenotus pantherinus ocellifer	WAM R 26375	12 km S of Goongarrie
Eremiascincus richardsoni	WAM R 6390	Boulder
Varanus t. tristis	WAM R 10417	Kalgoorlie
Acanthopis pyrrhus	WAM R 70699	Kalgoorlie
Denisonia fasciata	WAM R 10287	Kalgoorlie
Pseudechis australis	WAM R 61623	Kalgoorlie
Vermicella bimaculata	WAM R 4722	12 km SW of Kalgoorlie
Ramphotyphlops australis	WAM R 43591	67 km E of Kalgoorlie
R. bituberculatus	WAM R 5317	Broad Arrow
R. hamatus	WAM R 7025	Boulder
R. waitii	WAM R 4205	Bulong
Python spilotus imbricatus	WAM R 25102	20 km E of Kalgoorlie

* WAM Western Australian Museum, Perth
AMNH American Museum of Natural History NY
AM Australian Museum, Sydney

The two species of amphibia that were collected on quadrats during the survey are excluded from Table 9: *Neobatrachus wilsmorei* from quadrat 6W-04 (winter) and N. sp. (*?sutor* or *centralis*) from 6W-04 (winter), 6E-03 (summer) and 6E-05 (winter).

Accumulation curves for the reptiles from each quadrat are presented in McKenzie (1984, Fig. 4b); further sampling at 6E-01 and 6E-04 may have added species although neither quadrat was particularly poor in its species richness.

The richest quadrats for reptiles were those with a woodland canopy (6W-01, 6W-02, 6W-03, 6W-04, 6E-01 and 6E-06; see Table 9). The mean species richness of these six quadrats was 13.3 ± 3.1(SD). The other five quadrats, with vegetations ranging from shrub-mallee to those with dwarf shrub upper strata, had a mean species richness of 7.2 ± 2.3 (SD). Also implicit in the greater array of strata present at the woodland quadrats was greater plant species richness; the six woodland quadrats had a mean floristic richness of 76.5 ± 19.75 (SD) and the other five quadrats a richness of 52.0 ± 13.5 (SD) (calculated from Appendix I). We suppose that the greater structural diversity and greater species richness of the woodland quadrats offer a greater array of resource axes to reptiles. Kitchener *et al.* (1980a) and McKenzie *et al.* (1987) detected a similar relationship between reptile species richness and vegetation structural types in the adjacent Western Australian wheatbelt and Nullarbor regions respectively.

Keighery *et al.* (this publication) pointed out that the richest communities of ephemeral plants occurred on nutrient rich soils. Table 10 compares the species richness

Table 9 Species of reptiles recorded in the Kurnalpi-Kalgoorlie Study Area indicating number of records at each vertebrate quadrat during each survey period. The three survey periods — Summer (February 1981), Winter (August 1980) and Spring (October 1979) — are indicated as columns 1, 2 and 3 respectively for each quadrat.

Vertebrate Quadrat*	6W-05			6W-01			6W-02			6W-04			6W-03			6E-03			6E-01			6E-06			6E-02			6E-05			6E-04		
Vegetation Quadrat*	KK5			KK1			KK2			KK4+12			KK9+11			KK53			KK51			KK56			KK52			KK55			KK54		
Stratigraphy**	Qra			Qqs			Qqs			Qas			As			Agb			Qqz			Qqz			Qps			Ts			Tg		
Drift Fence Nights	10	10	16	10	10	9	5	5	9	10	10	10	5	5	10	9	5	5	10	10	9	10	10	10	10	10	9	10	10	10	10	10	10
Dipodactylus elderi										–	1	–																					
D. granariensis							–	–	2				2	–	2																		
D. maini				–	–	2	1	–	–				1	–	4							–	–	x									
D. pulcher				–	–	2				–	–	1							2	–	–												
G. variegata				1	–	1				1	–	–	1	–	–				–	2	2	–	–	1									
Heteronotia binoei				1	–	3	–	–	2	–	1	–	1	1	–	2	–	–															
Nephrurus vertebralis										1	–	–																					
Oedura reticulata							1	–	–																								
Phyllurus milii	–	–	1																2	1	2												
Rhynchoedura ornata										1	–	2										–	–	1									
Delma australis													1	–	–																	
D. nasuta																									–	1	3				–	1	1
Lialis burtonis										–	1	–													–	1	–						
Ctenophorus cristatus				1	–	–	–	–	2				–	–	x				–	–	2	–	–	1									
C. fordi										2	–	1													1	2	2	–	–	2	1	–	–
C. reticulatus				4	–	–	–	–	1	–	–	3				2	4	–	3	3	–										–	1	–
C. salinarum	7	1	4																														
C. scutulatus										1	1	5							1	–	2	2	–	1									
Caimanops amphiboluroides																						1	–	–									
Moloch horridus										1	–	–										–	1	–	1	–	–	3	–	–	1	–	–

Table 9 (cont).

Vertebrate Quadrat*	6W-05			6W-01			6W-02			6W-04			6W-03			6E-03			6E-01			6E-06			6E-02			6E-05			6E-04		
Vegetation Quadrat*	KK5			KK1			KK2			KK4+12			KK9+11			KK53			KK51			KK56			KK52			KK55			KK54		
Stratigraphy**	Qra			Qqs			Qqs			Qas			As			Agb			Qqz			Qqz			Qps			Ts			Tg		
Drift Fence Nights	10	10	16	10	10	9	5	5	9	10	10	10	5	5	10	9	5	5	10	10	9	10	10	10	10	10	9	10	10	10	10	10	10
Pogona minor																–	–	1	–	–	1	–	–	1	2	1	1	–	1	–	–	–	1
Cryptoblepharus plagiocephalus										1	1	2										1	–	–									
Ctenotus atlas										3	–	2													4	–	8	–	–	6			
C. leonhardii	3	–	2																														
C. schomburgkii										–	–	1							1	–	1							–	1	–			
C. uber uber				2	–	4	1	–	–							–	–	2															
Egernia depressa																–	–	x	2	–	2												
E. formosa				–	–	1										1	–	–	1	–	1												
E. inornata							1	–	–	–	–	1																					
Lerista muelleri				1	–	–	–	–	1	1	–	–	1	–	1							–	–	1									
L. picturata picturata							–	–	2				1	–	1																		
Menetia greyii													–	–	1																–	–	1
Morethia adelaidensis	–	1	8	–	–	1																											
M. butleri													1	–	1							1	–	–							–	–	1
Omolepida branchialis										–	1	1																			–	1	–
Tiliqua occipitalis																															2	1	1
T. rugosa				–	–	2	–	–	1	1	–	2	–	3	4				–	–	2				–	–	2				1	1	1
Varanus caudolineatus										–	–	1				3	–	–	–	–	1	–	–	1									
V. gouldii				1	–	–	–	–	1													1	–	–				1	–	–	1	–	–
Rhinoplocephalus monachus	1	–	–																–	1	–												
Pseudonaja modesta				–	–	1													1	–	–							–	–	1			
P. nuchalis													–	–	x																		
Species Richness	5			13			12			19			10			6			14			12			7			7			11		

* From Appendix 1.

** From Table 1.

x Indicates October 1987 records (excluding record of additional species *Ctenophorus maculatus*), subsequent to analysis

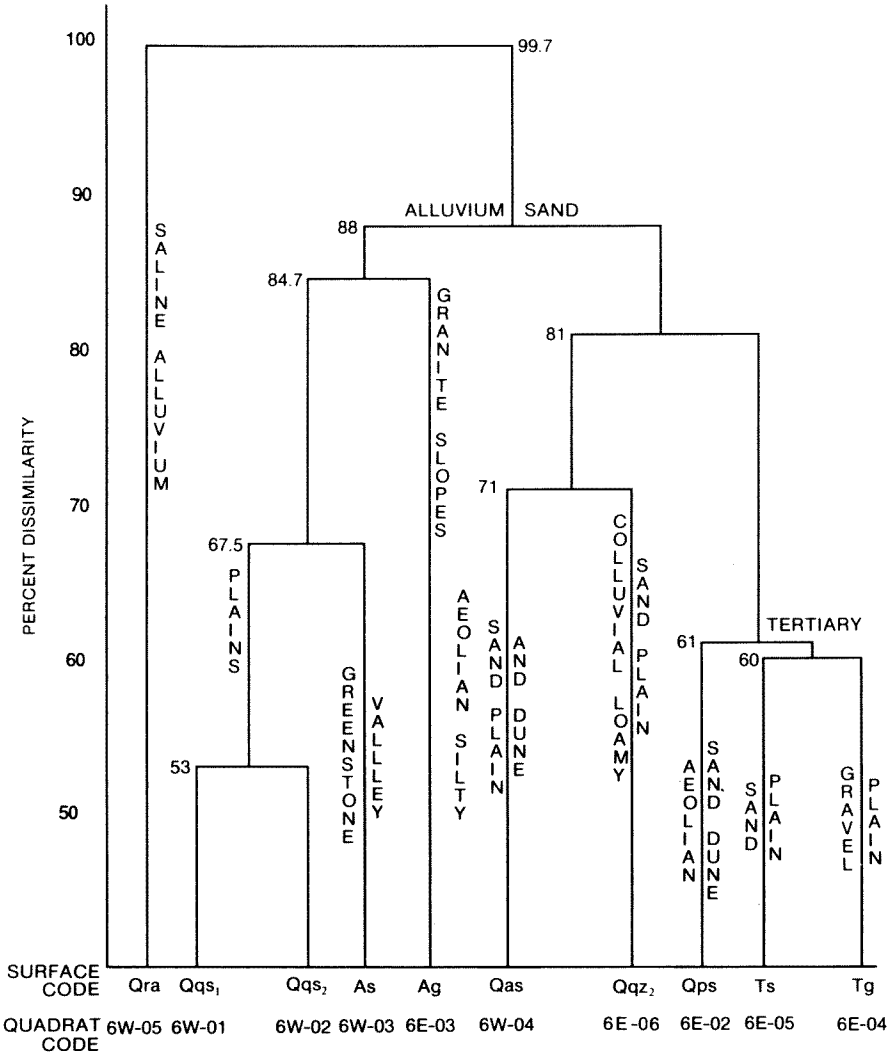


Figure 5 Reptile dendrogram resulting from the WPGMA classification (Sneath and Sokal 1973) of sample-site data.

of the reptiles with that of the ephemeral and perennial plants at the various quadrats. However, the correlation coefficients (Kendall's *Tau b*) were not significant.

The species composition of the reptile assemblages (Table 9) was analysed in McKenzie (1984 Fig. 5). When the quadrats were classified according to similarities in the species composition of their reptile assemblages, quadrats with similar surface stratigraphy were found to be clustered. In that paper, the quadrats were listed according to their surface-type — Qqs_1 is quadrat 6W-01, Qqs_2 is 6W-02, Qqz_1 is 6E-01 and Qqz_2 is

Table 10 Species richness of reptiles compared with plants.

Vertebrate Quadrat	Vegetation Quadrat Code	Species Richness Plants*	Reptiles
6W-01	KK1	85(39)	13
6W-02	KK2	60(21)	12
6W-03	KK9	70(38)	10
6W-04	KK4+	104(47)	19
6W-05	KK5	55(12)	5
6E-01	KK51	51(31)	14
6E-02	KK52	38(33)	7
6E-03	KK53	71(36)	6
6E-04	KK54	56(43)	11
6E-05	KK55	40(31)	7
6E-06	KK56	89(47)	12

* From Appendix I (Keighery *et al.* this publ.), total species (perennial richness)
\+ KK4 includes KK12. On its own, KK12 species richness = 63(35)

6E-06. This analysis has been re-run excluding 6E-01 because it is on an ecotone between the Qqz and Ag surface/vegetation types. The dendrogram's structure did not change (Figure 5).

Birds

Ninety-seven species of bird were recorded in the Kurnalpi-Kalgoorlie Study Area during our surveys. Eighty of these (Table 11) were recorded on surface-types consistently sampled by both quadrat and opportunistic techniques. The remaining 17 (Table 12) came from localised surface-types or from dams or lakes to which irregular or scant attention was given.

Twenty-five of the 44 non-passerines listed in Table 13 are swamp or lake birds; these habitats were scarcely sampled during our field work. Other non-passerines such as the Regent Parrot, Princess Parrot and Western Rosella are species near the edge of their geographic range, and are likely to have declined since settlement in the area. Five of the 20 passerine species that we failed to record can be included in this category; the Western Yellow Robin, Western Shrike-Tit, Blue-breasted Wren, Shy Hylacola and Silvereye are species of the more mesic districts to the south and west. With the reduction in vegetative cover caused by pastoral (grazing, burning) and mining activities (cutting timber to fuel the ore crushers), they are likely to have declined in the Study Area. The geographic range of two other passerines listed in Table 13 has declined since European settlement (the Chiming Wedgebill and Thick-billed Grass-Wren); both are probably now extinct in the Study Area.

The 161 species recorded since European settlement in the Study Area comprises 85 non-passerines and 76 passerines. Both Bassian and Eyrean components are present. The Eyrean component is richer in species because of the geographical location of the Study Area and its variety of distinctly Eremaean vegetations.

Table 11 List of birds recorded from the Kurnalpi-Kalgoorlie Study Area indicating number of sightings made in each stratigraphic surface-type during each survey period. The three survey periods — Spring (October 1979), Winter (August 1980) and Summer (February 1981) are indicated in columns 1, 2 and 3 respectively for each surface-type.*

Landform Code**	L			V			L			U			V			G			S			S			S		
Stratigraphy**	Qra			Qqs			Qas			As			Qqz			Agb			Qps			Ts			Tg		
NON-PASSERINES																											
Emu	3	–	5	–	11	–	–	–	14																23	–	–
Grey Teal				–	10	–																					
Whistling Kite																–	2	–									
Little Eagle	**1**	–	–																								
Spotted Harrier													–	1	–												
Wedge-tailed Eagle										–	–	2															
Australian Hobby										–	1	–															
Brown Falcon				–	1	–							–	–	2	1	–	–	1	–	1				1	–	–
Australian Kestrel																–	–	1									
Mallee Fowl																			N	N	N	–	T	–	N	N	N
Australian Dotterel	–	4	–																								
Common Bronzewing				–	1	3				–	1	2	2	–	–	–	–	1							–	1	1
Crested Pigeon	3	–	–	–	–	2																					
Purple Crowned Lorikeet				–	3	–				–	6	–	–	1	6	–	7	–									
Ring-necked Parrot	3	–	3	43	1	19	4	1	6	6	2	8	5	2	–	4	2	–							3	–	–
Mulga Parrot	16	–	–	–	1	–	–	–	7							10	–	6				2	2	–	4	–	–
Budgerigar																			–	–	**4**	–	–	**2**	–	–	**4**
Cockatiel	–	–	**1**	15	–	–										–	–	1									
Galah	21	2	–	–	10	–							–	–	1	7	3	14				–	1	–			
Pallid Cuckoo				–	4	–	–	1	–	–	1	–				–	1	–	–	2	–						
Black-eared Cuckoo													2	–	–												
Horsfields Bronze Cuckoo	–	4	–	–	2	–	–	1	–	–	1	–	–	4	–	–	3	–	–	4	–	–	1	–	–	5	–
Boobook Owl										–	–	1															
Tawny Frogmouth							1	–	–							3	–	–									
Australian Owlet-nightjar													1	–	–												
Red-backed Kingfisher										–	–	2															
Rainbow Bee-eater				–	–	19				–	–	**10**	–	–	6				–	–	**6**	–	–	**12**	–	–	**6**

Table 11 (cont).

Landform Code**	L			V			L			U			V			G			S			S			S		
Stratigraphy**	Qra			Qqs			Qas			As			Qqz			Agb			Qps			Ts			Tg		
PASSERINES																											
White-backed Swallow	12	–	–																								
Welcome Swallow	2	5	–				2	**2**	–																		
Tree Martin				4	–	–																					
Richards Pipit	7	5	4	1	–	–													–	–	2						
Ground Cuckoo-Shrike				4	–	–																					
Black-faced Cuckoo-Shrike				7	2	4	4	–	2	1	5	3	–	1	1	–	3	2				–	1	–			
White-winged Triller							–	**2**	–							–	1	–									
Jacky Winter	2	–	–	7	–	4	1	–	–	1	3	2	–	1	7												
Red-capped Robin	1	–	–	5	–	–	5	–	–	4	1	1	3	–	11	5	11	2				–	–	5	–	4	3
Hooded Robin	11	–	4	1	–	–																					
Rufous Whistler													2	3	5	–	4	3	1	–	–	–	1	4	2	4	2
Grey Shrike-thrush				1	–	–				1	–	–	–	2	5	1	7	1							2	–	–
Crested Bellbird	2	–	–	3	2	–	–	2	3				1	1	3	–	6	–	1	–	–	–	–	2	1	–	1
Grey Fantail																–	–	1									
Willie Wagtail	3	–	–	–	1	–				–	2	–															
White-browed Babbler	8	–	–	–	–	5	1	–	–	–	1	27				–	23	–				–	3	–	8	4	6
Southern Whiteface																9	7	2							–	2	–
Weebill				52	20	83	2	4	6	16	13	48	21	60	56	6	6	3	11	21	9	14	16	25	3	18	19
Broad-tailed Thornbill										3	4	7	2	7	5	2	11	9	5	4	–	–	–	4	1	8	5
Slatey-backed Thornbill																1	1	–									
Chestnut-rumped Thornbill				4	–	–	26	2	5	7	–	18	18	7	17	29	4	34	2	–	–	–	3	–	–	3	9
Yellow-rumped Thornbill	6	–	–							4	–	–				4	2	41									
Redthroat							2	–	–	1	–	–	4	–	2	1	4	9	2	–	–				1	1	5
Variegated Fairy-wren																14	15	16				–	1	–	15	5	–
White winged Fairy-wren	33	5	–	10	–	–																					
Brown Songlark	–	7	–																								
Australian Sittella				–	15	–							–	6	–												
White-browed Treecreeper													–	1	–												
Rufous Treecreeper				4	–	–																					
Mistletoe bird													–	–	4	–	1	1									
Striated Pardalote				25	6	25				–	4	5	1	2	2	–	1	–				1	3	3			
Brown Honeyeater										–	7	23				–	2	–							–	2	–

Table 11 (cont).

Landform Code**	L			V			L			U			V			G			S			S			S		
Stratigraphy**	Qra			Qqs			Qas			As			Qqz			Agb			Qps			Ts			Tg		
Singing Honeyeater	3	1	4				5	–	4	15	–	–				1	9	–				–	1	–			
Yellow-fronted Honeyeater																						2	–	–			
Yellow-plumed Honeyeater				25	4	1				–	6	2													–	1	–
White-eared Honeyeater				1	–	2							1	–	6				–	2	–	–	–	1	1	–	–
Brown-headed Honeyeater										–	–	5	12	1	4				9	–	–						
White-fronted Honeyeater				–	–	11	3	10	4	3	5	11	12	–	3	–	4	–	4	2	–	–	13	2			
White-cheeked Honeyeater													–	–	7												
Yellow-throated Miner	1	–	–	54	14	18	12	5	35	2	11	23	–	2	–				**10**	–	–	–	1	–	**1**	–	–
Spiny-cheeked Honeyeater	–	2	–	7	2	1	1	8	11	8	5	1	5	8	7	1	9	11	5	3	5	1	9	2	1	10	11
Red Wattlebird				5	3	23																					
White-fronted Chat	–	6	–																								
Orange Chat	4	–	–																								
Zebra Finch																–	–	9									
Magpie Lark				–	2	4																					
Black-faced Woodswallow	50	5	3	–	–	1				7	–	–															
Dusky Woodswallow				3	–	–										–	–	2									
Grey Butcherbird	2	–	–	3	–	–	3	–	2				1	3	3	2	–	–				1	–	–	1	–	–
Pied Butcherbird	–	–	2	3	5	1				–	–	2	–	1	–	–	2	–		–	1	–					
Australian Magpie	–	–	1	16	6	8				4	–	–	–	–	14												
Grey Currawong				3	2	2	2	–	–	1	–	6	–	1	1	1	–	–				–	–	1			
unidentified Corvid	29	4	–	6	–	2	2	–	–	–	–	2				–	2	1	–	4	–						

* The same individual may have been encountered several times, each encounter was recorded as a separate sighting.

** From Table 1

1 All sightings were of birds in flight

N Nest

T Tracks

Table 12 Bird species recorded from surface-types not systematically sampled in the Kurnalpi-Kalgoorlie Study Area.

NON-PASSERINES	
Hoary-headed Grebe	Black-fronted Plover
Pacific Heron	Black-winged Stilt
Black Swan	Red-necked Avocet
Mountain Duck	
Wood Duck	PASSERINES
Black-shouldered Kite	Chestnut Quail-Thrush
Collared Sparrowhawk	Pied Honeyeater
Coot	Crimson Chat
Banded Plover	Masked Woodswallow
Red-capped Plover	

The Royal Australasian Ornithologists Union "Atlas of Australian Birds" includes records of a further 64 species from the Study Area some of which date back to pre-1900 AD. These are listed in Table 13.

The more mobile birds (non-passerines) were poorly represented in our samples; overall, 44.3% of known species were recorded, but only 19.3% were recorded on quadrats. The quadrat-based strategy of survey was expected to be more effective for sampling relatively sedentary species with smaller home ranges and therefore greater densities in suitable habitat. Overall, 74.7% of the passerine species previously known from the Study Area were recorded during our field work, and 53.2% of these were recorded on quadrats. In comparison, sampling was restricted to just 10 quadrats representing only nine of the 27 surface-types recognised from the geological maps (see Table 1; Kriewaldt 1969; Williams 1973).

Each quadrat was sampled daily over five days during each of the three survey periods. The birds recorded on the quadrats are listed in Table 14.

Combined, the species richness of the ten quadrats did not change much from season to season; a total of 41 species were recorded in summer 1981, 42 in winter 1980, and 37 in spring 1979. In spring, 631 individual birds were recorded on the quadrats; summer and winter sampling yielded 497 and 457 bird sightings respectively.

The richest bird assemblages were not limited to vegetations dominated (in numbers or biomass) by trees; the *Acacia* shrubland of the granite apron sampled at 6E-03 was the richest quadrat in terms of both number of bird species (in all seasons) and number of individual birds. The scattered trees were only a very minor component of the vegetation at this quadrat (see KK53 of Appendix I) although some of the *Acacia* were trees.

No significant correlations were found between floristic and passerine richness (Table 15), even when perennial and ephemeral plants, and when seasonal bird assemblages were separated. However, a positive correlation between the number of vegetation strata and number of passerine species recorded at quadrats was significant (Kendall's *Tau b* = 0.79; $p<0.005$), even when summer (*Tau b* = 0.80; $p<0.005$), spring (*Tau b* = 0.84; $p<0.005$), but not winter assemblages, were analysed separately.

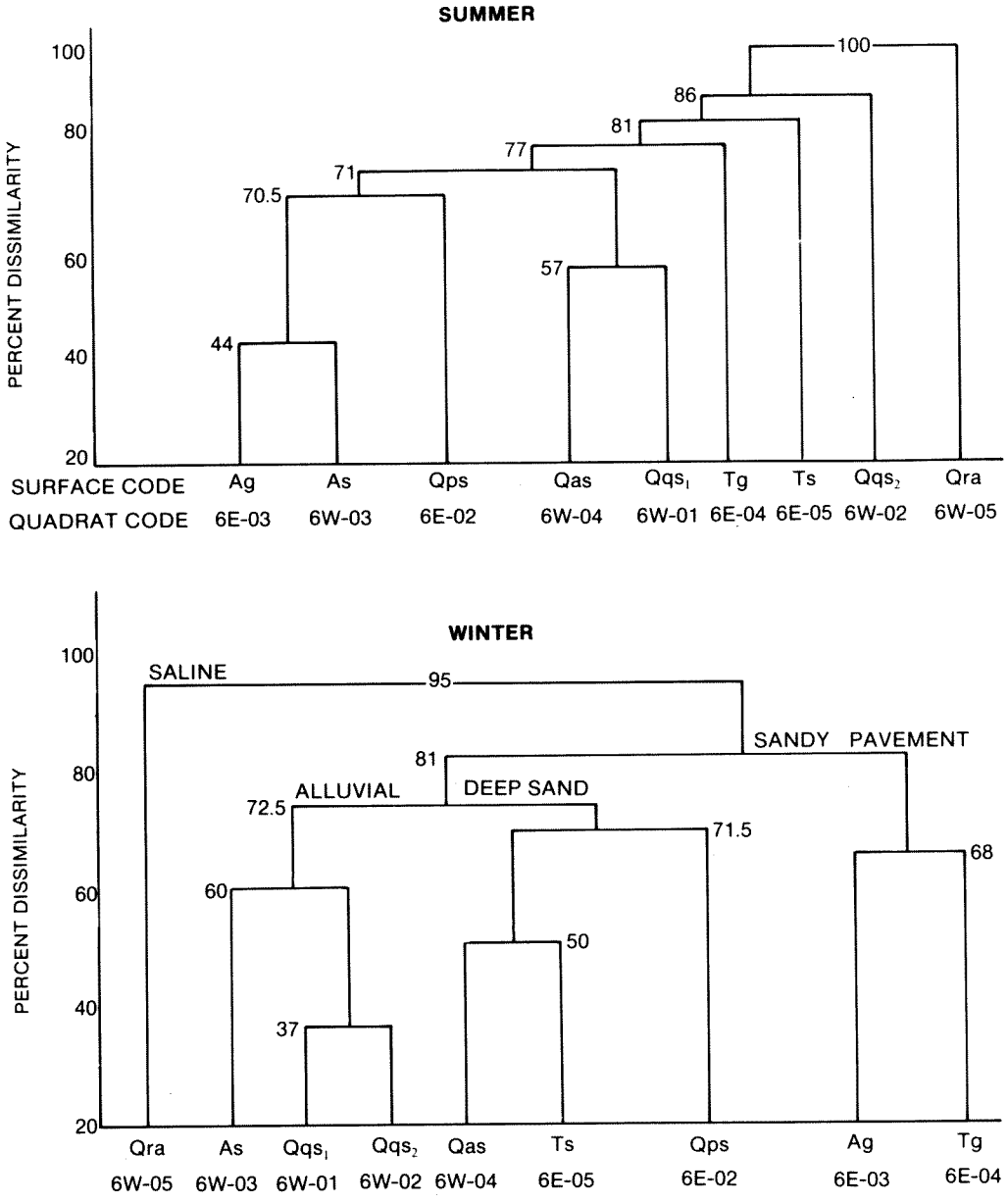
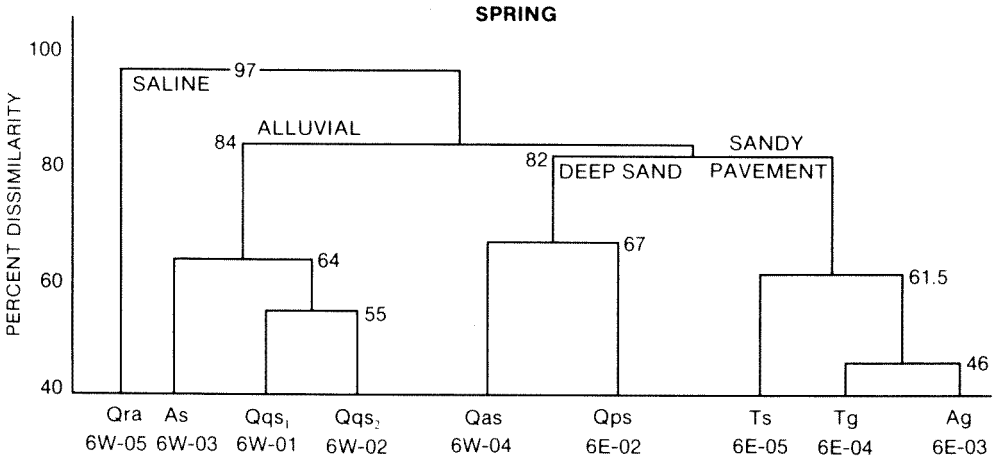


Figure 6 Passerine bird dendrograms resulting from the WPGMA classification (Sneath and Sokal 1973) of the sample-site data in Table 14 (except 6E-01).

Figure 6 (cont).



A positive correlation between the number of vegetation strata and the number of individual birds (either passerine densities or levels of observable activity) that were recorded at quadrats was also significant (Kendall's *Tau b* = 0.79; $p<0.005$), although passerine richness and abundance were strongly inter-correlated (*Tau b* = 0.87; $p<0.001$). Structural diversity in vegetation implies a greater array of foraging microhabitats for volant species than does floristic richness alone. For non-volant species such as reptiles, woodlands are likely to provide a wider array of foraging microhabitats (foliage, bark, litter etc) to partition. Year-round availability of resources on-site is not liable to be such a problem for heterotherms, despite their low mobility compared to birds.

Species accumulation curves for each bird quadrat are presented and discussed in McKenzie (1984); the dendrograms figured there-in are updated for this publication (Figure 6). The consistent clustering of 6E-03 (granite) and 6E-01 (colluvial loam) was discussed in the mammal section of this paper. The elimination of 6E-01 from the data-set on the grounds that it was potentially ecotonal did not change the cluster patterns of the other quadrats.

The greater mobility of birds compared with the other vertebrate groups sampled, allows them to follow and exploit seasonal patterns of flowering. Thus, the seasons were treated separately in analysing the bird data set (Table 14). The spring (October) and winter (August) dendrograms of passerine birds in McKenzie (1984) arrayed quadrats into similar clusters to those derived from the reptile data — a separation of saline, sandy, pavement and alluvial stratigraphic surface-types. In contrast, the dendrogram of late summer (February) assemblages indicated more marked differences between individual bird assemblages. Late summer is likely to be the time of lowest productivity in these environments.

Table 13 Other bird species recorded from the Kurnalpi-Kalgoorlie Study Area. Species last recorded during the historical time intervals recognised by the R.A.O.U. Atlas (Blakers *et al.* 1984) (1: pre-1900; 2: 1900-1950; 3: 1951-1976) are indicated.

Great Crested Grebe	Greenshank
Australian Pelican	Black-tailed Godwit (3)
Little Pied Cormorant	Sharp-tailed Sandpiper
White-faced Heron	Feral Pigeon
Cattle Egret	Spotted Turtle-Dove
Yellow Bittern (1986, vagrant)	Laughing Turtle-Dove
Glossy Ibis	Regent Parrot (3)
Straw-necked Ibis	Princess Parrot (2)
Yellow-billed Spoonbill	Western Rosella (1)
Freckled Duck	Barn Owl
Pacific Black Duck	Spotted Nightjar
Chestnut Teal	Sacred Kingfisher (3)
Australasian Shoveller	Fairy Martin
Pink-eared Duck	Southern Scrub-Robin
Hardhead	Western Yellow Robin (2)
Musk Duck	Western Shrike-Tit (1)
Black Kite (3, vagrant)	Gilbert's Whistler (3)
Square-tailed Kite	Chiming Wedgebill (3)
Brown Goshawk	Rufous Songlark
Black Falcon (3, vagrant)	Blue-breasted Wren (2)
Peregrine Falcon	Thick-billed Grass-Wren (2)
Malleefowl	Shy Hylacola (2)
Stubble Quail	Calamanthus
Little Button Quail	Western Warbler
Australian Crake	Slender-billed Thornbill (2)
Black-tailed Native Hen	New Holland Honeyeater (2)
Australian Bustard	Black Honeyeater (2)
Red-Kneed Dotterel	Silvereye
Hooded Dotterel	White-browed Woodswallow
Banded Stilt	Little Woodswallow
Wood Sandpiper	Australian Raven
Common Sandpiper (3)	Torresian Crow

Table 14 Species of birds recorded in the Kurnalpi-Kalgoorlie Study Area indicating number of sightings at each vertebrate quadrat during each survey period. The three survey periods — Spring (October 1979), Winter (August 1980) and Summer (February 1981) — are indicated in columns 1, 2 and 3 respectively for each quadrat.*

Stratigraphy**	Qra			Qqs			Qqs			Qas			As			Qqz			Agb			Qps			Ts			Tg		
Vegetation Quadrat***	KK5			KK2			KK1			KK4			KK9			KK51			KK53			KK52			KK55			KK54		
Vertebrate Quadrat***	6W-05			6W-02			6W-01			6W-04			6W-03			6E-01			6E-03			6E-02			6E-05			6E-04		
NON-PASSERINES																														
Emu										–	–	x	–	–	x															
Brown Falcon	–	–	x																			–	1	–				1	–	–
Australian Kestrel																			–	–	1									
Mallee Fowl																						N	N	N	–	T	–	N	N	N
Common Bronzewing																2	–	–	–	1	–									
Crested Pigeon				–	–	2																								
Purple-crowned Lorikeet							–	3	–							–	–	6												
Ring-necked Parrot	–	–	**1**	6	–	1	2	–	4	1	**1**	–	–	–	2	5	2	–	1	–	–							1	–	–
Mulga Parrot				–	1	–				–	–	4	–	–	x				5	–	2									
Budgerigar																						–	–	4	–	–	2	–	–	4
Cockatiel	–	–	1																											
Galah	–	–	2										–	–	x				–	–	**3**				–	1	–			
Pallid Cuckoo							–	4	–													–	2	–						
Black-eared Cuckoo																2	–	–										–	–	x
Horsfield's Bronze-Cuckoo	–	–	4				–	1	–	–	1	–				–	3	–	–	1	–	–	4	–	–	1	–	–	5	–
Australian Owlet-nightjar																1	–	–												
Rainbow Bee-eater							–	–	**7**													–	–	**6**	–	–	**12**	–	–	**6**
PASSERINES																														
Welcome Swallow	–	**5**	–							–	**2**	–																		
Tree Martin				4	–	–																								
Richards Pipit	–	4	–																											
Black-faced Cuckoo-Shrike				2	1	–	2	1	**3**	3	**1**	–	–	**1**	–	–	1	–	–	1	–				–	–	1	–	–	x
White-winged Triller										–	2	–							–	1	–									
Jacky Winter							1	–	3							–	1	3										–	–	x
Red-capped Robin							1	–	–	4	–	–	4	–	–	3	–	3	4	4	1				–	–	5	–	4	3
Hooded Robin	3	–	2																											
Rufous Whistler																2	2	2	–	3	2	1	–	–	–	1	4	2	4	2
Grey Shrike-Thrush													1	–	–	–	2	5	1	4	–							2	–	–
Crested Bellbird							1	–	–							1	1	1	–	1	–	1	–	–	–	–	2	–	–	1
White-browed Babbler										1	–	–	–	–	18				–	9	–							8	–	6
Southern Whiteface																			9	–	–							–	2	–
Weebill				9	1	5	23	17	55	2	4	6	15	5	18	21	56	47	6	5	2	11	21	9	14	16	25	3	10	19
Broad-tailed Thornbill													3	4	–	2	7	4	2	5	6	5	4	–	–	–	4	–	8	5

Table 14 (cont).

Slaty-backed Thornbill																						1	–	–												
Chestnut-rumped Thornbill							4	–	–	26	2	–	7	–	12	18	7	13	20	–	33	2	–	–	–	3	–	–	2	9					
Yellow-rumped Thornbill													4	–	–				1	–	41														
Redthroat													1	–	–	4	–	–	1	–	3	2	–	–				1	1	5					
Variegated Wren																			14	5	16							15	5	–					
White-winged Fairy-Wren	–	5	–	10	–	–																													
Brown Songlark	–	6	–																																
Australian Sittella							–	15	–																										
Rufous Treecreeper							1	–	–																										
Mistletoe Bird																			–	–	**1**														
Striated Pardalote				6	3	11	–	2	5	–	–	x	–	–	1	1	2	2	–	1	1				1	3	3								
Brown Honeyeater													–	–	17															–	2	–			
Singing Honeyeater	–	1	–							5	–	4	15	–	–				1	4	–				–	1	–								
Yellow-fronted Honeyeater																									2	–	–								
Yellow-plumed Honeyeater																														–	1	–			
White-eared Honeyeater							–	–	1							1	–	–							–	–	1	1	–	–					
Brown-headed Honeyeater																12	1	1				9	–	–											
White-fronted Honeyeater							–	–	11	3	10	2	3	1	5	11	–	–				4	2	–	–	13	2								
Yellow-throated Miner				11	9	2	–	1	6	9	5	18	2	8	7	–	2	–				**10**	–	–	–	1	–	**1**	–	–					
Spiny-cheeked Honeyeater							1	–	–	1	5	5	6	–	–	5	8	7	1	6	8	5	3	5	1	7	2	–	10	11					
Red Wattlebird				3	3	3	–	–	7	–	–	x	–	–	1																				
Black-faced Woodswallow	8	**2**	–																																
Grey Butcherbird							1	–	–	2	–	2				–	3	1	1	–	–				1	–	–	1	–	–					
Pied Butcherbird	–	–	2	2	2	–	–	3	–				–	–	1	–	1	–				–	1	–										
Australian Magpie				5	3	**1**	**2**	–	**1**				–	–	x																				
Grey Currawong				–	–	x	–	–	2							–	1	–	1	–	–														
Corvid	–	**4**	–	1	–	–	–	–	1										–	2	**1**	–	**4**	–											
Species Richness																																			
Seasonal Total	2	9	4	11	8	7	11	9	13	11	9	7	11	5	10	16	17	12	16	17	13	11	10	5	5	11	12	12	13	12					
Seasonal Passerines	2	7	2	10	7	5	10	6	11	10	7	6	11	5	9	12	15	11	14	14	11	10	6	2	5	8	10	9	11	9					
Total Passerines		9			10			19			12			17			19			22			12			15			17					
Number of Individuals		40			97			171			123			160			264			229			99			113			144					

* Each quadrat was sampled for five days over three seasons.
** Table 1
*** From Appendix I
x Indicates records on the quadrat in October 1987 (excludes record of additional species Chestnut Quail-thrush), subsequent to analysis
10 Indicates that all sightings were of birds in flight
T Tracks
N Nest

Table 15 Species richness of passerine bird assemblages compared with floristic-richness and plant structural diversity.

Quadrat Codes		Perennial Plants		Passerine Birds	
Vertebrate	Vegetation	Species richness[1]	No. of strata	Species richness[2]	No. of individuals
6W-01	KK1	85(39)	6	19	171
6W-02	KK2	60(21)	5	10	97
6W-03	KK11	74(32)	5	17	160
6W-04	KK4	104(47)	5	12	123
6W-05	KK5	55(12)	2	9	40
6E-01	KK51	51(31)	6	19	264
6E-02	KK52	38(33)	4	12	99
6E-03	KK53	71(36)	6	22	228
6E-04	KK54	56(43)	5	17	144
6E-05	KK55	40(31)	5	15	113

[1] From Appendix I.
[2] Seasonal values are presented in Table 14.

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