A BIOLOGICAL SURVEY OF THE HELENA AND AURORA RANGE, EASTERN GOLDFIELDS WESTERN AUSTRALIA.

Edited by:

Michael N. Lyons and Andrew Chapman

Comprising papers by:

A. Chapman, N. Gibson, R.P. McMillan, R. Thomas, G. Pronk, M.N. Lyons, and B.J. Lepshi.

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ABSTRACT

A biological survey was conducted of the Helena and Aurora Range. The range is the largest of six banded ironstone ranges within the Coolgardie IBRA Region. Data was collected for invertebrates, vertebrates, flora and vegetation.

The vertebrate fauna survey results do not indicate that the banded ironstone landform offers a unique or specialised habitat for the extant vertebrate fauna, though it may be the preferred habitat for some species, particularly reptiles. This conclusion is consistent with other studies of banded ironstone ranges in Western Australia.

A total flora of 324 taxa was recorded from the range, of which 303 were native and 21 were weeds. One species of declared rare flora and 10 taxa listed on CALM's priority flora list were found on the range. Four taxa appear endemic to the Helena and Aurora Range. None of these taxa are currently reserved. Six floristic community types were defined, these were highly correlated with topographic position and slope. Data is not yet available to determine the conservation status of the major community types identified however only a small proportion of the Bungalbin vegetation system is currently managed for conservation.

An invertebrate fauna including 142 insect taxa and 84 spiders was recorded for the range. For some groups, such as Orthoptera and Spiders the range supports a rich fauna. Further taxonomic and field collecting may reveal a small localised or endemic invertebrate fauna.

The inclusion of the Helena and Aurora Range and the surrounding woodlands and sandplains in the proposed extension to the Mount Manning Range Nature Reserve offers an opportunity to establish a large representative Nature Reserve with demonstrated high conservation values in an IBRA region which is inadequately represented by lands managed primarily for conservation.

RECOMMENDATIONS

1.
As the proposed reserve over the Helena and Aurora Range has been approved in principle by the Western Australian Government, (recommendation 10.5.2 CALM's Goldfields Regional Management Plan, CALM, 1994 and has received ministerial approval) CALM should proceed with the reservation recommendation.

2.
Following gazettal of the reserve priorities for management include:

a) Erosion control of mining exploration access tracks and grid-lines. This should include an approach to the previous tenement holder for financial assistance to address to detrimental effects of previous mineral exploration.

b) measures to ensure feral goats do not become established. In practice this involves discouraging the establishment of permanent waters by mining activity ie preventing costeans, open pits and road run-off providing a water source.

c) production of an area management plan for the reserve as resources and other priorities permit.

PART 1 INTRODUCTION

Andrew Chapman and Rob Thomas

REGIONAL SETTING AND PHYSICAL ENVIRONMENT

The Helena and Aurora Range (subsequently referred to as 'the Range') is located approximately 50 km north of Koolyanobbing and south of the existing Mount Manning Range nature reserve in the eastern Goldfields of Western Australia (Figure. 1). The Range is within the Coolgardie IBRA region which was formerly known as the botanical district of the same name or the Southwestern Interzone of Beard (1980) (Thackaway & Cresswell, 1995). As the name suggests the vegetation and fauna here is a blending of that of the more mesic south-west and the arid interior. Open eucalypt woodlands often with a chenopod shrub layer are prominent on calcareous red-brown sandy loams. Denser shrublands, mallees and thickets are associated with deeper, sandier soils and granite outcrops or greenstone and banded ironstone hills respectively. Not far to the north are the extensive Mulga woodlands of the Murchison IBRA region. Thus the Range sits close to the major biological divide known in Western Australia as the Mulga-eucalypt line. The reservation status of the Coolgardie IBRA region is <10% (Thackaway & Cresswell, 1995).

Apart from very small areas to the east of Southern Cross there has been no clearing of vegetation for agriculture in the Coolgardie IBRA region, however cutting of eucalypt timber for both fuel and for structural purposes in the mining industry over some 4 000 000 ha has modified the structure of these woodlands elsewhere in the region. Consequently, mature and uncut eucalypt woodlands such as those surrouding the Range have a high priority in conservation and management. Mining is a significant land use particularly in the two massive greenstone belts which strike NNW-SSE in both the west and centre of the region. Productive mining can significantly impact on these woodlands albeit over relatively small areas. Modern exploration, on the other hand is more benign but impacts much larger areas including providing access to areas which may result in secondary impacts such as erosion or illegal activities. Pastoral production occupies the eastern half of the region; impacts include localized degradation in the immediate vicinity of watering points, reduction of palatable perennial shrubs and increases of unpalatable species. The Range itself occupies vacant crown land, neither pastoralism nor timber cutting have impacted upon it or its surrounds. However extensive geological exploration of the banded ironstone resource has provided access to the Range and caused significant erosion. There has been recent open-pit production mining of gold just south of the Range.

Wildfires which are usually ignited by thunderstorms are very infrequent in both the Range and surrounding woodlands due to the very open nature of the vegetation and lack of a flammable understorey. In spite of this a lightning strike east of Bungalbin Hill did ignite the Range crest and slope vegetation on 26/11/95 and burnt 100 ha in 2 days. Wildfires are more frequent in the denser shrublands surrounding the Range.

Geologically the Helena and Aurora Range, and most of the Coolgardie IBRA Region, occupy the Archaen Yilgarn craton, part of the exposed original land surface of Australia. The Range itself comprises Archaen banded iron formation whose origin is iron oxides from bacteria laid down in river or lake sediments which subsequently became metamorphosed and uplifted by tectonic forces. Banded ironstone exposures are known from at least 6 localities in this IBRA region, however the Helena and Aurora Range is the largest and with a maximum height of 702m is certainly the most visually striking. Here banded ironstone occurs at two stratigraphic layers separated by basalt The upper layer includes red jasperlite which is particularly visible on the western arm of the Range, but the lower layer is thicker, up to 100 m, and contains the

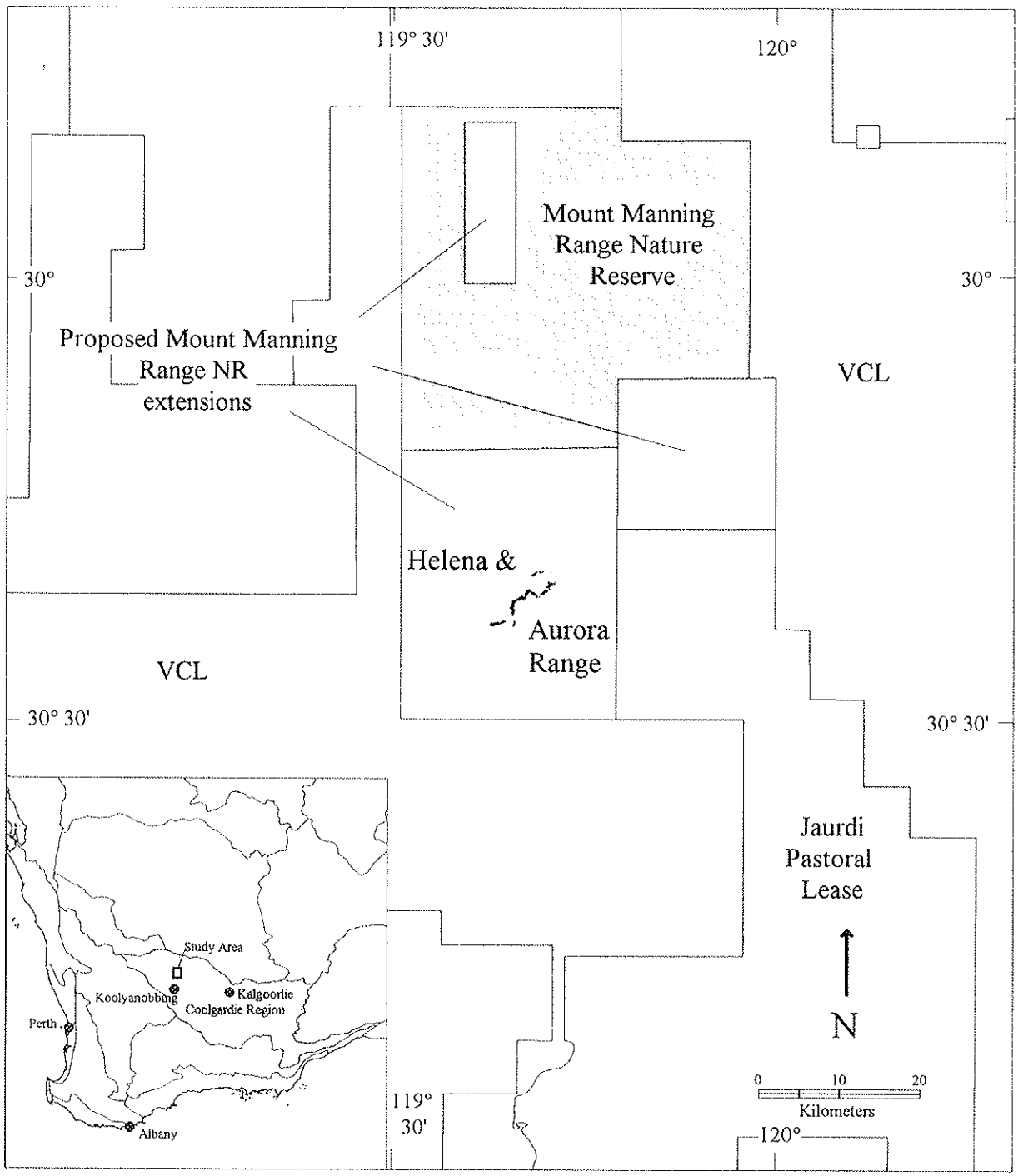


Figure 1. Regional setting of the Helena & Aurora Range. The inset indicates the Coolgardie IBRA Region (shaded).

identified iron ore resource of 61 million tonnes at 58% iron (Chin and Smith 1983). This is a larger resource than that at Koolyanobbing, Mount Jackson or Windarling Peak but is of a lower grade.

The nearest meterological recording station is Southern Cross which is 80 km to the south. Meterological data for Southern Cross are presented in Table 1. The climate of the Range and surrounds according to Bagnouls and Gaussen (1957) in Beard (1981) is 'semi-desert mediterranean'.

'Mediterranean' recognises that the rainfall is predominently in winter, 'semi-desert' recognises that there are between 9-11 dry months per year. Dry in this context is derived from the ombrothermic diagram system of Bagnouls and Gaussen (Ibid) whereby a dry month is one where temperature exceeds rainfall when plotted at a scale of $r=2t$. Whilst this system provides an adequate regional interpretation it fails to recognise two aspects pertaining particularly to the Range. Firstly there can be significant summer rainfall events from either convective thunderstorms or rain bearing depressions of tropical origin and also there are likely to be biologically significant microclimatic effects due to the topography of the Range. As an example of the latter it was apparent during fieldwork that strong, gusty, evening winds are present within the Range even when it is quite still elsewhere.

Apart from 1994 which was a dry year, the years preceeding, and including, the survey generally had above average rainfall as the following data indicate. The mean annual rainfall for Southern Cross is 285 mm; 1992 had 440 mm, 1993 had 318 mm, 1994 had 204 mm and 1995 had 476 mm. Work elsewhere in the Goldfields has demonstrated that rainfall, or the lack of it, has a direct and very pronounced bearing on the success of biological survey work (Chapman and Craig *in prep.*).

Table 1. Climatic Data for Southern Cross

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean monthly rainfall (mm)	13.9	20.0	21.3	22.9	34.3	41.6	38.2	30.9	18.5	16.0	15.2	12.4	285.2
Mean daily max. temp.	34.6	33.6	30.6	25.7	20.5	17.0	16.3	18.0	21.8	25.4	29.6	33.0	25.5
Mean daily min. temp.	17.2	17.1	15.1	11.4	7.6	5.7	4.4	4.8	6.4	9.2	12.8	15.5	10.6
Highest temperature	45.6	45.6	42.3	38.3	32.7	26.9	26.7	30.6	34.0	39.3	42.1	44.4	45.6
Lowest temperature	8.2	8.1	5.0	0.6	-3.3	-3.8	-3.0	-2.7	-1.6	-1.1	1.1	3.4	-3.8
Mean No. rainy days	2.6	2.9	3.3	4.8	7.5	10.3	10.7	9.2	6.1	4.7	3.5	2.6	68.3
Highest No. rainy days	10	11	10	12	24	20	25	18	13	11	12	9	-
Lowest No. rainy days	0	0	0	0	0	2	4	1	0	0	0	0	-

PREVIOUS BIOLOGICAL STUDIES AND RESERVATION PROPOSAL

The first biological studies of the Range and surrounds were those of Dell and How (1985) in which both Mt Jackson and the Range were study sites representing the Jackson-Kalgoorlie 'cell' of the System 11 biological survey of the eastern Goldfields. Data were recorded for 5 consecutive days in each of September 1979, April 1980 and November-December 1981. This study recorded data on vertebrates and flora from 7 quadrats 6 of which were in shrublands,

sandplains and woodlands north of the Range, one quadrat designated JK 18a was in a lower slope range habitat. The University of Western Australia conducted 11 field trips to the same sites as the previous study between 1989 and 1993 as student training in vertebrate community ecology. Together these studies revealed an extremely rich vertebrate fauna of 20 species of extant native mammals, 51 species of reptiles and 2 species of frogs. Of particular interest are two vicarious species pairs of mammals *Notomys mitchelli* and *N. alexis* as well as *Ningaui ridei* and *N. yvonnae* in sympatry . With 13 species of gekko; one of the the richest gekko assemblages in the world is present here, Chris Dickman *pers. comm.* in Henry-Hall (1990). Michael Craig *pers. comm.* has compiled a list of 91 bird species from both the above studies.

The Range and surrounds has also attracted the attention of botanists; in particular Ken Newbey, Steve Hopper, Franz Mollemans and Jeni Alford. As a result one endemic species, *Tetratheca aphylla*, which is declared rare,under the Wildlife Conservation Act, is known from the Range as well as 5 priority listed species known from surrouding sandplains and shrublands.

Henry-Hall (1990) summarized all existing biological and landform information and made the first boundary recommendations for a reserve incorporating the Helena and Aurora Range. Previously Keighery (1980) and Dell *et. al.* (1985) had indicated the high conservation values of the Range and surrounds and recommended a southern extension of the existing Mount Manning Range Nature Reserve. In the Regional Plan for the Goldfields Region, CALM (1994) endorsed the Henry-Hall (1990) proposal; currently the addition of 91 650 ha of vacant crown land including the Range as an extension to Mount Manning Range Nature Reserve has been approved by the Government (Figure 1). The extension is to have 'C' class status to be compatible with the existing reserve.

The purpose of the study reported here is to examine the banded ironstone landform of the Helena and Aurora Range and bring to parity data on its values for vertebrate and invertebrate fauna as well as vegetation and flora compared to the surrounding woodlands, sandplains and shrublands which by Western Australian standards have been particularly well studied.

PART 2 FLORA AND VEGETATION

Neil Gibson, Michael N. Lyons and Brendan J. Lepschi

ABSTRACT

A study was undertaken of the flora and plant communities of the Helena and Aurora Range. The range is formed from banded ironstone and basalts and is surrounded by an outwash plain derived from these units. Fifty-five quadrats were established and data from these were used to define six community types that were highly correlated with topographic position and slope. A total flora of 324 taxa was recorded from the range, of which 303 were native and 21 were weeds. The very good season of spring 1995 allowed extensive collections of annuals and geophytes to be made.

One species of Declared Rare Flora and 10 taxa listed on CALM's priority flora list were found on the range. One apparently new species of *Leucopogon* was on the range. Four taxa appear to be endemic to the Helena and Aurora Range, none of these taxa are currently reserved. A further five taxa are restricted to banded ironstone ranges or associated soils within 100 km of the Helena and Aurora Range and two of these are not reserved. Three taxa are recommended to be added to the priority flora list.

The floristic classification is in broad agreement with previous descriptions of the range but documents finer scale patterning than has previously been reported. A key to the major community types is provided. Data are not yet available to determine the conservation status of the major community types identified. Only a small proportion of the Bungalbin vegetation system is presently managed for conservation.

INTRODUCTION

Beard (1972) first described the major structural formations in the study area. He grouped his structural units into vegetation systems and defined the vegetation of the banded ironstones of the Helena and Aurora Range as forming part of the Bungalbin System. This system also encompasses the ironstone areas of the Hunt Range, the Watt and Yendilberin Hills to the east, the Mt Jackson Range to the west, a small range of hills to the north and the Koolyannobbing Range to the south. He describes the vegetation of these ranges as thickets dominated by *Acacia quadrimarginea, Acacia tetragonophylla*, *Dryandra arborea* (on rocky outcrops) and *Allocasuarina acutivalvis* with understoreys of such shrubs as *Dodonaea* spp., *Eriostemon brucei, Eremophila* spp., *Enchylaena tomentosa* and *Grevillea paradoxa*. The foot slopes of the Helena and Aurora Range and valley systems would fall into the *Eucalyptus salmonophloia - E. salubris* association of his very broad Jackson system. Keighery (1980) confirmed the occurrence of *Dryandra arborea* shrublands in the Die Hardy Ranges, Mt Jackson, Koolyanobbing Range, Mt Dimer, the Hunt Range and the Helena and Aurora Range.

Beard's pioneering work was followed up some years later with a major regional survey of the biota of the Eastern Goldfields, produced in a series of cell reports. The Jackson-Kalgoorlie report (Dell *et al.* 1985) covered the Helena and Aurora Range area. Dell *et al.* adopted a land system approach, somewhat broader than Beard's vegetation systems.

Newbey and Hnatiuk (1985) describe the vegetation of the Helena and Aurora Range under the heading, "Hills (banded ironstone formation)". They briefly describe the major structural units seen on the Helena and Aurora Range and note the *Dryandra arborea* shrublands on the steep upper slopes with *Eucalyptus ebbanoensis* mallee on the upper and lower slopes and *Acacia*

aneura low woodland on the pediment. They also note small areas of *Eucalyptus wandoo (=E. capillosa* subsp. *capillosa)* near the crest of the range.

Both Beard's survey and the later biological survey of the eastern goldfields were undertaken to provide regional overviews. Consequently the individual ranges were not sampled extensively. Indeed, only two sites from the Helena and Aurora Range are described in detail (Newbey and Hnatiuk 1985). The only other report on the vegetation of the study area is that of Henry-Hall (1990). This report details reserve recommendations for the southern goldfields. In the section on the proposed Bungalbin Hill extension Henry-Hall described the diverse nature of the vegetation of the range and provided a detailed description of some of the structural units.

The aim of the present work was to undertake a detailed floristic survey of the range to compile a detailed flora list for the range and the surrounding outwash areas, and to detail the vegetation patterning of this area.

METHODS

Fifty-five 20 m x 20 m quadrats were established on the range, its foot slopes and the outwash plain (Figure 2). These sites attempted to cover the major geographical, geomorphological and floristic variation found in the study area. Care was taken to locate sites in the least disturbed vegetation available in the area being sampled. Some difficulty was experienced in accessing the uplands of the western half of the Aurora Range due to lack of vehicle access but several foot traverses indicate that an adequate sampling of the tops and upper slopes has been achieved. No attempt was made to sample the Tertiary sand plain that surrounds the Helena and Aurora Range (Chin & Smith 1983).

Within each site all vascular plants were recorded. Twenty seven primarily upland sites were established in the last week of July 1995. These sites were revisited and a further 28 sites established in the last week of September 1995. Data on topographical position, slope, aspect, percentage litter, percentage bare ground, percentage exposed rock, vegetation structure and condition were collected from each site. Topographical position was scored on a subjective three point scale from ridge tops and upper slopes (1), to midslopes (2), and to lower slopes and broad flats (3). Slope was scored on a one to three scale from flat to steep. Aspect was recorded as one of 16 cardinal directions. Vegetation structure was recorded using Muir's (1977) classification.

All sites were permanently marked with four steel fence droppers and their positions fixed using a GPS unit (Appendix 1). Twenty four soil samples from the A horizon were collected and bulked from each site. These soil samples have not yet been analysed due to lack of resources.

Sites were classified according to similarities in species composition, in these analyses only perennial species were used to facilitate comparisons with classifications from other ranges in the area (Gibson & Lyons 1995, Gibson & Lyons *in prep.*).

The site and species classifications undertaken used the Czekanowski coefficient and "unweighted pair-group mean average" fusion method (UPGMA, Sneath and Sokal 1973). Semi-strong hybrid (SSH) ordination of the sites data was undertaken to show spatial relationships between groups and to elucidate possible environmental correlates with the classification (Belbin 1991). Statistical relationships between site groups for such factors as species richness, slope, aspect etc, were tested using Kruskal - Wallis non parametric analysis of variance (Siegel 1956).

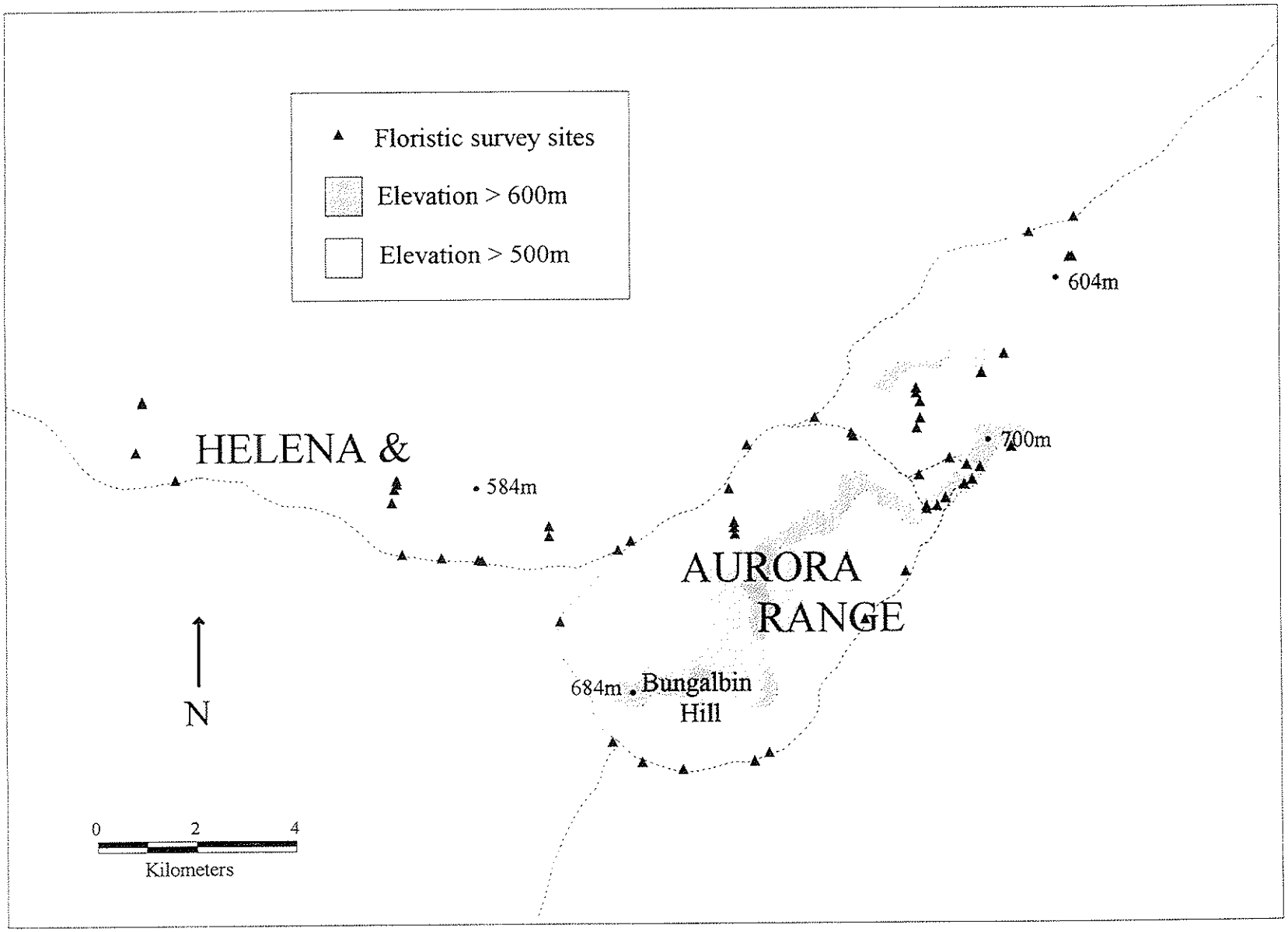


Figure 2. Study area showing location of floristic survey sites.

Nomenclature follows Green (1985) and current usage at the Western Australian Herbarium (PERTH). Selected voucher specimens will be lodged in PERTH.

RESULTS

FLORA

A total of 324 taxa (species, subspecies and varieties) were recorded from the Helena and Aurora Range. The flora list was compiled from taxa found in the 55 plots or the adjacent area, from opportunistic collections and from confirmed records held in PERTH (Appendix 2). Of these 324 taxa, 303 are native and 21 are weeds. The best represented families were the Asteraceae (50 native taxa and 6 weeds), Myrtaceae (30 taxa), Poaceae (12 native taxa and 8 weeds), Mimosaceae (17 taxa), Chenopodiaceae (14 taxa), Myoporaceae (14 taxa), Goodeniaceae (11 taxa), Fabaceae (10 taxa), and Proteaceae (10 taxa). This pattern is typical of the flora of the South Western Interzone (Newbey & Hnatiuk 1985). Good rains were experienced in the winter and early spring of 1995, reflected by the large numbers of annuals and geophytes on the flora list (Appendix 2).

The most common genera were *Eucalyptus* (19 taxa), *Acacia* (17 taxa), and *Eremophila* (14 taxa). Weed species were generally not a major component of the vegetation.

During the survey one species of Declared Rare Flora (DRF) was recorded along with 10 other taxa on CALM's priority flora list (CALM 1996). Two new populations of the DRF *Tetratheca aphylla* were located, as were new populations of some of the 10 priority taxa (Table 2, Figure 3). Previously one species of DRF and five priority taxa were known from the range (CALM 1994).

Table 2. Declared Rare Flora and Priority Flora found during the survey indicating the number of new populations located (CALM 1996).

Taxon	*Current priority listing*	*Number of new populations*
Acacia adinophylla ms	1	2
Acacia cylindrica	3	1
Daviesia purpurascens	4	3
Gnephosis intonsa	1	1
Grevillea erectiloba	4	3
Grevillea georgeana	3	1
Leucopogon breviflorus	2	6
Phlegmatospermum eremaeum	2	1
Prostanthera magnifica	4	1
Stenanthemum newbeyi	1	5
Tetratheca aphylla	R	2

Acacia adinophylla ms appears to be endemic to the Helena and Aurora Range. The understorey of the side slopes of the range is dominated by another range endemic, the undescribed grass *Neurachne* sp. Helena & Aurora (KR Newbey 8972) (Figure 4). This taxon is extremely widespread in the range but as yet has not been collected from any other range in the area. *Tetratheca aphylla* also appears to be endemic to the range. There is one collection in

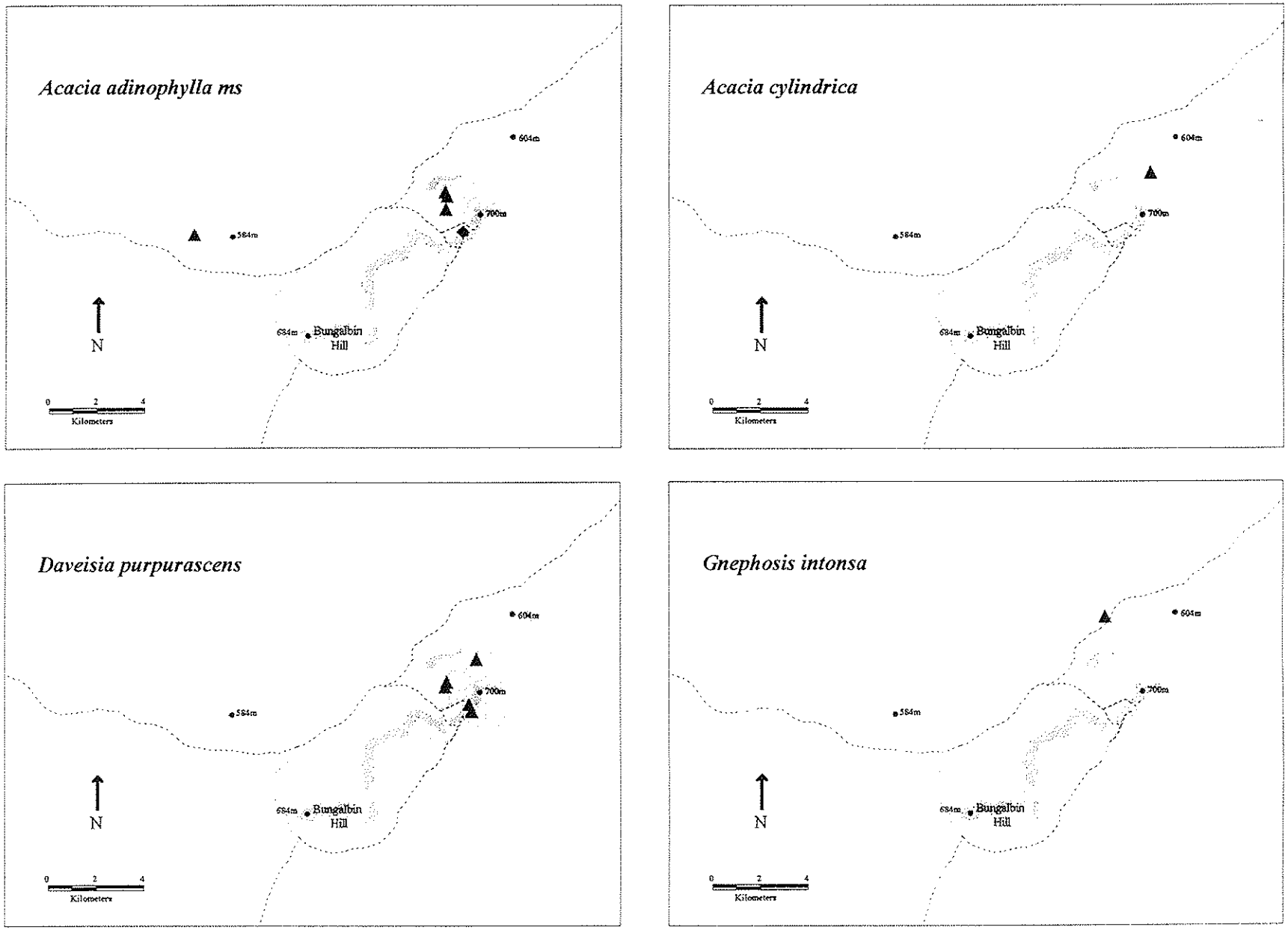
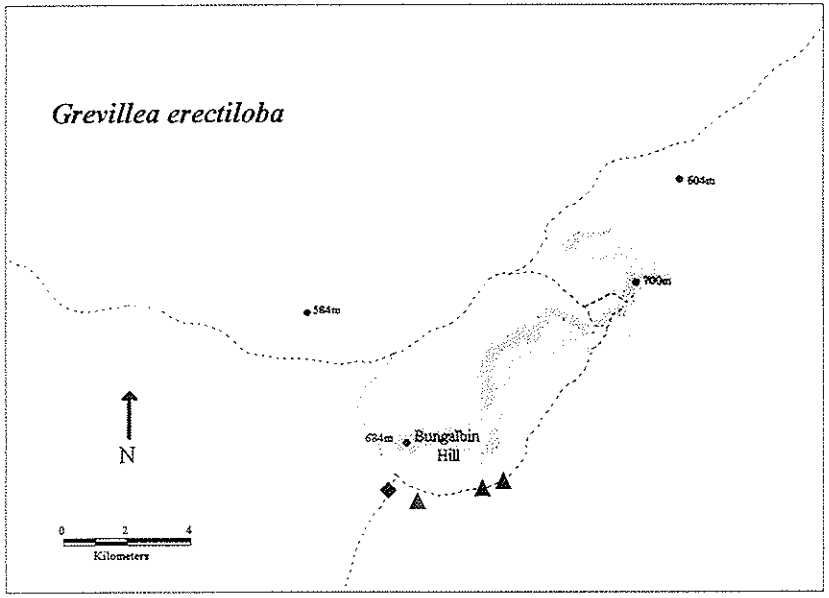
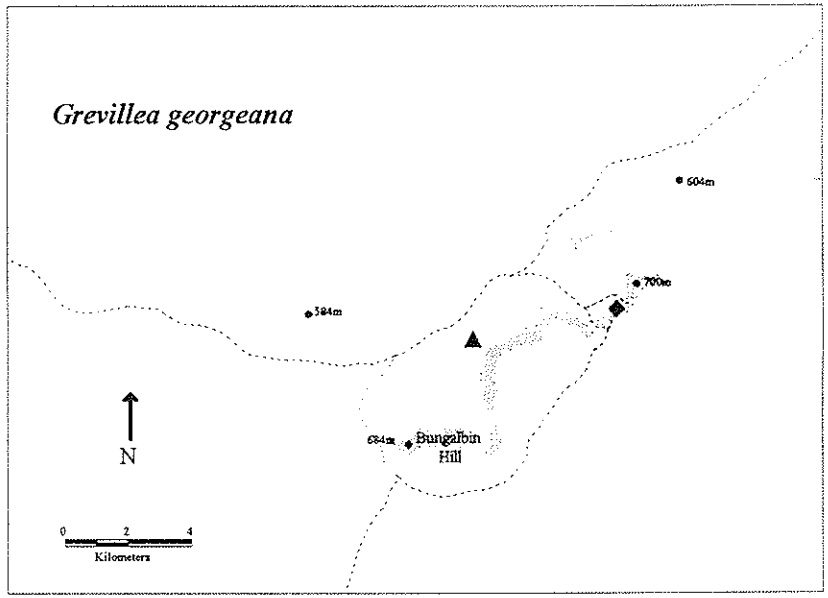
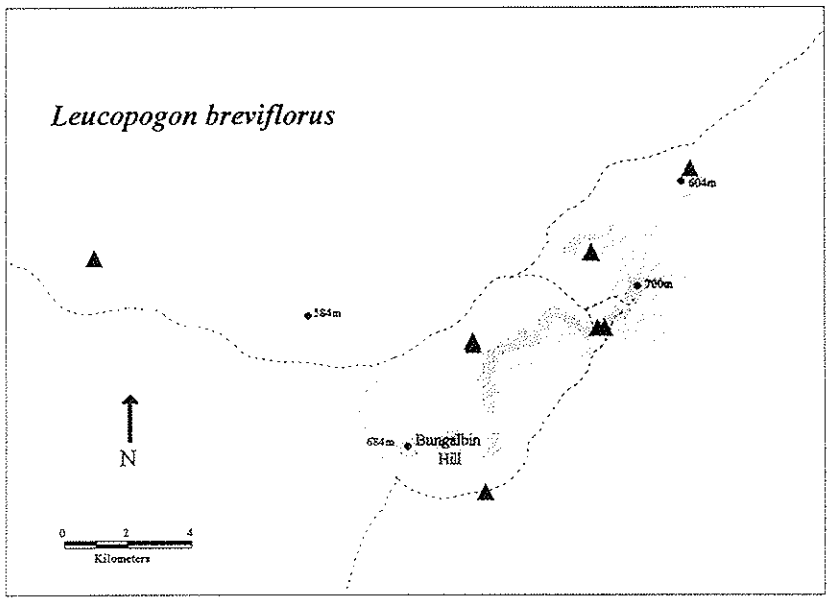
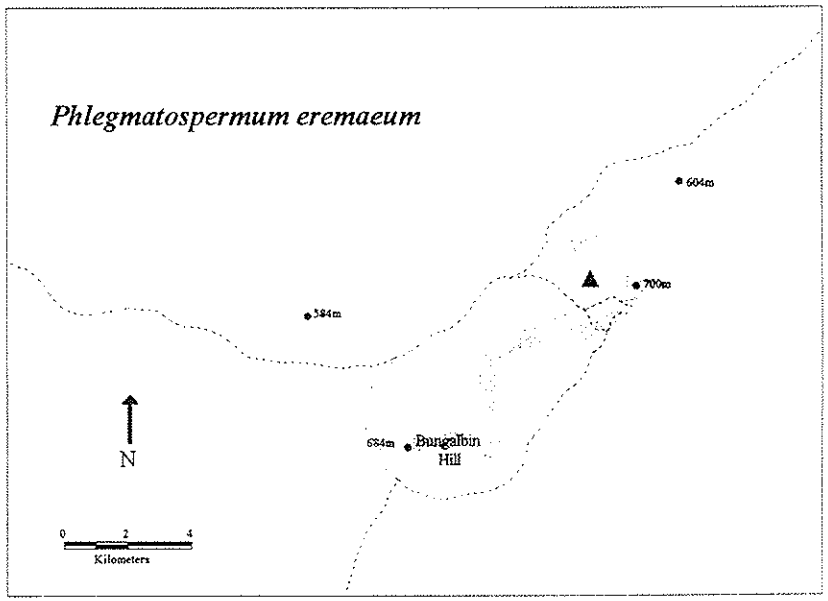


Figure 3. Populations of Declared Rare and Priority Flora recorded during the current survey. New populations (triangles) and known populations (diamonds).









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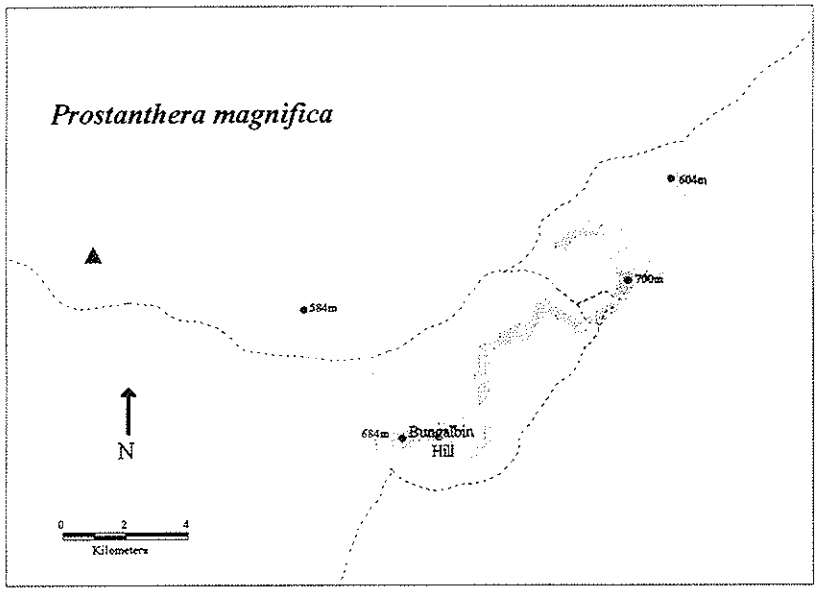
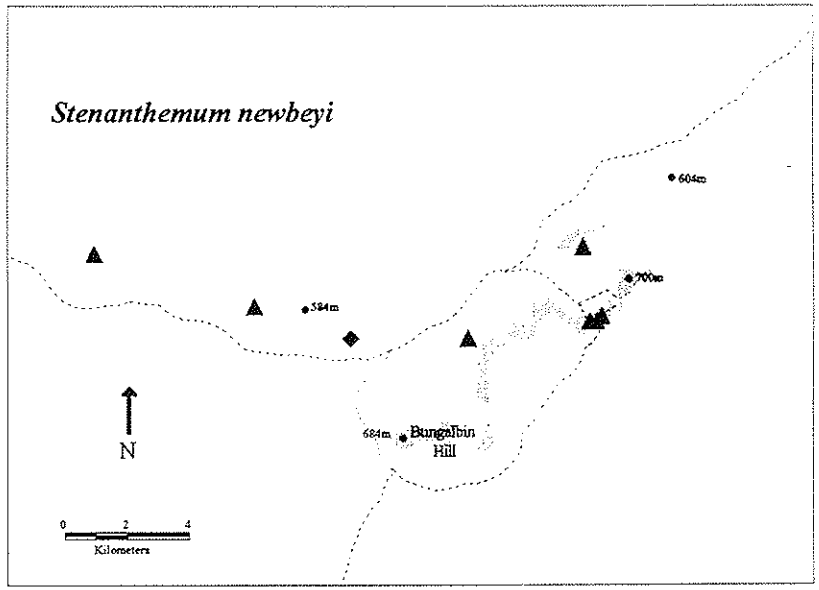




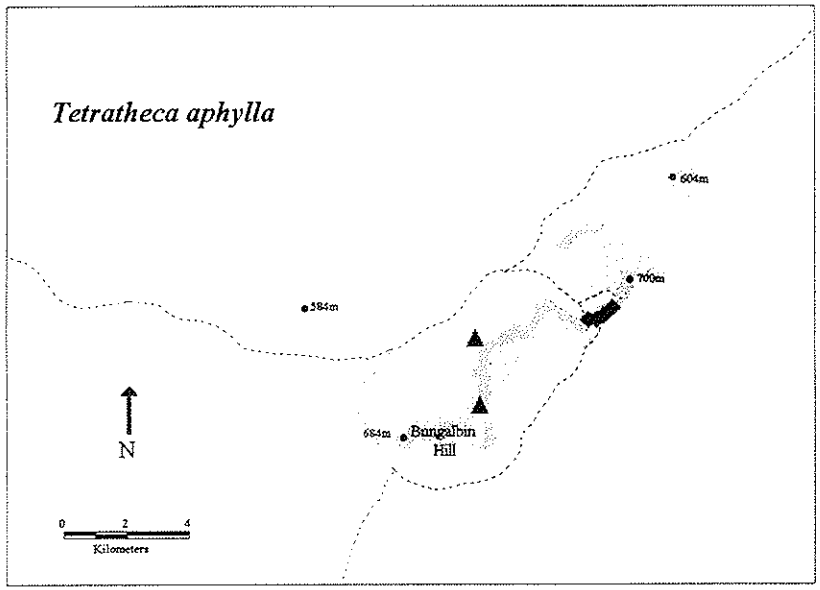


Figure 3. Cont'd.

PERTH with a location "10 km N of Bungalbin Hill", this appears to be in error and should read "10 km NE of Bungalbin Hill". Until recently *Stenanthemum newbeyi* was also believed to be restricted to the Helena and Aurora Range and nearby hills (Rye 1995), however recent field work has recorded this species on banded ironstones at Ennuin Station some 80 km to the south west.

Several other species (*A. cylindrica, Grevillea erectiloba, G. georgeana*, and *Mirbelia* sp. Helena & Aurora BJ Lepschi 2003) appear to be restricted to the banded ironstone ranges (or associated soils) within 100 km of Bungalbin Hill.

An undescribed species of *Leucopogon* was collected from a cliff line approximately 3 km east of Bungalbin Hill. This taxon (*Leucopogon* sp. Helena & Aurora BJL 2077) was locally abundant growing in association with *Tetratheca aphylla* but was not encountered elsewhere on the range. Another undescribed taxon, *Mirbelia* sp. Helena & Aurora (BJL 2003), was also collected on the range. This species has previously been collected from two locations, one north of the Hunt Range and the second in the Watt Hills. Both localities lie some 60 km from Bungalbin Hill. It is recommended that both these taxa be listed on CALM's priority flora list as Priority 1 and Priority 2 respectively (Table 3, Figure 4).

Table 3. Taxa from the study area requiring priority listing and the number of known populations

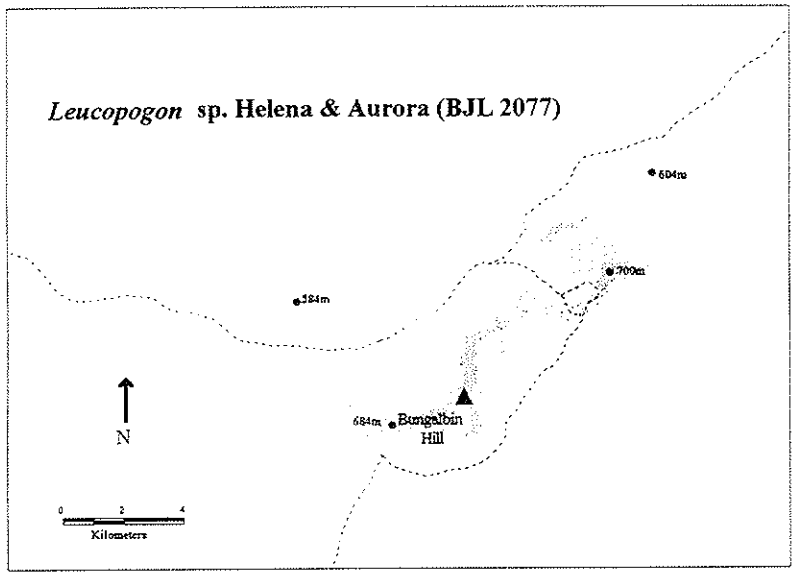
Taxon	*Recommended priority listing*	*Number of known populations*
Leucopogon sp. Helena & Aurora (BJL 2077)	1	1
Mirbelia sp. Helena & Aurora (BJL 2003)	2	3
Echinopogon ovatus	2	5

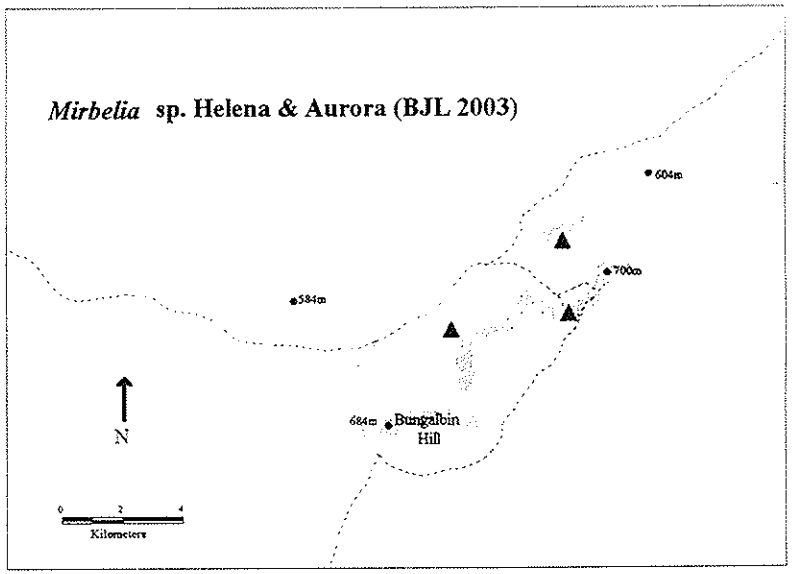
(Priority 1 taxa are defined as:- Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, eg. road verges, urban areas, farmland, active mineral lease, etc., or the plants are under threat, eg. 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 2 taxa are defined as:- 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 (ie not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.).

Daviesia purpurascens has recently been delisted from DRF to Priority 4. Data from this survey supports this reassessment. This species was found to be very widespread on the range, occupying both the massive ironstone tops as well as the side and midslopes.

Echinopogon ovatus was collected at the base of the same cliff line at which *Leucopogon* sp. Helena & Aurora (BJL 2077) was found. This grass is known from only six collections in Western Australia, one from near Onslow and the rest in the Margaret River - Nannup area. It is recommended that this species also be listed on CALM's priority flora list as Priority 2.





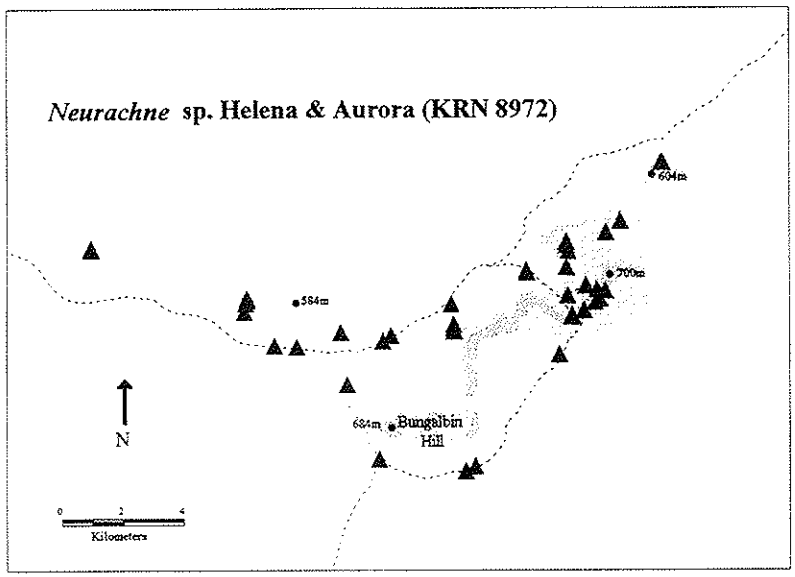


Figure 4. Populations of new and undescribed taxa recorded during the current survey.

VEGETATION

For the floristic analysis two species had to be amalgamated into a species complex due to difficulty of differentiating between them (*Vulpia myuros* and *V. muralis*). Only material that could be identified to species level was included in the analysis (c.99% of records). In the 55 quadrats established on the Helena and Aurora Range 233 taxa were recorded, 117 of these being perennials (see Appendix 3). Twenty seven perennials occurred at only one site. These singletons have little effect on the community classification and were excluded. As a result the final data set consisted of 90 taxa in 55 sites. Species richness ranged from three to 20 taxa per site, with individual taxa occurring in between two and 36 sites.

Multivariate analysis can assist in sorting both sites and species data such that patterns in species composition are more easily seen. The decision as to the number of site and species groups defined is subjective and related to the scale of pattern of interest (Kent and Coker 1992). In this analysis site groups are discussed at the six group level which best reflects the scale of patterning seen in the field.

The dendrogram shows the six community types recognised in the analysis (Figure 5). The primary division seen in the dendrogram between community types 1-4 and community types 5 and 6 separates skeletal and weathered soils of the uplands and slopes from the deeper calcareous fertile soils of the valley bottoms. This can also be clearly seen in the sorted two way table generated from the site and species classifications (Table 4).

Community types 1 and 2 are largely confined to the ridge tops and upper slopes of the Helena and Aurora Range. Both community types develop on skeletal yellow or red soils. Taxa in species group H are typical species of community type 1; these include *Acacia quadrimarginea, Grevillea zygoloba, Allocasuarina acutivalvis, Melaleuca nematophylla, Dryandra arborea* and *Calycopeplus paucifolius* (Table 4). This community is generally dominated or co-dominated by the species listed above. Average species richness was 14.7 taxa / plot.

Community type 2 was entirely restricted to the massive ironstone tops slopes and breakaways of the range. This community was generally dominated by either *Eucalyptus ebbanoensis* or, on the small breakaways, by *Eucalyptus capillosa* subsp. *capillosa*. Taxa from species group B, H and I are most consistently present, but with a lower representation of taxa from species group H compared to community type 1. Average species richness was 13.6 taxa / plot.

The open side slopes of the Helena and Aurora Range are primarily occupied by community type 3. This community is generally dominated or co-dominated by *Eucalyptus ebbanoensis* and / or *E. corrugata*, with an understorey dominated by the *Neurachne* sp. Helena & Aurora (KRN 8972). Occasionally this community may be dominated by *Acacia* spp. rather than the eucalypt species. Typical taxa of this community are species in species groups A and B. Taxa in species groups D, F, G, H and I are completely or almost completely lacking from this community type (Table 4). Average species richness was 10.5 taxa / plot.

Community type 4 was restricted to the lower slopes and flats below the range. It was a species-poor community (in terms of perennials) with an average species richness of 7.9 taxa / plot. This community was variously dominated by *Acacia aneura, A. resinimarginea* or *A. acuminata*, or occasionally by *Eucalyptus ebbanoensis* and / or *E. hypochlamydea* subsp. *hypochlamydea*. Where eucalypts dominated, the understorey included taxa such as *Grevillea zygoloba* and *Eremophila clarkei*, species more typical of upland areas. The only understorey species that were largely constant to this group are *Neurachne* sp. Helena & Aurora (KRN

8972), *Austrostipa elegantissima, Olearia pimeleoides* and *Dianella revoluta* (Table 4). It differed from community type 5 which also occurs on the flats below the range by the almost complete lack of chenopod species.

Figure 5. Dendrogram of the sites from the Helena and Aurora Range area showing the six group level classification.

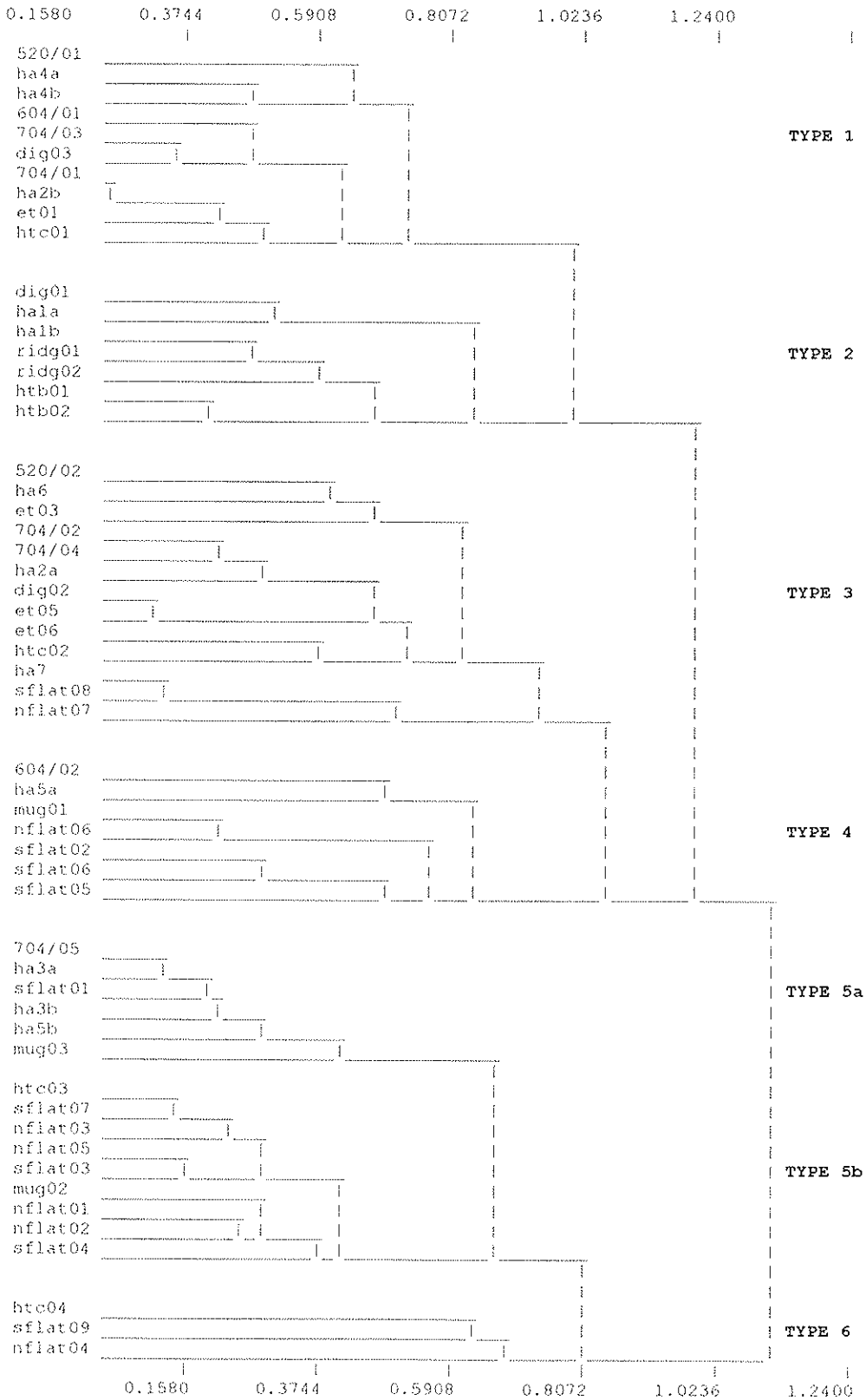
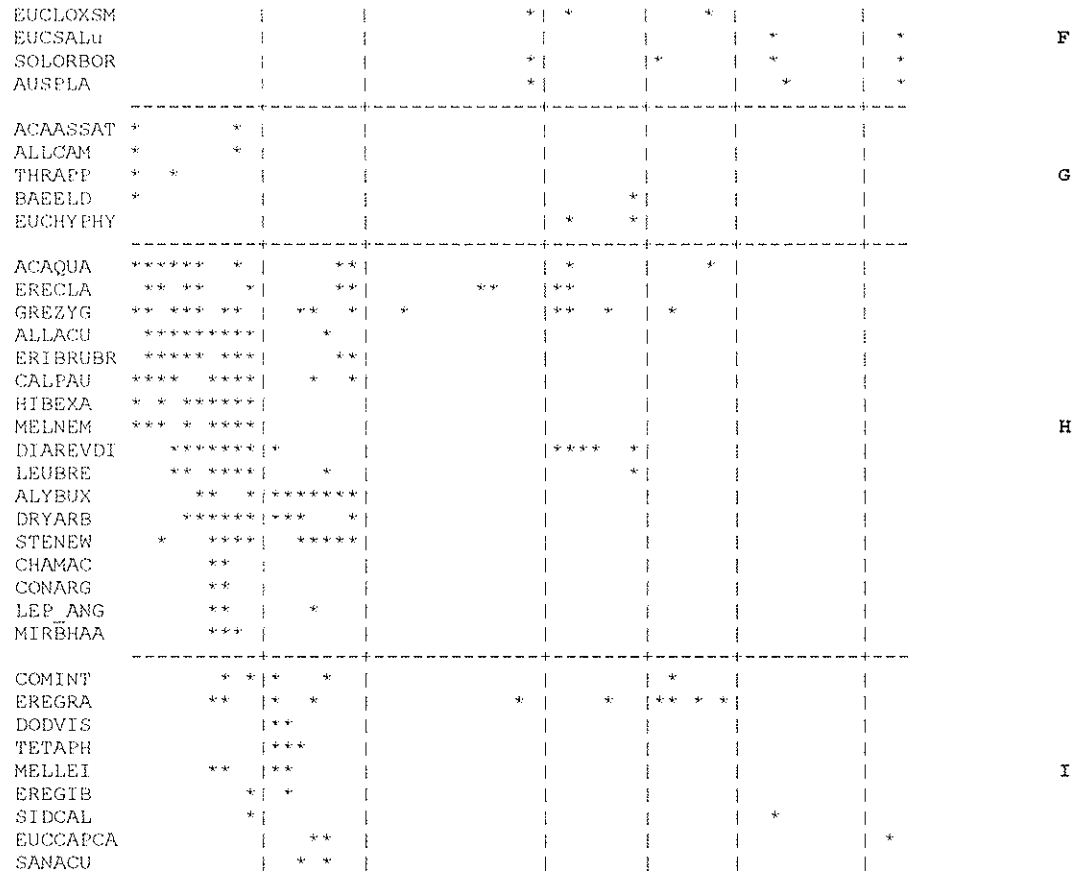


Table 4. Sorted two way table of the Helena and Aurora Range sites showing species occurrence by community type. Site codes appears as columns, species code as rows (see Appendix 2 for full species names).

```
                               COMMUNITY TYPE
                  1          2            3           4          5         6
TAXA                                                        a         b          SPECIES
                                                                                  GROUP
            5hh67d7heh|dhhrrhh|5he77hdeehhsn|6hmnsss|7hshhm|hsnnsmnns|hsn
            2aa00i0att|iaaiitt|2at00aitttaff|0auffff|0afaau|tffffufff|tff
            04444g420c|g11ddbb|060442g00c711|45g1111|43135g|c1111g111|c11
            /ab//0/b10|0abgg00|/ 3//a0560 aa|/a0aaaa|/aabb0|0aaaa0aaa|0aa
            0  0030  1|1  0012|0  00 2  2 tt|0 1tttt|0 t  3|3tttt2ttt|4tt
            1  13 1   |   12  |2  24      00|2  0000|5 0   | 0000 000| 00
                      |       |           87|   6265|  1   | 7353 124| 94
                      |       |             |       |      |         |
                      |       |             |       |      |         |
ACAACU                |       |          ***|       |   *  |         |
ACAPRA                |       | **       ***|       |      |         |
ACARES                |       |  *       ** |     **|      |         |
PHECAN                |       |  *       ** |      *|      |         |
CASMEL                |       |  *       *  |       |      |         |
DAVPUR                | *     |*     **  *  |       |      |         |           A
ERERUG                |       |      **  ** |       |      |      ** |
SANSPI         * *    |      *|       ** * *|       |      |         |
ACAADI        *       |       | **    *     |       |      |         |
ACAERE                |       |* *          |       |      |         |
GREHAPHA              |       |  *     *    |       |      |         |
            ----------+-------+-------------+-------+------+---------+---
ACAERI                |       |**   *  *    |       |      |     **  |
MAIRAD                |       | *           |       |*     |     *   |
ACATET                | *   * |             |       | *  **|         |
DODMIC                |     * |        *    |       |      |         |
DODLOB               *|    ***| *  *        |       |      |         |
EREOPP                |  *****| *  **       |*      |     *|*        |
SCASPI                |     **|***          |*      |**   *|        *|
WESCEP                |  ** * |***     * *  |       |      |         |           B
EUCCOR                |       |*  ********* |       |***** |         |
EUCEBB        *   *   |***  **|********* ** |*      |****  |         |
NEUHAA      **********|***   *|********** **|*******|******|         |
PTIOBO               *|*   *  |*  **  *    *|       |******|      *  | **
OLEMUE        *       |****** |**   ****  * | *     |*** * |***** ** | *
AUSELE         *******|* *****|      **  ***| * *** |******|*********|**
OLEPIM       *       *|*    **|  *     **** | * ****|***   |         |
            ----------+-------+-------------+-------+------+---------+---
ACAANE           *    |       |             |  ***  |      |         |
HAKMIN                |       |          ** |    ** |      |         |
PROGRY          **    |       |           * |    ***|      |         |
ACACOOEF        *     |       |             |    *  |      |         |           C
BRAGRE          *     |       |             |       |     *|         |
ERELAT       *  *     |       |             |       |      |         |
            ----------+-------+-------------+-------+------+---------+---
ACACOL                |       |  *          | *     |  *   |   **    |
EUCLON                |       |             |       |      | * **    |
EUCYIL                |       |             |       |      |   **    |
EUCSHE                |       |             |       |      |** *   * |           D
EREINT                |       |             |       |      |*       *|
ERESCO                |       |             |       |      |*** *   *|
EREION                |       |*            |    *  |      |    *   *|
            ----------+-------+-------------+-------+------+---------+---
ATRNUM                |       |*            |       | ***  |*********|
SCLDIA                |       |             |       | *****| ********|  *
ATRVES                |       |             |       |   * *|*********|* *
MAIGEO                |       |    **   *   | *     |******|*** *****|
MAITRI                |*      |*   *        |       |******| *** *** |
ENCTOM                |*      |            *|       |     *|     *   | *         E
EREDECDE              |       |          ***| *   * |   * *|      *  |
RHADRU                |       |            *|       | * * *|      *  |
SENARTFI      *       |       |*         ***|       |** ** |  *** *  |
EUCSALm               |       |             |       |      |      ***|
MAITOMTO              |       |             |       |     *|      *  |
SCLFUS                |       |             |       |  *  *|     ** *|
BOSWAL                |       |             |  *    |      |       * |
EUCTRA                |       |             |       |      |     * * |
EXOAPH            *   |*     *|      *      |       |      |    *  * |
            ----------+-------+-------------+-------+------+---------+---
ACAHEM                |       |             |       |    * |         |*
```



Community type 5 consisted of the eucalypt woodlands on the flats below the range with a diverse chenopod understorey. No single eucalypt species consistently dominated this community type with species such as *Eucalyptus salmonophloia, E. salubris, E. longicornis, E. sheathiana, E. transcontinentalis, E. ebbanoensis* and *E. corrugata* dominating at different sites. Taxa in species group E (mainly chenopods) largely defines this group (Table 4). This group was quite species-rich with an average of 13.1 taxa / plot. This group can be further subdivided into two subgroups. Type 5a are those woodlands close to the change in slope where *E. ebbanoensis* and *E. corrugata* form an overstorey over chenopods and *Neurachne* sp. Helena & Aurora (KRN 8972). Type 5b is more typical of the extensive flats between the ranges where these slope species drop out. Indeed type 5a can be considered transitional between community type 3 and type 5b.

The final community type consists of three heterogenous species-poor quadrats (average species richness 4.7 taxa / plot). One quadrat appears to be related to the *Eucalyptus capillosa* subsp. *capillosa* stands classified into community type 2 and the other two quadrats appear to be species-poor examples of community type 5. The numerical techniques used in this analysis are known to be sensitive to species richness.

Physical correlates

It is clear from the above community descriptions that one of the primary correlates with community type is topographic position and slope class. Significant differences were found between community means for these parameters (Table 5). Community type 2 was entirely restricted to tops and upper slopes, while community type 1 extended down to the midslopes where suitable outcropping of banded ironstone occurred. Both community types were

restricted to the steeper slope classes (Table 5). Community type 3 occurred at an intermediate position in the landscape and consequently occurred across a broader range of slope classes. Community types 4 and 5 occurred low in the landscape, generally on gentle slopes.

There was also significant differences between the community types in percentage exposed rock and percentage litter cover (Tables 6 & 7). Percentage exposed rock showed a similar pattern to slope, with highest degree of rock exposure in those community types on the steepest slopes while percentage litter cover showed the inverse pattern.

Ordination results

Ordination of the site data was undertaken to show spatial relationships between groups and to better elucidate possible environmental correlates with the classification. The results of a two dimensional ordination (stress level 0.24) shows clear separation of most of the classificatory groups (Figure 6). The upland and upper slope community types (1 and 2) occur in upper left quadrant while the midslope and valley floor types (3 and 5) occur in the lower right quadrant. Community type 4 on yellow or red loams falls in an intermediate position. Further interpretation of the ordination may be possible when soil chemistry and soil mechanical data become available.

Table 5. Whisker plots of slope class (1=flat to 3=steep) and topographic position (1=uplands and upper slopes, 2=midslopes, 3=lower slopes and valley bottom) showing differences between the means of the floristic community types (Community types are rows, soil parameters are columns)

KEY

L=lower limit.....1=1st Quartile.....M=mean
D=Median.... .3=3rd quartile.....U=upper limit
*=more than one symbol at print position

Topography class Kruskal-Wallis: 35.743 df: 5 Probability: < 0.0001

```
  1.000               1.500               2.000               2.500               3.000
GRP +-------------------+-------------------+-------------------+-------------------+

 1  *===M============3-----------------------U
 2  *
 3  L-----------1======================M=====D=============3------------------------U
 4                                           L---------1=================M==========*
 5                                           L1===================M=================*
 6  L---------------1=====================================M=========================*
```

Slope class Kruskal-Wallis: 19.726 df: 5 Probability: 0.0014

```
  1.000               1.500               2.000               2.500               3.000
GRP +-------------------+-------------------+-------------------+-------------------+

 1                                           L--------1==================M==========*
 2                                           L-1===================M================*
 3  L------------------1=====================D=M=========================3----------U
 4  L----------1=================M===========*      3
 5  L-----------1=================M==========*      3
 6  *==========================M=====================================3--------------U
```

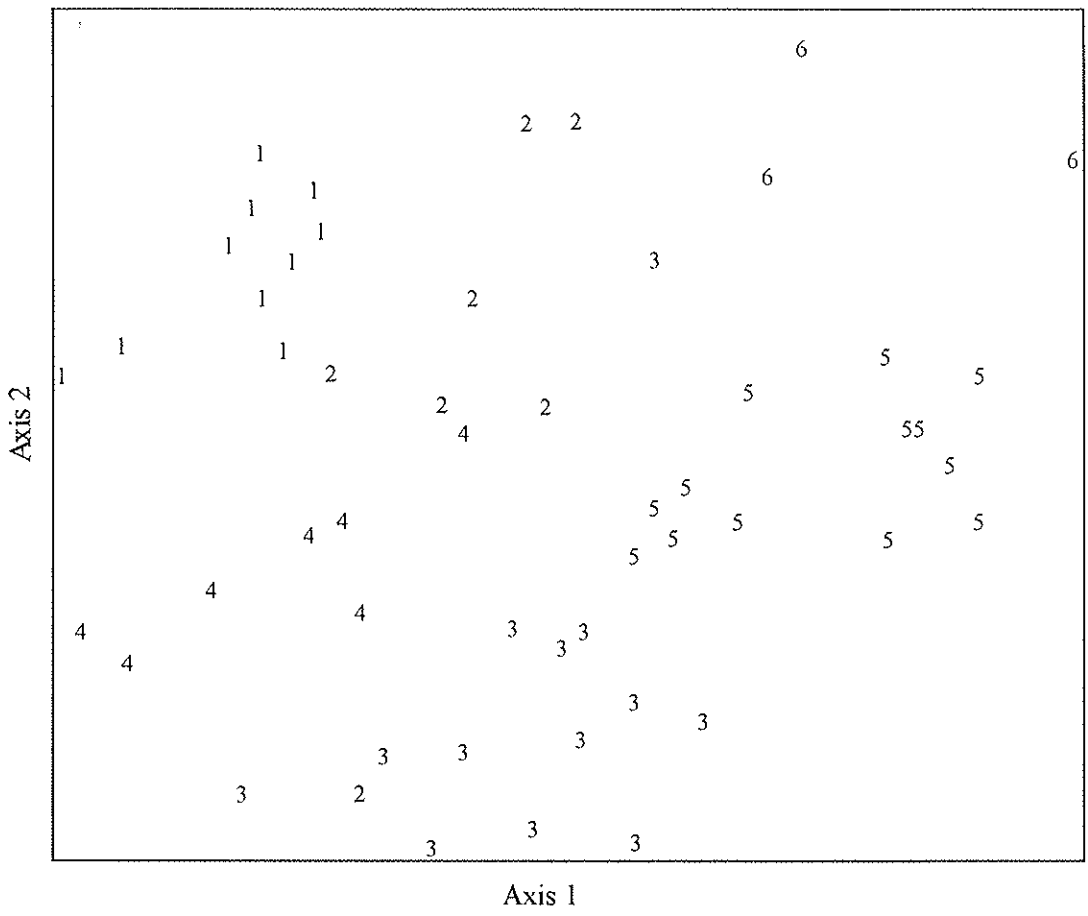


Figure 6. Ordination of sites. Numbers correspond to floristic groups.

Table 6. Degree of rock outcrop in plot by community type.

Community type	< 25% surface rock	25-50% surface rock	> 50% surface rock	Number of quadrats
1		2	8	10
2			7	7
3	4	1	8	13
4	4	1	2	7
5	10	2	3	15
6	2		1	3

Table 7. Degree of litter cover in plot by community type.

Community type	< 25% litter	25-50% litter	> 50% litter	Number of quadrats
1	6	4		10
2	7			7
3	10	2	1	13
4	4	3		7
5	3	9	3	15
6	1		2	3

DISCUSSION

Three hundred and twenty four taxa were recorded from the Helena and Aurora Range. Little detailed survey work has been carried out on the individual ranges of the goldfields. Some recent work has also been completed on the Bremer Range (c. 240 km to the south east) and the Parker Range (some 130 km to the south) (Table 8) (Gibson & Lyons 1995).

Table 8. Comparison of the floras of the Helena and Aurora Range , the Bremer Range and the Parker Range.

	Helena & Aurora Range	Bremer Range	Parker Range
Total taxa	325	269	256
Declared Rare Flora	1	1	-
Priority taxa	10	6	8
New taxa	1	2	2
Eucalyptus spp.	19	30	29
Acacia spp.	17	17	20
Eremophila spp.	14	11	7
Melaleuca spp.	5	19	14

The higher number of taxa recorded at the Helena and Aurora Range compared to the other two ranges most likely reflects a seasonal component. Good rains prior to the 1995 season lead to a

profusion of annual taxa compared to the 1994 season (when the other ranges were sampled), which was very poor for annual species and geophytes.

The similar numbers of priority taxa that have been recorded from the ranges indicates the poor state of knowledge of a significant number of taxa from these range systems. This is further borne out by the discovery of one or two new taxa on each range for a limited survey effort, generally less than 10 days per range.

The data also shows significant biogeographical differences in the most species-rich genera between the Helena and Aurora Range and the ranges to the south. *Eucalyptus* and *Melaleuca* numbers drop off toward the north, while *Acacia* numbers stay roughly constant and numbers of *Eremophila* spp. increase northward.

The current survey has identified three taxa that should be listed on the CALM priority list. Two taxa (*Leucopogon* sp. Helena & Aurora (BJL 2077)\ and *Mirbelia* sp. Helena & Aurora (BJL 2003)) have very limited distributions while the third (*Echinopogon ovatus)* has an outlying population in the Helena and Aurora Range (main distribution in Margaret River - Nannup area, but also with a record from Onslow).

Our data and records from the WA Herbarium show that four species appear to be endemic to the Helena and Aurora Range and a further five taxa are regional endemics (found within 100 km) of the banded ironstone ranges and associated soils of this area (Table 9). The majority of these taxa are not known from any conservation reserve.

Table 9. Local and regional endemic taxa.

Taxon	**Endemic status**	**Reservation status**
Acacia adinophylla	Endemic to Helena & Aurora Rg	Not reserved
Leucopogon sp. Helena & Aurora (BJL 2077)	Endemic to Helena & Aurora Rg	Not reserved
Neurachne sp. Helena & Aurora (KRN 8972).	Endemic to Helena & Aurora Rg	Not reserved
Tetratheca aphylla	Endemic to Helena & Aurora Rg	Not reserved
Acacia cylindrica	Regional endemic	Known from 1 reserve
Grevillea erectiloba	Regional endemic	Known from 2 reserves
Grevillea georgeana	Regional endemic	Known from 1 reserve
Mirbelia sp. Helena & Aurora (BJL 2003)	Regional endemic	Not reserved
Stenanthemum newbeyi	Regional endemic	Not reserved

The vegetation patterning encountered on the range was highly correlated to topographic position and substrate (as in Gibson & Lyons 1995). Two community types were restricted to upper slopes, there was a broad midslope community type and two community types were found on the lower slopes and flats. This classification, although based only on presence / absence data, accords well with the structural descriptions of Beard (1972), Newbey and Hnatiuk (1985) and Henry-Hall (1990), but provides more detail and shows relationships between the floristic groups.

Significant differences in species richness were found between different community types (Table 10). The species poor community type 6 had significantly less species than all other

community types except for type 4. The shrublands on the massive tops (community type 1) were significantly richer than community types 3 (side slopes) and 4 (foot slopes) but had a similar richness to eucalypt - chenopod woodlands (type 5) of the valley flats. The other upland community type (type 2) had a lower richness than community type 1 and was again significantly richer than community type 4.

It is interesting to find the highest species richness of perennial taxa at both ends of a presumed productivity gradient. Community types 1 and 2 occur on skeletal soils on massive banded ironstones while community type 5 occurs on deep clay-rich soils of the outwash plain.

Table 10. Species richness of community types (based on perennials) from the Helena and Aurora Range with singletons excluded. Means which are not significantly different (P > 0.05 Mann Whitney U-test) are indicated by superscript of same letter.

Community type	**Mean**	**Standard deviation**
1	14.70^{a}	3.466
2	13.57^{ab}	2.499
3	10.54^{bc}	3.815
4	7.86^{cd}	2.850
5	13.13^{ab}	2.446
6	4.67^{d}	1.247

Given the strong correlations with substrate and topographic position it was possible to generate a key to the major floristic units found on the range (Table 11), despite the fact that the community classification was derived from presence / absence data only. It should also be possible to map the floristic units from good quality aerial photography.

Table 11. Key to the major floristic community types found on the Helena and Aurora Range.

1. Upland or midslope sites on massive banded ironstone.
    2. Shrublands or woodlands not dominated by eucalypt species.
    Community type 1.
    2. Woodlands dominated by *Eucalyptus ebbanoensis* and /or *E. corrugata* or *E. capillosa* subsp. *capillosa* with *Alyxia buxifolia* and / or *Stenanthemum newbeyi* in understorey. *Community type 2.*
1. Midslope or valley bottoms not on massive banded ironstones.
    3. Midslope community dominated by *Eucalyptus ebbanoensis* and /or *E. corrugata* over *Neurachne* sp. Helena & Aurora (KRN 8972), chenopods absent.
    Community type 3
    3. Lower slope or valley.
        4. Community type generally dominated by *Acacia* spp. or if dominated by eucalypts then with *Eremophila clarkei* and *Grevillea zygoloba* present.
        Community type 4
        4. Community dominated by eucalypts over chenopod shrublands
        Community type 5

Some of the floristic units showed some degree of internal heterogeneity and with further sampling it may be possible to describe further subtypes. For example, community type 2 contains two sites dominated by *Eucalyptus capillosa* subsp. *capillosa* which are structurally

distinct from the other quadrats in this group. One quadrat in community type 6 also appears to be a depauperate example of this subunit.

Similarly, community type 4 has potential for subdivision into a mulga subgroup, an *Acacia resinimarginea* subgroup and a eucalypt subgroup. More data would need to be collected from these communities to determine subgroup structure.

Community type 6 does not appear to be a natural group. One quadrat appears to be related to community type 2 while the other two quadrats appear to be related to community type 5. Interestingly, in a classification of the full data set (perennials, geophytes and annuals) the *E. capillosa* subsp. *capillosa* quadrat falls with the other quadrats dominated by this species (community type 2), but the remaining two quadrats form the centre of a small group of species-poor sites restricted to the flats. Further sampling of this community type is needed to clarify its relationships to other communities of the flats.

The endemic taxa of the Helena and Aurora Range are completely unreserved. Beard (1972) places the vegetation of the range into his Bungalbin system, a small part of which occurs on Jaurdi Station to the east. CALM holds the lease to this station and has recommended the southern area become State Forest and the northern part become a Nature Reserve (CALM 1994, Figure 1). As yet it is not possible to determine if the community types found on the Helena and Aurora Range also occur on the banded ironstone areas on Jaurdi Station. The bulk of Beard's Bungalbin vegetation system occurs from the Helena and Aurora Range west to the Mt Jackson area. None of this area is in the current reserve system.

It is regrettable that past exploration activity in the area was not rehabilitated. Track and grids left in this environment take many years to recover due to the slow growth rates found in these environments. Some of the tracks left on steeper slopes show significant erosion.

The results of this study support the recommendations of Keighery (1980), Henry-Hall (1990) and CALM (1994) that the Helena and Aurora Range should be declared an A-class Nature Reserve vested in the NPNCA for the protection of flora and conservation of the ironstone vegetation communities.

PART 3 VERTEBRATE FAUNA

By Andrew Chapman and Grant Pronk

METHODS

The approach taken to sampling vertebrate fauna in the Helena and Aurora Range was determined by two factors. Firstly the requirement to make a comparable effort in sampling the banded ironstone (BIF) landform as had been made for other landforms surrounding the Range during previous surveys. There was also the opportunity to look at the influence of position in the Range ie altitude on faunal utilization of its habitats as there is a decrease in soil depth and an increase in banded ironstone exposure with increasing altitude. Thus having recognized 'crest','upper slope' 'mid-slope','lower slope' and internal 'valley' primary habitats which corresponded roughly with different, but consistent vegetation structure and floristics it was necessary to allocate trapping effort to cover the spatial extent of the Range as well as variation within each primary habitat. Three transects, each with quadrats in each of the primary habitats were established to achieve these requirements. One quadrat was established in an internal valley in a section of the Range with complicated structure. Seven quadrats were used, their locations are indicated in Figure 7.

Each quadrat comprised a paired line of pit traps with a joining drift fence. Each line comprised 6 x 20 litre buckets 40 cm deep with an aperture diameter of 29 cm at a spacing of approximately 10 m joined by a 30 cm high aluminium fly wire fence which was set into the soil. On account of the rocky nature of the substrate it was necessary to drill the banded ironstone with a rockdrill to insert an a explosive charge to fracture it before digging a hole to accomodate each pit trap. A cage trap for larger fauna was set at each quadrat. In addition 3 lines each of 20 Elliott traps were set either on very steep slopes occupied by *Eucalyptus capillosa* woodland or on ridges with massive banded ironstone exposure. Thus each quadrat became a primary sampling site for small mammals, reptiles, frogs and ground inhabiting invertebrates.Trapping effort was 720 pit trap nights and 480 Elliott trap nights. In addition to pit trapping each quadrat was searched for litter inhabiting and nocturnal fauna. At each quadrat vertebrate fauna was identified, weighed, measured (snout-vent length for reptiles and hindfoot and ear for some mammals), marked with a texta pen (except gekkoes) and released. A small number of voucher specimens were lodged in the Western Australian Museum to confirm identifications (see Appendix 5). Photographers Jiri and Marie Lochmann photographed a range of mammals and reptiles from the September 1995 sampling session. Birds were recorded opportunistically at each quadrat and as well in surrounding woodlands while travelling from quadrat to quadrat. Mist nets were set for bats, but mist-netting was unsuccessful due partly to the windy conditions at night in the Range.

Reconnaisance, site selection and pit trap setting was undertaken 22-27 July 1995. The first sampling session was between 22-29 September 1995 and the follow up between 24 February and 1 March 1996. For the Spring survey, weather was cool-warm, minimum temperatures ranged 10-15°C with mean 12.2°C and maximum temperatures ranged 20-30°C with mean 24.6°C and light rain on two occasions; for the Summer survey warm to hot weather prevailed. Minimum temperatures ranged 13-22°C with mean 15.8°C, and maximum temperatures ranged 30-39°C with mean 33.8°C. There was no rain, though there were summer thunderstorms in the vicinity.

All data was entered into a data base, some 350 entries were classified as either CR (for Range crest including quadrats 1, 4 and Elliott site E3), US (for upper slope including Elliott sites E1 and E2), MS (for mid slope including quadrat 2), LS (for lower slope including quadrats 3, 5 and 6) and VL (for internal valley including quadrat 7). Thus this data base (Appendix 5)

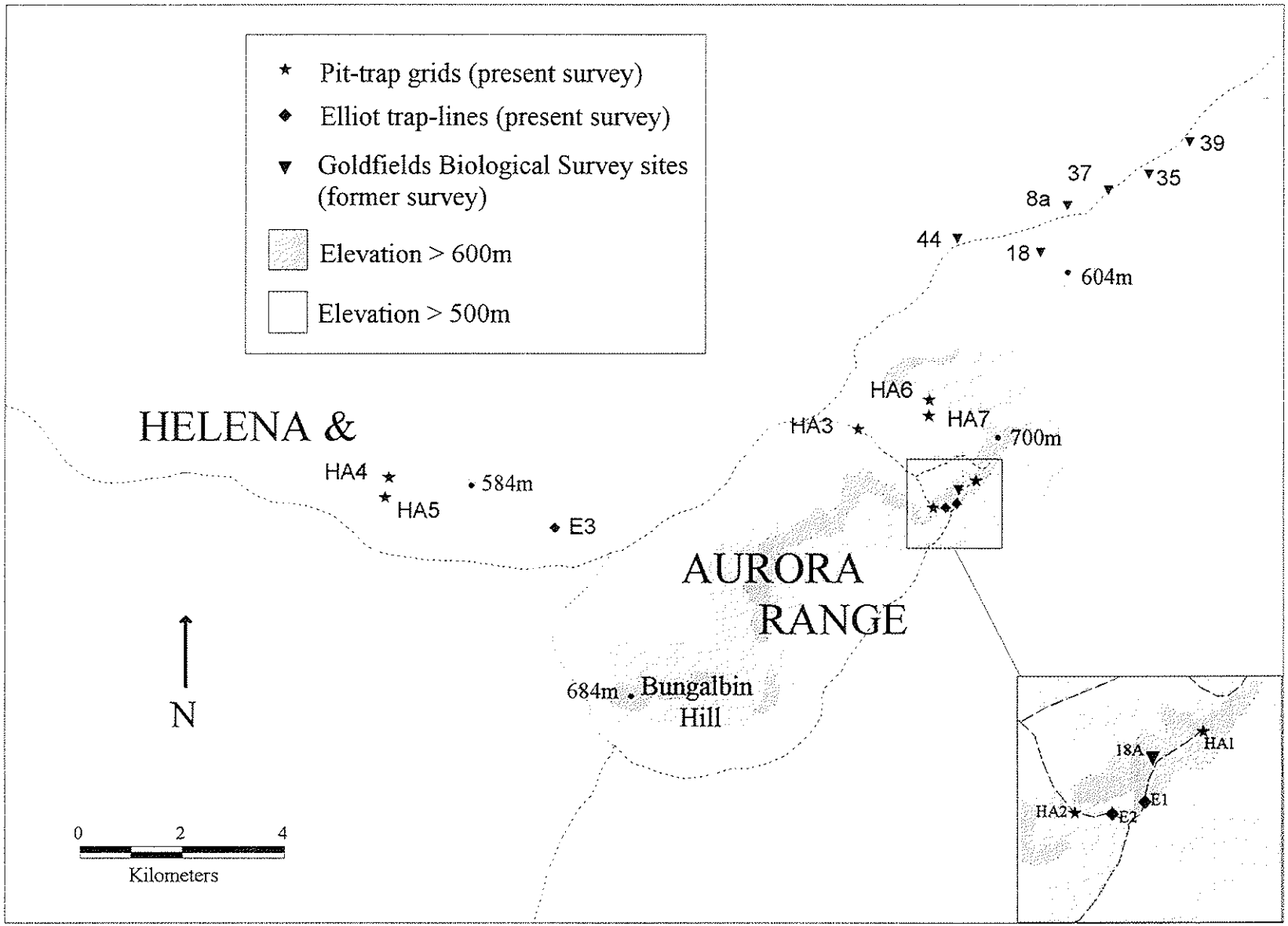


Figure 7. Fauna quadrat locations, Helena and Aurora Range.

forms a list of all vertebrate fauna utilising the Range as a distinct landform and indicates some degree of habitat discrimination within the Range. A secondary data base (Appendix 6) records all fauna recorded in peripheral woodlands. In the annotated list a 'record' refers to a notebook, data sheet or data base entry; irrespective of size of flock or number of individuals seen at any one point.

RESULTS

This survey reveals that the vertebrate fauna of the Helena and Aurora Range, as a distinct landform, comprises 8 species of native mammal, 52 bird species, 28 reptile species and one amphibian. Complete data are in the primary and secondary data bases (Appendices 5 & 6) which are summarized in the following annotated lists.

MAMMALS

Euro (*Macropus robustus)*
Six records, usually of solitary animals; one pair and twice a group of three, including a female with pouch young were recorded in February. Most were in crest or upper slope habitats, once in lower slope woodland.

Pygmy Possum (*Cercartetus concinnus*)
Five records including one recapture; from quadrats 1A (1), 3B (1) and 4B (3). Four of five records were on Range crest habitats ie *Eucalyptus ebbanoensis* over *Neurachne sp.* on exposed BIF surfaces. One record on Range lower slope *Eucalyptus corrugatai* woodland. All records were in Spring, one female weighed 10.0g, males weighed 9.0-12.0g.

Little Long-tailed Dunnart (*Sminthopsis dolichura*)
Seven records from quadrats 1A (1), 1B (2), 4A (1), 4B (1), 6A (1), 6B (1). Five of seven were Range crest habitats (as above), two were lower slope woodlands. All records were in Autumn-Summer, females weighed 7.0-12.5g (N=5), males weighed 11.0-13.5g (N=2).

Ningaui (*Ningaui yvonnae*)
One record only, a female weighing 7.6g from quadrat 5A in lower slope *Eucalyptus ebbanoensis* woodland over *Neurachne sp.*

Brush-tailed Possum (*Trichosurus vulpecula*)
One record, old Possum scats of indeterminate age, were located in a cave in upper slope BIF at 30° 22.59'S, 119° 39.28'E.

Echidna (*Tachyglossus aculeatus*)
Numerous records, fresh scratchings and scats were recorded throughout the Range and one animal was observed in lower slope woodland.

Sandy Inland Mouse (*Pseudomys hermannsburgensis*)
Three records, from quadrats 3A (1), 5B (1), 6B (1); all of these were lower slope woodlands. All records were in Summer, a male weighed 12.0g, and a female 17.2g.

Lesser Stick Nest Rat (*Leporillus apicalis)*
Dis-used nests of sticks and amberat in shallow caves and overhangs in massive BIF exposures in Range crest habitats were recorded on several occasions. They were relatively infrequent compared to elsewhere in the Eastern Goldfields.

Dingo (*Canis lupus dingo*)
One record, fresh tracks in lower slope woodland in summer.

Goat (*Capra hircus*)
One record, old scats in crest habitat at site E3. This record indicates that in favourable seasons ie. when there is surface water available goats, probably from Mt Jackson, will reach the Range. A lack of permanent water prevents permanent establishment.

Rabbit (*Oryctolagus cuniculus*)
Three sightings, usually solitary animals, one pair; in crest, mid slope and valley habitats. Other records of dung heaps indicate that rabbits are present throughout the Range but in relatively low numbers.

AMPHIBIANS AND REPTILES

Kunapalari frog (*Neobatrachus kunapalari*)
One record, pit-trapped at quadrat 1B in Range crest habitat in September.

Diplodactylus assimilis
One record, from quadrat 7A, a valley habitat in Summer

Diplodactylus granariensis
Nine records,from quadrats 2B (1), 3A (1), 3B (3), 5B (2), 7A (1) and 7B (1), most of these are lower slope habitats with one each from mid slope and valley. Records were approximately evenly divided between Spring and Autumn. One Spring female was gravid with 3 eggs.

Diplodactylus maini
Seven records, from quadrats 3A (5), 3B (1), 5B (1). These are all lower slope habitats on deeper soils than elsewhere in the Range. Six records were in Spring.

Diplodactylus pulcher
Twenty five records, from quadrats 1B (5), 2A (1), 2B (8), 3A (2), 3B (2), 5A (2), 5B (5). This is a broad spectrum of Range habitats from crest to lower slope. All but two records were in Spring.

Gehyra variegata
Seven records, from quadrats 5A (1), 5B (2), 6A (3) and 7A (1). These are all lower slope and valley Range habitats. All but one record was in Summer.

Heteronotia binoei
Seven records, from quadrats 1A (2), 4B (1), 6B (1), 7A (1) and two were hand caught in lower slope *Eucalyptus corrugata* over *Neurachne sp.*. This is a broad spectrum of Range habitats. Most records were in Spring.

Barking Gekko *(Underwoodisaurus milii)*
Two records, from quadrat 1A (1) and 7A (1); these are Range crest and valley habitats; one record from each of Spring and Summer.

Scalefoot (*Pygopus lepidopodus)*
One record, from quadrat 7A, a Range valley habitat in Summer.

Crested Dragon (*Ctenophorus cristatus*)
Two sight records in Summer at quadrat 7A and in lower slope woodland *Eucalyptus ebbanoensis* over *Neurachne sp.*.

Reticulated Dragon (*Ctenophorus reticulatus*)
Two records, both from quadrat 1B on Range crest, one in each of Spring and Summer.

Bearded Dragon (*Pogona minor*)
One sight record, active at 1.00AM at Quadrat 1B on Range crest in Summer.

Tympanocryptis cephala
Five records,from quadrat 1A (1) and hand caught in upper, mid and lower slope habitats; occupying a broad spectrum of Range habitats. Present in Spring and Summer.

Tree Goanna (*Varanus tristis*)
Four records, from 1B (2-includes recapture), 3A (1) and 6B (1). Recorded only in Summer in crest and lower slope Range habitats.

Perentie (*Varanus giganteus*)
Two sight records, in upper slope habitat at E2 site and in lower slope *Eucalyptus ebbanoensis* woodland over *Neurachne sp.*

Cryptoblepharus plagiocephalus
Four records, from quadrats 2A (3) and 2B (1). All these are mid slope habiats, all records were in Spring.

Ctenotus uber
Twenty nine records, from quadrats 1B (2), 2A (2), 2B (1), 3A (4), 3B (6), 4A (2), 4B (1), 5A (1), 6B (1), 6A (3), 7A (4) and 7B (2). As such *Ctenotus uber* the only species recorded from all quadrats, it is widespread and abundant in the Range. The majority of records were in Summer.

Cyclodomorphus branchialis
Three records, from quadrats 1A (1), 6B (1) and hand caught in *Eucalyptus corrugata* over *Neurachne sp.*. These are Range crest and lower slope habitats; recorded in Spring and Summer.

Egernia formosa
One record, from quadrat 3A in lower slope woodland in Summer.

Eremiascincus richardsonii
Three records, from quadrats 3A (1) and 3B (2), these are lower slope woodland Range habitats, all records in Summer.

Menetia greyii
Five records, from quadrats 1A (1), 2A (4), crest and upper slope Range habitats. Four of five records were in Spring.

Morethia butleri
Four records, from quadrats 4B (1), 5B (1) and 2A (2), crest, middle slope and lower slope Range habitats, all records were in Spring.

Yellow-faced Whip-snake (*Demansia psammophus reticulata*)
One record, photographed by Marie Lochmann in lower slope woodland of *Eucalyptus ebbanoensis.*

Rosen's snake (*Denisonia fasciata)*
One record, hand caught in lower slope woodland, *Eucalyptus ebbanoensis* over *Neurachne sp.* in Spring.

Monk snake *(Rhinoplocephalus monachus)*
Two records, quadrats 1B (1) and 5B (1), crest and lower slope Range habitats, both records in Spring.

Ramphotyphlops australis
Three records, from quadrats 1A (1), 4B (1) and 5B (1), crest and lower slope Range habitats, all records were in Spring.

Ramphotyphlops bituberculatus
Three records, from quadrats 3A (2) and 5A (1), lower slope Range habitats, all records were in Spring.

Ramphotyphlops hamatus
One record, quadrat 3B (1), lower slope Range habitat, in Spring

BIRDS
(Nomenclature and order follow (Christidis and Boles 1995))

Mallee Fowl (*Leipoa ocellata*)
One record, disused nest in lower slope shrubland at 119° 35'E, 30° 21'S.

Brown Goshawk (*Accipiter fasciatus*)
Two records, solitary birds over lower slope woodland in Spring.

Wedge-tailed Eagle (*Aquila audax*)
Five records, solitary birds and twice a pair, flying over Range, all records in Winter and Spring.

Australian Hobby (*Falco longipennis)*
One record, a solitary bird flying low over Range in Summer.

Peregrine Falcon (*Falco peregrinus*)
Two records, solitary birds flying over Range and along cliff line in Spring and Summer.

Common Bronzewing (*Phaps chalcoptera*)
One record, solitary bird in upper slope shrubland in Summer.

Purple-crowned Lorikeet (*Glossopsitta porphyocephala*)
Three records, small flocks to 6 flying through the Range or perching in lower slope woodlands, in Spring and Summer.

Regent Parrot (*Polytelis anthopeplus*)
One record, two birds in lower slope woodland in Winter.

Australian Ringneck (*Bernardius zonarius*)
Three records, solitary birds and flocks to three in upper slope *Dryandra arborea* shrubland and *Eucalyptus capillosa* woodland, in Winter and Spring.

Budgerigar (*Melopsittacus undulatus*)
Three records, small flocks to 6 flying through lower slope woodlands in Spring.

Black-eared Cuckoo (*Chrysococcyx osculans*)
One record, in upper slope shrubland in Summer.

Horsefield's Bronze-Cuckoo (*Chrysococcyx basalis*)
Four records, all in lower slope woodlands in Spring.

Southern Boobook (*Ninox novaeseelandiae*)
Two records, once calling and seen in upper slope mallee, both records in Spring.

Tawny Frogmouth (*Podargus strigoides*)
One record, one bird in mid slope mallee in Winter.

Spotted Nightjar (*Eurostopodus argus*)
One record, one bird in crest mallee in Summer.

Australian Owlet-nightjar (*Aegotheles cristatus*)
Two records, calling at night on Range crest and one found dead, apparently disgorged by a snake, possibly a python in *Eucalyptus capillosa* woodland, both records in Summer.

Rainbow Bee-eater (*Merops ornatus*)
Numerous records during Summer survey, recorded as being 'constantly present in all habitats.'These records indicate congregating prior to departing north.

Rufous Treecreeper (*Climacteris rufa*)
Two records, both in lower slope woodland, in Spring.

Striated Pardalote (*Pardalotus striatus*)
Twelve records, solitary birds and small flocks to c.3-4 in crest, upper, mid and lower slope Range habitats. Nearly all records were in Spring, with one from each of Winter and Summer.

Shy Heathwren (*Hylacola cauta*)
Two records, small flocks of three and five in denser mallee in Range valley habitat in both Spring and Summer.

Redthroat (*Pyrrholaemus brunneus*)
One record, solitary bird in denser mid slope *Allocasuarina campestris* shrubland in Winter.

Weebill (*Smicrornis brevirostris*)
Thirteen records, small flocks to four birds in crest, mid and lower slope and valley Range habitats, most records in Spring but also recorded in Winter and Summer.

Inland Thornbill (*Acanthiza apicalis*)
Three records, small flocks to five birds in denser shrublands in crest, upper slope and valley Range habitats in Winter and Summer.

Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*)
Two records, in upper slope and valley shrublands in Spring and Summer.

Red Wattlebird (*Anthochaera carunculata*)
Three records, solitary birds and small flocks to 3-4 in lower slope woodlands, all records in Winter and Spring.

Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*)
Eleven records, usually heard and small flocks to four, present all seasons in all Range primary habitats.

Yellow-throated Miner (*Manorina flavigula*)
One record, solitary bird in mid slope shrubland in Spring.

Singing Honeyeater (*Lichenostomus virescens*)
Ten records, solitary birds and small flocks to five in denser vegetation of crest, upper and mid slope habitats. Present in all seasons, feeding in flowering *Dryandra arborea* in Winter.

White-eared Honeyeater (*Lichenostomus leucotis*)
Seven records, solitary birds and flocks to three in all Range primary habitats except crest and in all seasons.

Yellow-plumed Honeyeater (*Lichenostomus ornatus)*
Four records, small flocks of three -four only in lower slope woodlands in Spring.

Brown-headed Honeyeater (*Melithreptrus brevirostris*)
Three records, flocks to 15 in crest and upper slope *Dryandra arborea* shrublands and in lower slope *Eucalyptus corrugata* woodlands, in Winter and Summer.

Brown Honeyeater (*Lichmera indistincta*)
Sixteen records, flock size variable, in all Range primary habitats and in all seasons but less frequently recorded in Summer.

White-fronted Honeyeater (*Phylidonyris albifrons*)
Seven records, solitary birds and small flocks to three in crest, upper and mid slope habitats, all records were in Spring.

Jacky Winter (*Microeca fascinans*)
Two records, solitary birds in lower slope woodland and valley habitats in Spring.

Red-capped Robin (*Petroica goodenovii)*
Four records, solitary birds and flocks to six in mid and lower slope woodlands in all seasons.

Hooded Robin (*Melanodryas cucculata*)
Two records, solitary birds in mid and lower slope shrublands in Winter and Spring.

Western Yellow Robin (*Eopsaltria griseogularis*)
One record, solitary bird in dense mallee in Range valley habitat in Summer.

Chestnut Quail-thrush (*Cinclosoma castanotus*)
One record, solitary bird in lower slope woodland in Winter.

Varied Sitella (*Daphoenositta chrysoptera*)
One record, flock of seven in lower slope *Eucalyptus corrugata* woodland in Summer.

Crested Bellbird (*Oreoica cristatus*)
Eleven records, usually heard in all Range primary habitats in all seasons.

Rufous Whistler (*Pachcephala rufiventris*)
Seven records, usually heard in thicket-like upper and mid slope as well as valley vegetation, most records were in Spring.

Grey Shrike-thrush (*Colluricincula harmonica*)
Ten records, solitary birds and pairs in all Range primary habitats except lower slope woodlands, not recorded in Summer.

Willie Wagtail (*Rhipidura leucophrys*)
Five records, all solitary birds in lower and upper slope habitats in Spring and Summer.

Black-faced Cuckoo-shrike (*Coracina novaehollandiae*)
Two records, solitary birds flying over crest and mid slope habitats in Spring and Summer.

Little Woodswallow (*Artamus minor*)
Four records, solitary birds and flocks to six flying over or along upper and mid slope cliffs in all seasons.

Grey butcherbird (*Cracticus torquatus*)
Two records, solitary birds in crest habitats in Summer.

Pied Butcherbird (*Cracticus nigrogularis)*
Four records, solitary birds in crest and lower slope habitats in Spring and Summer

Grey Currawong (*Strepera versicolor)*
Eight records, solitary birds and pairs in upper, mid and lower slope Range habitats in Winter and Spring.

Little Crow (*Corvus coronoides*)
One record, solitary bird flying over mid slope in Winter.

Zebra Finch (*Taeniopygia guttata)*
One record, a pair in valley in Spring.

Mistletoebird (*Dicaeum hirundinaceum*)
One record, solitary bird in lower slope woodland in Spring.

DISCUSSION

The results of this survey indicate that the vertebrate fauna of the Helena and Aurora Range is a subset of the fauna of the wider area, in particular of the proposed extension to the Mt Manning Range Nature Reserve. There is little to suggest that the banded ironstone landform offers a unique habitat for vertebrate fauna, though there are indications that locally it is particularly well suited to and utilized by some species.

All species of mammals and birds reported here have been previously recorded from the surrounding woodlands, shrublands and sandplains. The reptiles *Egernia formosa, Varanus tristis, Demansia psammophus reticulata, Denisonia fasciata* and *Ramphotyphlops bituberculatus* have not been previously recorded from the proposed reserve, but there is nothing to suggest that they are restricted to the Range itself. *Ctenotus uber, Cyclodomorphus branchialis, Tympanocryptis cephala* and *Cryptoblepharus carnabyi* (the latter from Dell and How 1985) form a suite of reptile species which may be locally restricted to the BIF landform. This comment applies particularly to *Ctenotus uber* which was recorded 29 times from all quadrats in the Range but not once in the surrounding habitats in previous studies. A similar situation prevailed in a recent study of the fauna of Mt Elvire pastoral lease CALM (*unpublished data*) and as well in the Mt Manning Range (Burbidge *et. al.* 1995).

The mammal data indicate that most species utilize Range crest habitats with massive BIF exposure, an exception is Sandy Inland Mouse (*Pseudomys hermannsburgensis*) which in the present study was only recorded from lower slope primary habitats. This is to be expected as this species requires deeper soils in which to burrow.

Two species, Lesser Stick-nest Rat (*Leporillus apicalis*) and Brush-tailed Possum (*Trichosurus vulpecula*) which were once present now no longer occur in the Range. The Lesser Stick-nest Rat is now extinct in Australia; the Brush-tailed Possum has declined markedly in the arid and semi-arid zone but is still known from isolated populations elsewhere including the adjacent Wheatbelt.

The bird data indicate that 52 of a total of 92 species recorded from the proposed reserve utilize Range habitats. With the exception of Little Woodswallow and possibly Peregrine Falcon for breeding, no bird species are entirely dependent on the Range as a distinct landform. However several species including Rufous Whistler, Spiny-cheeked Honeyeater, Singing Honeyeater, White-fronted Honeyeater, and Redthroat utilize the dense thicket-like vegetation of the Range as the habitat in which they are most frequently recorded. Tree Dryandra (*Dryandra arborea*) particularly when it is flowering, is an important plant species for birds.

Although the primary objective of the present survey was to examine the BIF landform, data were also obtained on bird use of the peripheral woodlands. The secondary data base (see Appendix 6) indicates a small suite of woodland inhabiting birds including Major Mitchell's Cockatoo, Yellow-plumed Honeyeater, Dusky Woodswallow, Emu and Galah which are not recorded from the Range; in addition there are several species including Chestnut Quail-thrush, Rufous Tree-creeper and Pied Butcherbird which are only marginally present in the Range landform in that they were only recorded in lower slope habitats.

Two mammal species, Western Grey Kangaroo (*Macropus fuliginosus*) and Red Kangaroo (*Macropus rufa*) were also recorded in peripheral woodlands but not within the Range itself.

Comparison with other studies of the BIF landform.
Elsewhere in southern Western Australia similar surveys have been conducted in the Ravensthorpe Range (Chapman & Newbey 1995), Mt Manning Range (Burbidge *et.al.* 1995) and Mt Elvire pastoral lease CALM (*unpublished data*). Only the Mt Elvire survey in which 720 Elliott trap-nights in BIF recorded one *Pseudantechinus woolleyae,* and nothing else, indicated any specialised mammal use of this landform. The Ravensthorpe Range and Mt Manning Range surveys had a similar result to the present one; ie. that a wide range of ground inhabiting vertebrates and birds utilise habitats provided by the Range as a distinct landform, but with very few exceptions, they are species which also occur in other habitats.

PART 4 INVERTEBRATE FAUNA

By R. P. McMillan

METHODS

Invertebrate fauna were collected concurrently with the survey for vertebrates. The primary source of material was from pit traps; fauna was collected in the early morning and invertebrates brought in for processing. By the time sorting and setting was completed the environment had warmed so that it was possible to hand collect. This involved moving into selected areas away from the immediate camp.

Insects were pinned, selected ants, centipedes, scorpions and spiders were preserved in 70% alcohol. Sampling by hand (net) was carried out in the following areas:

Weathered banded ironstone hill from base to the top, approx 200m.

On the plain, red loam soil in:

Woodland environments of *Acacia acuminata*, *A. aneura*

Woodland environments of eucalypyt species particularly mallees.

Copses of Mauve *Eremophilia* and *Dodonea* sp.surrounding a swamp.

In addition nocturnal insects were collected by sheet and mercury vapour lamp

RESULTS

This survey recorded 142 species of insects and 84 species of spiders. Lists of specimens collected from the Spring and Summer sampling sessions are in Appendices 7 & 8 respectively. Temperatures over Summer were not excessive.

Table 12 shows the temperatures over a four day period. There were very few flowers and the *Eucalyptus* spp were heavy in bud. The environment was dry when compared with September with few nomadic type Arthropoda present, this was evident from the pit trap sampling.

Table 12. Temperatures 26-29 February 1996

Date	Time	Temperature
26 Feb		25° C
27 Feb	0530	17° C
	1230	29° C
	1330	31° C
	2245	17° C
28 Feb	0530	13° C
	1230	27° C
	2240	18° C
29 Feb	0600	14° C
	1200	32° C
	1425	34° C
	2245	20° C

Observations follow on some of the more obvious insects encountered:

BLATTODEA Cockroaches
With the exception of *Methana* sp. and *Periplanata* sp. all specimens collected were apterous ground species. Below are some examples:

Polyzosteria mitchelli a spectacular blue - grey and yellow cockroach approximately 35mm in size. specimens were found in litter at the base of Mulgas, under bark on fallen tree trunks, on the stems and leaves of *Eremophila* sp. and Quondong bushes as well as in the pit traps.

P. cuprea a beautiful dark iridescent copper/green cockroach was found in open areas in *Neurachne* sp.

Platyzosteria grandis up to 38mm in size, a large black species, was found in litter at the base of Eucalypts. It also was collected at Hg light, here the creatures would come running in from the surrounding darkness.

Platyzosteria sp 1 a small, 10mm, yellow with fine black bands, common in litter at the base of Eucalyptus.

All the apterous species collected are known to be well adapted to extremely harsh climatic conditions. Little is known of the feeding habits of these indigenous species, it must be assumed that they exist on a diet of decaying organic material in the plant litter. This opens up a possible field of investigation into the energy relationship between these insects and their environment. Figure 8(a) shows the numbers of species of Cockroaches at sample sites.

ORTHOPTERA Grasshoppers, crickets
Species generally considered to be phytophagous feeding on grasses, sedges and green leaves of trees. In the ranges specimens were found associated with dead leaf litter beneath *Acacia aneura, A. acuminata, Santalum acuminatum* and *Eremophila* sp.. In the environment of lichen covered ironstone specimens were difficult to see, due to their cryptic colouration that generally matched or blended them with their environment.

Similar species on Meka Station, in the Murchison, were observed scraping lichen from rock surfaces. While other species have been observed scraping lichen from rocks in the Darling Ranges. It is possible that the species observed in the ranges also have a similar diet.

Specimens of the genus *Ursunella*, family Catantopinae or spur throated grasshoppers, were found in sheltered locations in patches of ironstone pebbles in red sandy loam beneath Mulga trees. All specimens observed were covered with a find powder of red dust, this could have come from the habit these grasshoppers have of burying themselves in the sandy loam.

Chortoicetes sp. a free flying locust was common in open glades with Everlastings and other green plants. Some specimens were found feeding on leaves of *Eremophila*. Members on the genus were responsible for great damage to crops and pastures as well as native plants in the 1970's.

Coryphistes sp. was found associated with Mulga, Quondong and Eucalypts. In each case the insects were found on the stems or trunks of these trees. On Mulga they were a dark charcoal grey, on eucalypts a very pale grey and on the Quandongs they were a pale black. In each case the insects blended in with the background. Figure 8(b) shows the number of species at sample sites.

COLEOPTERA Beetles
These were the common insects in the environment.

Carabidae were will represented in the pit traps, 15 genera being collected. these beetles are well known as active carnivores and spiders trapped in the pits were often predated before the pits could be emptied.

Scarabaeidae Samples of these insects were only collected at Hg light. It was surprising that none of these ground frequenting beetles were taken from the pits.

Buprestidae Jewel Beetles.These were rare, with only 4 species being collected. All the specimens were nectar feeders taken by net from eucalypt flowers & *Leptospermum* sp. As there were flowering eucalypts, Melaleucas and Leptospermums it was surprising that there were so few of these beetles.

Curculionidae Weevils. 9 species collected, 6 of these came from the pits others came from mallee flowers. The ground specimens from pits included *Cubicorrhynchus* sp. and *Leptopius* sp. these are detritus feeders. Figure 8(c) shows beetles species in each area.

HYMENOPTERA Wasps, Bees, Ants.
These three groups were active throughout the area, with only Mutillidae being taken from pits (7 species). Hg light attracted 7 species of Ichneumonidae and 1 species of Evanidae. Mallee flowers & Asteraceae attracted Pompilidae and Tiphidae wasps.

Native bees were active in most nectar and pollen producing flowers, 19 species were collected, 8 of these have yet to be determined. The domestic, feral bee, was common throughout the area.

Ants were plentiful and specimens were collected from pits, nests, flowering plants, leaves and stems of Acacias and Quandongs and trunks and leaves of Mallees. Forty three species were listed. Figure 8(d) shows the ant species in each area.

ODONATA Dragonflies
Three species collected in the swamp area, these do not compare with named specimens in the WA Museum's extensive collection.

Damselflies, 2 species collected by sweeping from leaves of Acacias, 1 species from Hg light.

PHASMATODEA Stick insects
One species collected from fine Mulga stems and from Hg light.

HEMIPTERA Bugs
Five species of Homotera swept from Acacias and from Hg light.

Twenty six species of Heteroptera collected by sweeping from foliage and Mallee flowers as well as from Hg light. Included in this number were 12 predators, included in this group were 2 species of aquatic predators: *Agraptocorixa parvipunctata*, Family Corixidae a Water-boatman, and *Anisops gralis* a Back-swimmer, Family Notonectidae. Both these species are associated with fresh water pools. The closest such environment was at least 4km from the Hg light.

NEUROPTERA. Lacewings
The larval pits of these insects were very common in open sandy areas, it was therefore surprising that more adults were not present, only 2 species were collected *Chrysoptera* sp., Green lacewings, and *Glenoleon* sp., Antlions, these latter species are well known for their beautiful wings and antennae, specimens from the arid areas are marked with bands of rich brown and black.

MECOPTERA Scorpion-flies
Only 1 species was collected from the swamp area, it was determined as *Harpobittacus australis*. These insects are predators and prey upon soft bodied insects such as moths, flies and larval stages of some insects, they have been recorded as preying on certain spiders.

DIPTERA Flies
Four species collected. This group is really neglected, specimens being overlooked in favour of others. The species collected were all predators. It must be mentioned that the Bush-fly and green Blow-fly were present in profusion.

LEPIDOPTERA Butterflies
Five species recorded, no collections were made. The specimens were present throughout the environment, at our camp site we watched a number of Lesser Wanderers, *Danaus chrysippus* and chequered Swallowtails, *Papilio demoleus* flying on what seemed a fly path to the East. Wood Whites, *Delias aganippe* were observed flying at hill tops and at bushes of Quandongs.

Figure 8(f) shows numbers of species of insects at each pit sampling site. A list of the insect species is shown in Appendix 7. Figure 9 compares the number of taxa in each insect group and also includes the MYRIAPODA.

MYRIAPODA Centipedes, Scorpions and Spiders.
The myriopoda represent the higher order consumers, the main predators in the invertebrate fauna system. They play a significant role in the control of insect numbers. A healthy population of predators indicates an environment with a good food source that can support them. This situation exists in the Helena & Aurora Ranges.

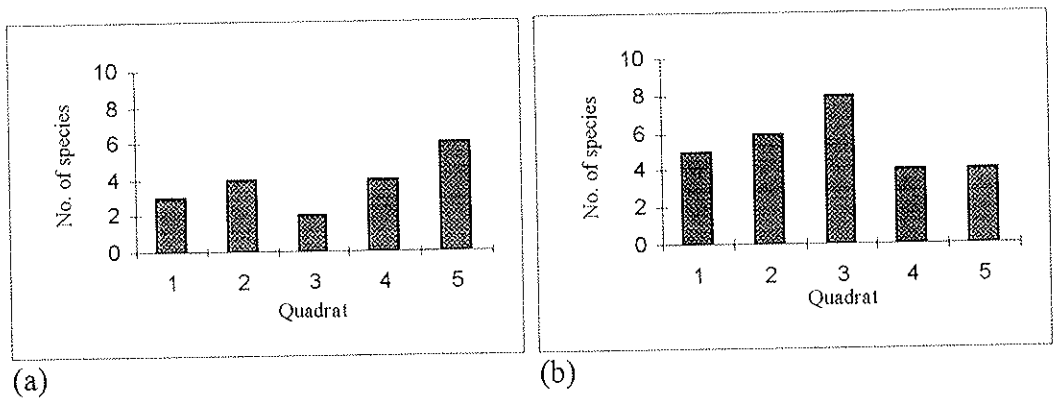
In the collection now in the WA Museum are:

5 species of Centipedes
3 species of Scorpions
92 species of Spiders

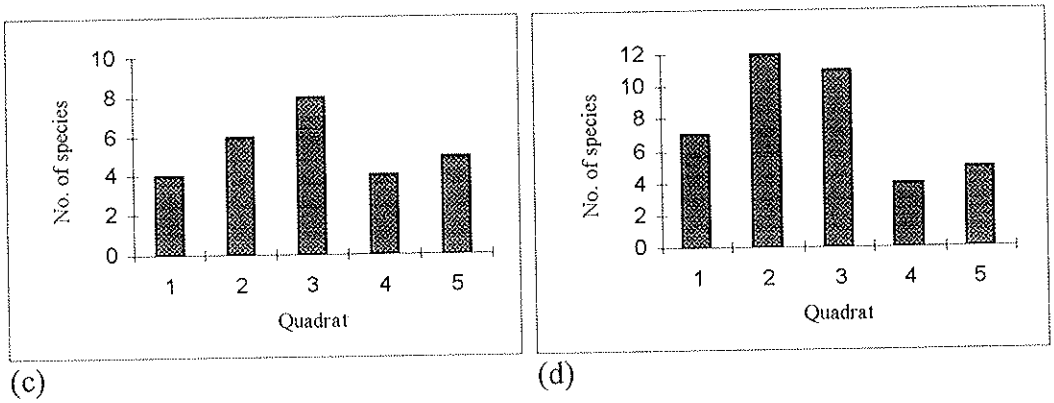
This is an impressive list in the total collection of Arthropoda. (see figures 8(e) & 9). In the Scorpion collection is a possible new species.

Most spider samples came from the pits. Lycosidae (Wolf Spiders, 18 species) were the most abundant with Zodariidae (16 species) the next most common. In both these groups there are many species to be yet identified.

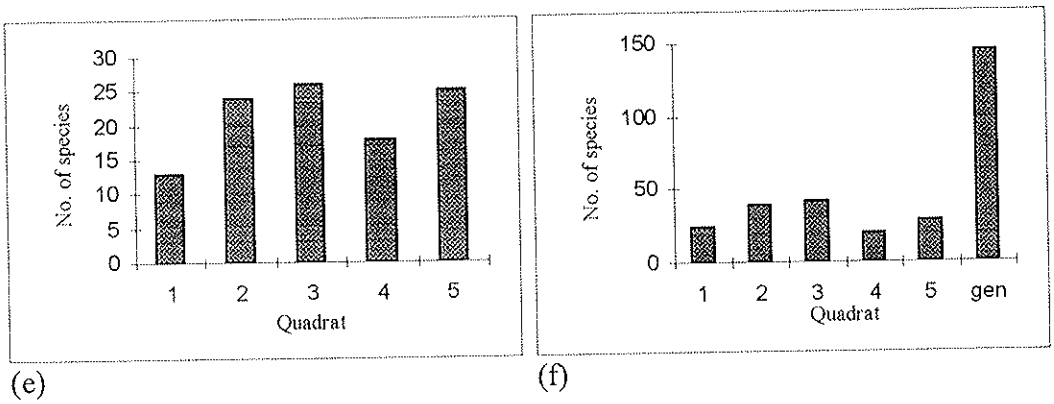
In the Fissidentati 7 specimens may prove to be an undescribed genus.



(a) (b)



(c) (d)



(e) (f)

Figure 8. Number of species in each invertebrate group recorded for each quadrat, (a) Cockroaches, (b) Grasshoppers & Crickets, (c) Beetles, (d) Ants, (e) Spiders and (f) all insect groups (includes general column for entire study area).

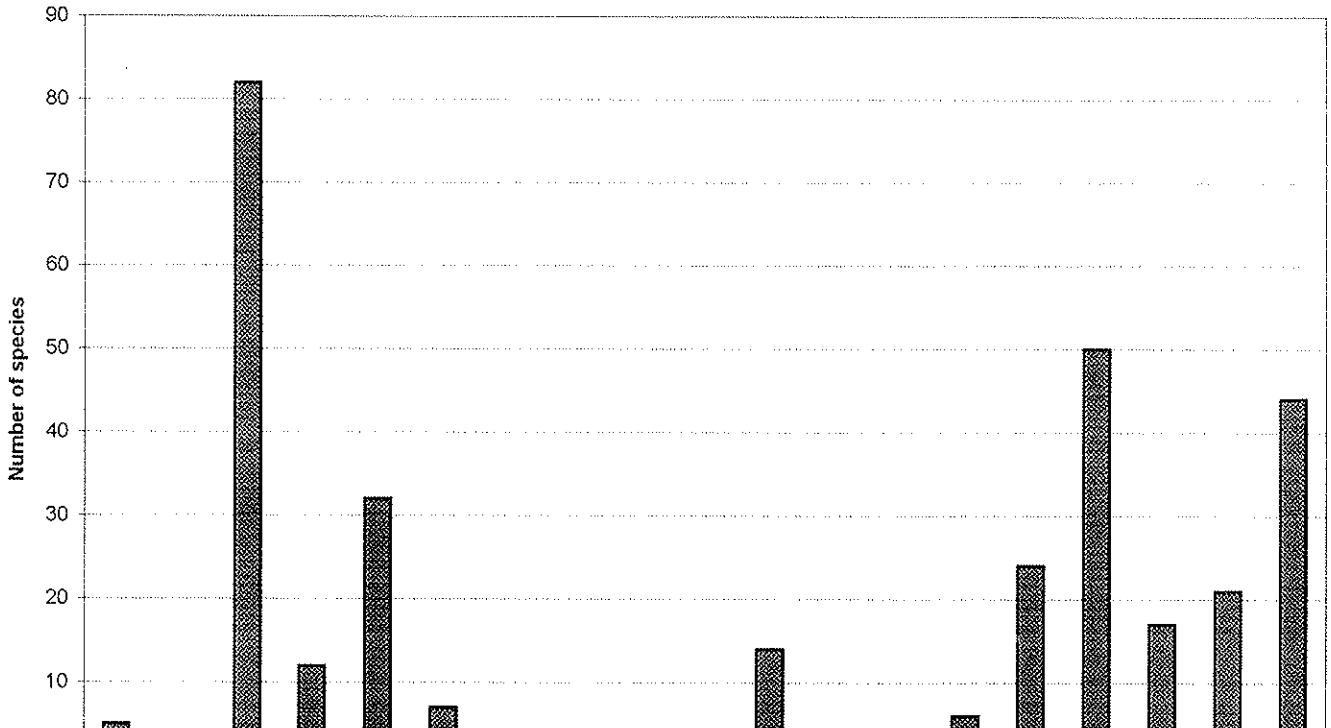


Figure 9. Number of species of Invertebrates in each group. September/October. 1995.

It was surprising that more Mygalomorphae, Trap-door spiders, were not caught in the pits, 6 species of Nemesiidae are to be identified. 1 species of Barychelidae and 1 species of Idiopidae are also on the det list.

Of interest was a large Lycosidae, *Lycosa* spl collected under Hg light, this species came from the darkness to capture a moth, it ended in a container of alcohol, on other nights the Hg light was not visited by spiders.

Table 12 details those invertebrates that are additional to the overall list. Species that were collected in the September survey which are listed in Appendix 7 were not re-collected in the follow up survey. Appendix 8 lists all invertebrates collected during the second survey.

Table 12. Additional taxa encountered during the survey not included in Appendices.

MYRIAPODA

Chilopoda
Scopendridae
Ethmostigma curtipes

Scuterigeridae
Allotheura sp.

Scorpionida

Scorpionidae
Urodachus novaehollandiae

Araneae

Araneidae
Nephila edulis the webs of these large spiders were noted throughout the area. They were not in evidence in September.
Gnaphosidae
Eucoptarthria sp.
Salticidae
Sandalopdes sp.
Deinopidae
Deinipsis sp.
Hersiliidae
Tamopsis sp.
Theriidae
Latrodectus hasselti
Mygalomorphae
Aname sp.

INSECTS

Blattidae
Platyzosteria coolgadiensis
Zonioploca sp.
Mantodea
Orthodera sp.
Paraxpypillus sp.

Tettigonidae
species 3
Acridiidae
species 1
Goniaea sp.
Hemiptera
Cydnidae
Adrissa sp. 2
Reduviidae
Ectomocoris sp.
Pentatomidae
Poicilometis sp.
Coleotichus sp.
Coleoptera
Carabidae
Carenum sp.
Parroa apicalis
Elateridae
Pseudotetralobus sp.
Tenebrionidae
Helea sp.
Homotrystris carbonara
Chrysomelidae
Paropsis sp. A rugose black species
Curculionidae
Polyphrades uniformis
Hymenoptera
Vespidae
Abiopa sp. could be new species
Mutillidae

Ephutomorpha rugicollis
Ephutomorpha sp. 2
Ephutomorpha sp. 3

Apoidea
Anthrophora sp.
Formicidae
Dolichoderinae
Technomyrmex sp.
Formicinae
Camponotus gasseri

MOLLUSCA
Land snails. Two species of these were collected from the swamp area. A Camaenid landsnail shell was determined as *Sinumelon kalgum* collected in September. Eight specimens from the same locality are yet to be identified.

DISCUSSION

The value of the Helena and Aurora Range and surrounds as a habitat for invertebrates derives from two factors. Firstly the area is intrinsically rich in species; for example this survey recorded 34 species of Grasshoppers compared to 17 species for the Greenough Dune system, McMillan & Foulds (1980); 13 for the Beekeepers Reserve near Leeman, Foulds & McMillan (1982) and 8 species for the Burma Road reserve, Foulds & McMillan (Ibid). A similar situation exists with Spiders; this circumstance, as spiders are higher order consumers in invertebrate food chains, indicates a rich and varied fauna as evidenced by the 142 species of insects recorded.

Additionally the woodland and mallee vegetation of the Helena and Aurora Range and surrounds are similar to, and geographically quite close to, the vegetation of the Western Australian wheatbelt which has largely been cleared for agriculture. Thus to a degree the invertebrates of this area offer a window on a fauna which has all but disappeared, or at least been so fragmented as to loose some of its biological integrity.

Further work in the area is undoubtedly warranted; this applies in particular in hotter summer weather when other insect groups, particularly Jewel Beetles should be encountered.

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APPENDIX 1

Locations for Helena and Aurora Range floristic quadrats.

Site	Latitude (DMS)			Longitude (DMS)		
520/01	30	19	50	119	42	41
520/02	30	20	3	119	42	24
604/01	30	18	49	119	43	31
604/02	30	18	49	119	43	33
704/01	30	21	47	119	39	16
704/02	30	21	47	119	39	16
704/03	30	21	44	119	39	15
704/04	30	21	40	119	39	15
704/05	30	21	18	119	39	12
dig01	30	21	4	119	42	22
dig02	30	21	3	119	42	12
dig03	30	20	59	119	41	59
et01	30	20	13	119	41	34
et03	30	20	22	119	41	37
et05	30	20	39	119	41	34
et06	30	21	10	119	41	36
ha1a	30	21	13	119	42	16
ha1b	30	21	16	119	42	10
ha2a	30	21	32	119	41	42
ha2b	30	21	30	119	41	42
ha3a	30	20	44	119	40	46
ha3b	30	20	42	119	40	45
ha4a	30	21	12	119	35	1
ha4b	30	21	14	119	35	1
ha5a	30	21	18	119	34	59
ha5b	30	21	26	119	34	58
ha6	30	20	16	119	41	34
ha7	30	20	33	119	41	37
htb01	30	21	48	119	36	56
htb02	30	21	48	119	36	56
htc01	30	20	19	119	31	49
htc02	30	20	20	119	31	49
htc03	30	20	52	119	31	44
htc04	30	21	10	119	32	14
mug01	30	22	3	119	35	34
mug02	30	22	5	119	36	5
mug03	30	22	4	119	36	2
nflat01	30	18	22	119	43	34
nflat02	30	18	32	119	43	0
nflat03	30	22	0	119	35	5
nflat04	30	20	32	119	40	17
nflat05	30	20	50	119	39	25
nflat06	30	21	52	119	37	57
nflat07	30	21	58	119	37	48
ridg01	30	21	25	119	41	56
ridg02	30	21	30	119	41	50
sflat01	30	22	45	119	37	4
sflat02	30	24	3	119	37	43
sflat03	30	24	16	119	38	5
sflat04	30	24	21	119	38	36
sflat05	30	24	16	119	39	30
sflat06	30	24	10	119	39	41
sflat07	30	22	43	119	40	54
sflat08	30	22	12	119	41	26
sflat09	30	20	51	119	42	46

APPENDIX 2

Flora List for the Helena and Aurora Range.

This list includes all taxa from both the sampling quadrats and the opportunistic collections and confirmed records from PERTH. Nomenclature follows Green (1975) and current usage at PERTH (ms denotes a manuscript name).

Family: Adiantaceae
- Cheilanthes austrotenuifolia
- Cheilanthes brownii
- Cheilanthes lasiophylla
- Cheilanthes sieberi subsp. sieberi

Family: Aizoaceae
- Gunniopsis quadrifida
- * Mesembryanthemum nodiflorum
- Tetragonia sp.

Family: Amaranthaceae
- Ptilotus aervoides
- Ptilotus carlsonii
- Ptilotus drummondii var. drummondii
- Ptilotus exaltatus
- Ptilotus gaudichaudii
- Ptilotus holosericeus
- Ptilotus obovatus

Family: Anthericaceae
- Arthropodium curvipes
- Thysanotus patersonii

Family: Apiaceae
- Daucus glochidiatus
- Hydrocotyle rugulosa
- Trachymene ornata
- Trachymene pilosa
- Uldinia ceratocarpa

Family: Apocynaceae
- Alyxia buxifolia

Family: Asclepiadaceae
- Rhyncharrhena linearis

Family: Asphodelaceae
- Bulbine semibarbata

Family: Aspleniaceae
- Pleurosorus rutifolius

Family: Asteraceae
- Actinobole uliginosum
- Angianthus tomentosus
- Bellida graminea
- Blennospora drummondii
- Brachyscome ciliaris
- Brachyscome iberidifolia
- Brachyscome perpusilla
- Calotis hispidula
- * Centaurea melitensis
- Cephalipterum drummondii
- Ceratogyne obionoides
- Chrysocephalum semicalvum
- Chthonocephalus pseudevax
- Euchiton sphaericus
- Gilberta tenuifolia
- Gilruthia osbornei
- Gnephosis intonsa
- Hyalosperma demissum
- Hyalosperma glutinosum subsp. glutinosum
- * Hypochaeris glabra
- Isoetopsis graminifolia
- Lawrencella davenportii
- Lawrencella rosea
- Lemooria burkittii
- Leucochrysum fitzgibbonii
- Millotia myosotidifolia
- Minuria cunninghamii
- Olearia decurrens
- Olearia exiguifolia
- Olearia humilis
- Olearia muelleri
- Olearia pimeleoides
- * Osteospermum clandestinum
- Podolepis canescens
- Podolepis capillaris
- Podolepis lessonii
- Podotheca gnaphalioides
- Pogonolepis stricta
- * Pseudognaphalium luteoalbum
- Rhodanthe laevis
- Rhodanthe manglesii
- Rhodanthe oppositifolia
- Rhodanthe pygmaea
- Rhodanthe rubella
- Rhodanthe stricta
- Schoenia cassiniana
- Senecio glossanthus
- Senecio picridioides
- Senecio quadridentatus
- * Sonchus oleraceus
- * Sonchus tenerrimus
- Streptoglossa liatroides
- Trichanthodium skirrophorum
- Triptilodiscus pygmaeus
- Waitzia acuminata
- Waitzia citrina

Family: Boraginaceae
- Halgania sp. 1 (BJL 2049)
- Halgania sp. 2 (BJL 2082)

Family: Brassicaceae
- Arabidella sp.Goldfields (P.G.Wilson 7183)
- Lepidium oxytrichum
- Lepidium phlebopetalum
- Phlegmatospermum eremaeum
- * Sisymbrium irio
- Stenopetalum filifolium
- Stenopetalum robustum

Family: Caesalpiniaceae
Senna artemisioides subsp. filifolia
Senna cardiosperma subsp. cardiosperma
Senna pleurocarpa var. pleurocarpa

Family: Campanulaceae
Wahlenbergia tumidifructa

Family: Caryophyllaceae
* Cerastium glomeratum
Stellaria filiformis

Family: Casuarinaceae
Allocasuarina acutivalvis
Allocasuarina campestris

Family: Chenopodiaceae
Atriplex nummularia
Atriplex vesicaria
Enchylaena tomentosa
Halosarcia halocnemoides
Maireana georgei
Maireana radiata
Maireana tomentosa subsp. tomentosa
Maireana trichoptera
Rhagodia drummondii
Rhagodia preissii subsp. preissii
Sclerolaena diacantha
Sclerolaena drummondii
Sclerolaena fusiformis
Sclerolaena obliquicuspis

Family: Chloanthaceae
Newcastelia viscida

Family: Colchicaceae
Wurmbea tenella

Family: Convolvulaceae
Convolvulus erubescens

Family: Crassulaceae
Crassula colorata

Family: Cupressaceae
Callitris glaucophylla

Family: Cyperaceae
Isolepis congrua
Lepidosperma aff. tenue (KRN 9197)
Lepidosperma aff. angustatum
Schoenus nanus

Family: Dasypogonaceae
Chamaexeros macranthera
Lomandra effusa

Family: Dilleniaceae
Hibbertia exasperata

Family: Droseraceae
Drosera macrantha subsp. macrantha

Family: Epacridaceae
Leucopogon breviflorus
Leucopogon sp. Helena & Aurora (BJL 2077)

Family: Euphorbiaceae
Calycopeplus paucifolius
Monotaxis occidentalis
Poranthera microphylla

Family: Fabaceae
Bossiaea walkeri
Daviesia benthamii subsp. acanthoclona
Daviesia purpurascens
Mirbelia depressa
Mirbelia microphylla
Mirbelia sp. Helena and Aurora (BJL 2003)
Swainsona canescens
Swainsona kingii
Swainsona oliveri
Templetonia sulcata

Family: Geraniaceae
* Erodium cicutarium
Erodium crinitum
Erodium cygnorum subsp. cygnorum

Family: Goodeniaceae
Brunonia australis
Dampiera lavandulacea
Dampiera spicigera
Goodenia berardiana
Goodenia havilandii
Goodenia mimuloides
Goodenia occidentalis
Goodenia peacockiana
Goodenia pinnatifida
Scaevola spinescens
Velleia rosea

Family: Haemodoraceae
Conostylis argentea

Family: Haloragaceae
Gonocarpus nodulosus
Haloragis gossei
Haloragis trigonocarpa

Family: Juncaginaceae
Triglochin sp.

Family: Lamiaceae

Prostanthera campbellii
Prostanthera grylloana
Prostanthera magnifica
Westringia cephalantha
Westringia rigida

Family: Lauraceae
Cassytha melantha

Family: Lobeliaceae
Lobelia gibbosa

Family: Loganiaceae
Phyllangium paradoxum

Family: Loranthaceae
Amyema miquelii
Amyema preissii
Lysiana casuarinae

Family: Malvaceae
Lavatera plebeia
Lawrencia repens
Sida aff. spodochroma
Sida calyxhymenia
Sida excedentifolia ms

Family: Mimosaceae
Acacia acuminata
Acacia adinophylla ms
Acacia aneura
Acacia assimilis subsp. atroviridis
Acacia colletioides
Acacia coolgardiensis subsp. effusa
Acacia cylindrica
Acacia eremophila
Acacia erinacea
Acacia hemiteles
Acacia hystrix subsp. hystrix ms
Acacia aff. multispicata
Acacia prainii
Acacia quadrimarginea
Acacia resinimarginea
Acacia steedmanii
Acacia tetragonophylla

Family: Myoporaceae
Eremophila alternifolia
Eremophila clarkei
Eremophila decipiens subsp. decipiens
Eremophila gibbosa
Eremophila granitica
Eremophila interstans
Eremophila ionantha
Eremophila latrobei
Eremophila maculata subsp. brevifolia ms
Eremophila oldfieldii
Eremophila oppositifolia
Eremophila rugosa ms
Eremophila saligna
Eremophila scoparia

Family: Myrtaceae
Baeckea elderiana
Calothamnus gilesii
Eucalyptus aff. oleosa
Eucalyptus calycogona
Eucalyptus capillosa subsp. capillosa
Eucalyptus celastroides
Eucalyptus clelandii
Eucalyptus corrugata
Eucalyptus cylindrocarpa
Eucalyptus drummondii
Eucalyptus ebbanoensis
Eucalyptus ewartiana
Eucalyptus hypochlamydea subsp. hypochlamydea ms
Eucalyptus longicornis
Eucalyptus loxophleba subsp. smooth bark
Eucalyptus ravida
Eucalyptus salmonophloia
Eucalyptus salubris
Eucalyptus sheathiana
Eucalyptus transcontinentalis
Eucalyptus yilgarnensis
Homalocalyx thryptomenoides
Leptospermum roei
Melaleuca eleuterostachya
Melaleuca leiocarpa
Melaleuca nematophylla
Melaleuca radula
Melaleuca uncinata
Rinzia carnosa
Thryptomene appressa

Family: Ophioglossaceae
Ophioglossum lusitanicum

Family: Orchidaceae
Caladenia incensa ms
Caladenia incrassata ms
Caladenia microchila ms
Caladenia saccharata
Cyanicula amplexans ms
Pterostylis aff. nana
Pterostylis picta
Thelymitra aff. macrophyllum

Family: Orobanchaceae
* Orobanche minor

Family: Oxalidaceae
Oxalis perennans

Family: Phormiaceae
Dianella revoluta var. divaricata

Family: Pittosporaceae
Cheiranthera filifolia
Pittosporum phylliraeoides

Family: Plantaginaceae
Plantago aff. hispidula (NG & ML 1732)
Plantago drummondii
Plantago turrifera

Family: Poaceae
* Aira caryophyllea
Amphipogon caricinus var. caricinus
Bromus arenarius
* Bromus diandrus
* Bromus rubens
Danthonia caespitosa
Danthonia setacea
Echinopogon ovatus var. pubiglumis
Elymus scaber
Eragrostis dielsii
Eragrostis eriopoda
* Hordeum glaucum
Neurachne sp Helena & Aurora (KRN 8972)
* Pentaschistis airoides
* Rostraria pumila
Austrostipa elegantissima
Austrostipa platychaeta
Austrostipa trichophylla
* Vulpia bromoides
* Vulpia myuros - muralis complex

Family: Polygalaceae
Comesperma integerrimum

Family: Polygonaceae
Muehlenbeckia adpressa
Muehlenbeckia florulenta

Family: Portulacaceae
Calandrinia corrigioloides
Calandrinia eremaea

Family: Proteaceae
Dryandra arborea
Grevillea acuaria
Grevillea erectiloba
Grevillea georgeana
Grevillea haplantha subsp. haplantha
Grevillea nematophylla
Grevillea paradoxa
Grevillea zygoloba
Hakea minyma
Hakea preissii

Family: Rhamnaceae
Stenanthemum intricatum
Stenanthemum newbeyi

Family: Rubiaceae
* Galium aparine
* Galium murale

Family: Rutaceae
Eriostemon brucei subsp. brucei
Eriostemon tomentellus
Phebalium canaliculatum
Phebalium tuberculosum

Family: Santalaceae
Exocarpos aphyllus
Santalum acuminatum
Santalum lanceolatum
Santalum spicatum

Family: Sapindaceae
Dodonaea inaequifolia
Dodonaea lobulata
Dodonaea microzyga
Dodonaea rigida
Dodonaea stenozyga
Dodonaea viscosa

Family: Solanaceae
Nicotiana occidentalis
Nicotiana rotundifolia
Solanum hoplopetalum
Solanum lasiophyllum
Solanum orbiculatum subsp. orbiculatum
Solanum plicatile

Family: Sterculiaceae
Brachychiton gregorii
Keraudrenia integrifolia
Rulingia cuneata
Rulingia luteiflora
Rulingia magniflora

Family: Thymelaeaceae
Pimelea microcephala

Family: Tremandraceae
Tetratheca aphylla

Family: Urticaceae
Parietaria cardiostegia

Family: Zygophyllaceae
Zygophyllum apiculatum
Zygophyllum eremaeum
Zygophyllum fruticulosum
Zygophyllum ovatum

APPENDIX 3

Floristic data set for the Helena and Aurora Range.

The full data set (233 taxa x 55 quadrats) is provided in Cornell University Condensed Format. The species code are derived from the first three letters of the genus and species names with a further two letters from intraspecific rank where applicable except where otherwise listed below. *Vulpia myuros* and *V. muralis* proved difficult to differentiate and have been treated as a species complex in flora list and the analysis.

Latitude and longitude of sites are given in Appendix 1.

Nonstandard species codes.

Eucalyptus salmonophloia	EUCSALm
Eucalyptus salubris	EUCSALu

```
Helena and aurora range dataset 5-12-96
(13I6)                                                                  5
     1     4     7    13    19    25    35    41    42    50    67   106   109
   112
     1   113   118   126   141   148   159   181   216   217   218   219   224
   228
     2     8     9    23    61    77    89    90   133   139   148   151   177
   179
     2   191   196   207   218   230
     3    13    18    35    42    50    62    83   104   106   109   113   126
   132
     3   148   190   208   217   218   219   228
     4    62    72    79    80    90   113   133   148   191   218   219   220
   228
     5    18    20    42    49    50    51    55    56    60    62    67    68
    75
     5    90   101   118   121   131   132   140   141   144   146   148   159
   164
     5   171   181   206   208   210   216   219   220   228
     6    89    90   148   175   179
     7     6    11    13    18    29    30    43    48    50    62    67    68
    72
     7    78    83   104   109   113   118   126   132   141   148   150   169
   208
     7   219   224   228
     8    64    80    89    90   136   139   148   175   179   218   228
     9    38    39    75    89    90   104   136   137   139   148   151   152
   161
     9   175   176   178   179   187   191   196   201   208   218   224   228
    10    17    20    31    37    50    51    54    56    58    59    60    62
    66
    10    68    70    75    90   101   102   121   122   128   130   135   139
   140
    10   144   148   151   152   155   159   161   164   179   193   197   198
   202
    10   207   208   210   215   219   225   228
    11    37    50    60    61    81    89    90   101   121   148   151   159
   171
    11   181   183   197   203   208   216   218   219   226   227
    12     3    13    18    20    35    52    62    68    72    83   109   113
   118
    12   145   148   169   171   190   208   218   219   224   228   229
    13     4    13    18    19    27    35    41    42    48    50    56    57
    62
    13    67    68    83    86   113   118   119   121   126   127   132   141
   146
    13   148   156   159   171   181   183   193   206   208   216   218   219
   223
    13   228
    14     2     5     8    12    14    44    90   111   113   148   152   157
   191
    14   218   219   224   228   230
    15     2    61    81    89    90   133   148   151   179   190   208   218
    16     9    65    72    89    90   109   111   148   151   152   190   224
   230
    17    15    20    51    61    66    68    74    90   140   148   151   215
    18    20    68    80    90   113   148   151   189   206   208   215   230
    19     9    80    89    90   136   148   151
    20    17    18    37    40    42    49    50    54    55    57    60    62
    67
    20    68    69    75    83   113   118   121   126   131   132   140   141
   142
    20   144   146   148   156   159   171   172   181   183   206   208   210
   216
    20   219   223   226   228
    21    15    22    23    54    58    59    60    75    86    89    90   103
   109
    21   113   136   139   148   151   152   161   175   176   177   179   180
   187
    21   191   194   196   203   208   210   218   219   228
    22     1    23    24    38    39    60    73    75    86    89    90   103
   136
    22   139   148   164   173   177   179   180   194   196   197   207   208
   210
    22   228   231   233
    23    13    18    35    42    50    72    78    83   109   113   126   141
   148
    23   152   218   219   228
    24     2    13    18    42    50    72    83    90   118   126   133   141
   148
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24 151 175 196 206 219 228
25 5 13 21 35 50 62 72 73 91 93 103 104
109
25 113 120 126 133 136 148 151 152 171 177 208 218
219
25 224 228 229
26 10 13 15 39 48 50 53 86 89 93 117 133
136
26 139 148 151 175 177 179 194 196 207 208 210 218
219
26 228
27 2 9 12 64 80 90 137 148 151 175 191 218
230
28 1 12 14 16 27 38 39 44 56 60 61 73
81
28 86 89 90 103 106 110 115 121 144 147 149 152
156
28 157 158 161 181 190 192 193 196 197 198 203 208
210
28 219 224 227 228 230
29 13 15 20 64 65 72 80 83 90 103 126 151
152
29 175 181 191 206 208 216 218 219 220 223 228 230
30 13 20 37 40 42 50 51 56 60 64 68 72
80
30 83 90 101 106 113 126 134 148 152 155 167 171
172
30 175 177 181 183 185 190 191 197 198 206 207 208
210
30 218 219 228
31 17 18 20 33 37 42 50 51 54 56 58 60
62
31 64 67 68 72 74 83 86 118 121 122 126 132
141
31 144 148 152 159 167 170 171 177 179 181 183 197
199
31 200 206 207 208 210 216 219 226 228
32 50 60 67 72 89 136 148 152 159 164 167 181
182
32 183 207 216 219 226 228
33 23 24 76 80 82 97 136 151 208 233
34 10 24 32 34 46 58 60 71 94 104 116 126
162
34 174 176 192 202 208 210 211 213 222 226 233
35 3 26 28 29 35 39 50 62 86 103 104 120
123
35 124 126 148 177 192 222 224 228
36 9 23 24 70 98 136 137 139 176 194 195 208
231
36 233
37 15 17 24 29 30 32 34 37 39 45 46 47
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37 59 70 73 75 80 85 86 106 109 114 120 123
128
37 136 138 139 143 144 148 153 156 160 161 163 164
168
37 173 176 177 179 180 185 186 191 192 194 195 197
202
37 208 212 221 226 233
38 9 23 24 37 73 81 95 136 138 139 151 165
176
38 178 179 180 194 195 196 208 210
39 23 24 28 81 95 97 98 101 133 136 139 151
176
39 178 194 208 210 231 233
40 23 24 46 58 60 82 86 96 123 133 136 139
151
40 164 168 176 178 192 194 196 197 199 201 202 207
208
40 210 218 222 231 233
41 17 24 38 39 56 60 69 86 96 106 116 120
125
41 168 173 174 176 177 178 179 185 186 194 201 202
204
41 209 210 227 232 233
42 5 23 24 92 97 99 133 139 151 176 178 192
194
42 196 208 209 210 231 233
43 3 16 17 26 32 46 50 60 62 86 103 104
116

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 43   122   144   148   149   152   164   178   181   192   207   208   210
219
 43   224   228
 44     1    12    17    32    34    36    39    45    56    60    70    73
 86
 44    93   100   102   107   116   120   122   144   148   149   154   161
164
 44   176   177   179   180   181   187   190   192   196   201   202   207
208
 44   209   210   221   224   226
 45    17    20    27    37    42    50    58    60    63    75    80    87
113
 45   121   130   131   144   151   161   171   181   184   197   206   208
210
 45   218   219   230
 46    17    18    20    27    37    50    54    58    60    64    80    87
121
 46   130   132   144   151   156   159   161   164   166   171   179   181
183
 46   189   197   198   205   206   208   210   219   220   223   226   227
 47     5    23    89    90   133   136   139   148   151   152   175   176
177
 47   178   179   194   195   207   208   210   228
 48     3     6    26    48    50    75    77    86   103   104   113   115
119
 48   148   152   164   169   181   208   210   219   222   224   228   229
 49     5    23    24    77    82    92    99   101   136   151   178   194
196
 49   208   233
 50    23    24    76    77    82    95   136   165   176   178   191   194
195
 50   208   210   214   233
 51    14    25    35    62    67    84    91   104   109   126   129   132
148
 51   152   157   169   210   218   219   222   224   228
 52    14    26    35    48    50    58    73   104   105   106   115   126
148
 52   152   164   169   181   208   210   218   219   222   224   227
 53    23    24    82    88    92    97   108   136   139   151   165   178
194
 53   208   210   233
 54     1    12    14    35    58    73    75    81    89    90   115   126
133
 54   148   151   152   157   169   175   177   188   196   207   208   218
219
 54   222   224   228
 55    17    27    38    56    58    69    70    87   121   130   144   151
161
 55   179   181   183   197   208   210   219   223   226   228
  0
ACAACU  ACAADI  ACAANE  ACAASSATACACOL  ACACOOEFACACYL  ACAERE  ACAERI  ACAHEM
ACAMUL  ACAPRA  ACAQUA  ACARES  ACATET  ACTULI  AIRCAR  ALLACU  ALLCAM  ALYBUX
AMYMIQ  AMYPRE  ATRNUM  ATRVES  BAEELD  BELGRA  BLEDRU  BOSWAL  BRACIL  BRAGRE
BRAPER  BROARE  BRODIA  BRORUB  BRUAUS  BULSEM  CALCOR  CALERE  CALHIS  CALINC
CALMIC  CALPAU  CALSAC  CASMEL  CENMEL  CEPDRU  CERGLO  CEROBI  CHAMAC  CHEAUS
CHEBRO  CHESIESICHTPSE  COMINT  CONARG  CRACOL  CYAAMP  DANCAE  DANSET  DAUGLO
DAVPUR  DIAREVDIDODINA  DODLOB  DODMIC  DODVIS  DROMACMADRYARB  ELYSCA  ENCTOM
ERAERI  ERECLA  EREDECDEEREGIB  EREGRA  EREINT  EREION  ERELAT  EREOLD  EREOPP
ERERUG  ERESCO  ERIBRUBRERITOM  EROCIC  EROCYGCYEUCCAPCAEUCCEL  EUCCOR  EUCEBB
EUCHYPHYEUCLON  EUCLOXSMEUCRAV  EUCSALm EUCSALu EUCSHE  EUCTRA  EUCYIL  EUC_OL
EXOAPH  GALMUR  GILOSB  GILTEN  GONNOD  GOOBER  GOOHAV  GOOMIM  GOOOCC  GREACU
GREHAPHAGREPAR  GREZYG  GUNQUA  HAKMIN  HALGOS  HALTRI  HIBEXA  HYADEM  HYAGLUGL
HYDRUG  HYPGLA  ISOGRA  LAWDAV  LAWREP  LAWROS  LEMBUR  LEPOXY  LEPROE  LEPROT
LEP_ANG LEUBRE  LEUFIT  LOBGIB  LOMEFF  MAIGEO  MAIRAD  MAITOMTOMAITRI  MELLEI
MELNEM  MELUNC  MESNOD  MILMYO  MINCUN  MIRBHAA MONOCC  NEUHAA  NICOCC  OLEDEC
OLEMUE  OLEPIM  OPHLUS  OXAPER  PARCAR  PENAIR  PHECAN  PHETUB  PHYPAR  PITPHY
PLAAFFHIPLADRU  PLATUR  PODCAN  PODCAP  PODGNA  PODLES  POGSTR  PROGRY  PROMAG
PTEHAIRYPTEPIC  PTIAER  PTICAR  PTIDRUDRPTIEXA  PTIGAU  PTIHOL  PTIOBO  RHADRU
RHOLAE  RHOMAN  RHOOPP  RHOPYG  RHORUB  RHOSTR  RHYLIN  RINCAR  SANACU  SANSPI
SCASPI  SCHCAS  SCHNAN  SCLDIA  SCLFUS  SENARTFISENGLO  SENQUA  SIDCAL  SOLLAS
SOLORBORSONOLE  STEFILm STEFILs STEINT  STENEW  STEROB  AUSELE  AUSPLA  AUSTRI
STRLIA  SWAKIN  SWAOLI  TEMSUL  TETAPH  THEAFFMATHRAPP  THYPAT  TRAORN  TRAPIL
TRIPYG  TRISKI  ULDCER  VELROS  VULBRO  VULMYU  WAHTUM  WAIACU  WAICIT  WESCEP
ZYGERE  ZYGFRU  ZYGOVA
520/01  520/02  604/01  604/02  704/01  704/02  704/03  704/04  704/05  dig01
dig02   dig03   et01    et03    et05    et06    ha1a    ha1b    ha2a    ha2b
ha3a    ha3b    ha4a    ha4b    ha5a    ha5b    ha6     ha7     htb01   htb02
htc01   htc02   htc03   htc04   mug01   mug02   mug03   nflat01 nflat02 nflat03
nflat04 nflat05 nflat06 nflat07 ridg01  ridg02  sflat01 sflat02 sflat03 sflat04
sflat05 sflat06 sflat07 sflat08 sflat09
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APPENDIX 4

Quadrat locations for vertebrate and invertebrate trapping sites and opportunistic record localities.

Site	Latitude	Longitude
HA1(a)	30 21.20'S	119 42.25'E
HA1(b)	30 21.23'S	119 42.17'E
HA2(a&b)	30 21.53'S	119 41.68'E
HA3 (a&b)	30 20.72'S	119 40.72'E
HA4(a&b)	30 21.22'S	119 35.04'E
HA5 (a&b)	30 21.41'S	119 34.93'E
HA6(a)	30 20.34'S	119 41.63'E
HA6(b)	30 20.30'S	119 41.62'E
HA7(a&b)	30 20.53'S	119 41.61'E
E1	30 21.49'S	119 41.98'E
E2	30 21.52'S	119 41.84'E
E3	30 21.73'S	119 37.04'E

Miscellaneous localities listed in Appendices 5 & 6.

Upper camp	30 21.16'S	119 42.24'E
Lower camp	30 21.00'S	119 41.00'E
Mug tree rock hole	30 22.12'S	119 36.12'E
Marda Dam turn-off.	30 37.74'S	119 21.96'E
Wetland site	30 19.12'S	119 41.52'E

APPENDIX 5

Vertebrate fauna records for the Helena and Aurora Range.

Explanation of column headings and codes.

Number
Number of individuals captured or sighted.

FW Few
MY Many

Quadrat
Quadrats as shown in figure 7. Elliot trap lines are prefixed by the letter E.

Topographic position

		quadrats
CR	Range crest	1, 4, E3. (see figure 7).
US	Upper slope	E1, E2.
MS	Mid slope	2.
LS	Lower slope	3, 5, 6.
VL	Internal valley	7.

Comments

Includes details of localities of records.
WAM Western Australian Museum.
Reptile Snout vent lengths (SVL's) and weights.

TAXON	DATE	NUMBER	QUADRAT	TOPO. POSITION	COMMENTS
BIRDS					
Australian. Hobby	27/2/96	1	2	MS	
Australian. Sitella	28/2/96	7		LS	near Quadrat 7
Black-eared Cuckoo	27/2/96	1	E2	US	
Black-faced Cuckoo. Shrike	27/9/95	1		MS	walking near 30 23'S, 119 39'E
Black-faced Cuckoo. Shrike	29/2/96	1	1	CR	
Boobook Owl	28/9/95	1		US	Peter's ridge Euc, ebbanoensis
Boobook Owl	25/9/95	1	1	CR	calling at camp, but distant
Bronzewing Pigeon	27/2/96	1		US	
Brown Goshawk	26/9/95	1		LS	Peter's camp 30 21'S, 119 41'E
Brown Goshawk	26/9/95	1		LS	Peter's camp 30 21'S, 119 41'E
Brown Honeyeater	24/9/95	MY	2	MS	
Brown Honeyeater	26/9/95	FW	4	CR	
Brown Honeyeater	27/9/95	1	2	MS	
Brown Honeyeater	28/9/95	1	5	LS	
Brown Honeyeater	28/9/95	1	4	CR	
Brown Honeyeater	26/9/95	1	5	LS	
Brown Honeyeater	22/7/95	FW		US	
Brown Honeyeater	23/7/95	1		LS	
Brown Honeyeater	23/7/95	MY		CR	
Brown Honeyeater	23/7/95	FW		CR	
Brown Honeyeater	24/7/95	FW	2	MS	
Brown Honeyeater	26/9/95	MY	E3	US	
Brown Honeyeater	27/9/95	1		MS	as above
Brown Honeyeater	28/9/95	1		US	cave at 30 22'S, 119 39'E
Brown Honeyeater	26/2/96	1		US	near Quadrat 1
Brown Honeyeater	29/2/96	FW		US	east side of Range
Brown-headed Honeyeater	22/7/95	3		US	feeding on flowering Dryandra arborea
Brown-headed Honeyeater	27/7/95	7	1	CR	feeding on flowering Dryandra arborea
Brown-headed Honeyeater	28/2/96	15		LS	near Quadrat 7
Budgerygah	25/9/95	FW	3	LS	
Budgerygah	25/9/95	2	5	LS	
Budgerygah	26/9/95	FW	5	LS	
Chestnut Quail-thrush	23/7/95	1		LS	

Corvid	28/9/95	1	E2	MS	
Crested Bellbird	26/9/95	1	4	CR	
Crested Bellbird	28/9/95	1	5	LS	
Crested Bellbird	28/9/95	1	4	CR	
Crested Bellbird	28/9/95	1	E2	MS	
Crested Bellbird	26/9/95	1		MS	
Crested Bellbird	26/9/95	1	3	LS	
Crested Bellbird	26/9/95	1	5	LS	
Crested Bellbird	27/9/95	?	E2	LS	
Crested Bellbird	23/7/95	1		CR	
Crested Bellbird	23/7/95	1		LS	
Crested Bellbird	28/2/96	1		LS	near Quadrat 7
Currawong	24/9/95	1	E2	LS	
Currawong	26/9/95	1	E2	LS	
Currawong	28/9/95	1	E2	MS	
Currawong	26/9/95	2	E1	MS	
Currawong	22/7/95	2		US	
Currawong	23/7/95	1		LS	
Currawong	27/9/95	1		US	as above
Grey Butcherbird	26/2/96	1	1	CR	imm.
Grey butcherbird	29/2/96	1	1	CR	
Grey Currawong	26/9/95	1	E3	US	
Grey Shrike-thrush	24/9/95	1		MS	in gorge adj E1
Grey Shrike-thrush	26/9/95	1	E2	CR	
Grey Shrike-thrush	27/9/95	1	2	MS	
Grey Shrike-thrush	26/9/95	1		MS	
Grey Shrike-thrush	26/9/95	2	2	MS	
Grey Shrike-thrush	25/9/95	1	7	VL	
Grey Shrike-thrush	23/7/95	1		MS	
Grey Shrike-thrush	24/7/95	1	2	MS	
Grey Shrike-thrush	27/9/95	1		US	as above
Grey Shrike-thrush	28/9/95	1		US	cave at 30 22'S, 119 39'E
Hooded Robin	23.7.95	1		LS	
Hooded Robin	27/9/95	1		MS	
Horsefield's Bronze Cuckoo	25/9/95	1		LS	Peter's camp 30 21'S, 119 41'E
Horsefield's Bronze Cuckoo	25/9/95	1	5	LS	
Horsefield's Bronze Cuckoo	26/9/95	1	5	LS	

Horsefield's Bronze Cuckoo	28/9/95	1	5	LS	
Inland Thornbill	24/7/95	2	1	CR	
Inland Thornbill	28/2/96	4	E2	US	
Inland Thornbill	28/2/96	5	7	VL	
Jacky Winter	27/9/95	1		LS	as above
Jacky Winter	27/9/95	1		VL	
Little Crow	23/7/95	1		MS	
Little Woodswallow	26/9/95	4	E1	MS	
Little Woodswallow	25/9/95	1	E1	MS	
Little Woodswallow	28/9/95	6		US	cave at 30 22'S, 119 39'E
Little Woodswallow	26/2/96	1		US	near Quadrat 1
Mallee fowl	25/9/95			LS	disused nest at 119 35'E, 30 21'S
Mistletoebird	26/9/95	1		LS	Peter's camp 30 21'S, 119 41'E
Owlet Nightjar	24/2/95	1	1	CR	calling at night
Owlet Nightjar	28/2/96	1		US	disgorged by ?Python in E. capillosa
Peregrine Falcon	28/9/95	1	1	CR	
Peregrine Falcon	29/2/96	1		US	east side of Range
Pied Butcher bird	26/9/95	1	E2	CR	
Pied Butcher bird	28/9/95	1	5	LS	
Pied Butcherbird	26/9/95	1	5	LS	
Pied Butcherbird	26/2/96	1		LS	near Bungalbin Hill
Port Lincoln Ringneck	27/9/95	3		US	
Port Lincoln Ringneck	23/7/95	3		MS	
Port Lincoln Ringneck	26/9/95	1	E3	US	
Purple-crowned Lorikeet	27/9/95	FW		US	
Purple-crowned Lorikeet	27/9/95	?		LS	as above
Purple-crowned Lorikeet	28/2/96	6		LS	near Quadrat 7
Red Wattle Bird	28/9/95	1	5	LS	
Red Wattlebird	26/9/95	FW	5	LS	
Red Wattlebird	23/7/95	1		LS	
Red-capped Robin	26/9/95	1	6	LS	
Red-capped Robin	27/9/95	6		LS	near 30 22'S, 119 38'E
Red-capped Robin	26/7/95	1		MS	near Quadrat 4
Red-capped Robin	28/2/96	3		LS	near Quadrat 7
Redthroat	24/7/95	1	2	MS	
Regent Parrot	26/7/95	2	5	LS	
Rufous Tree-creeper	25/9/95	1	5	LS	

Rufous Tree-creeper	26/9/95	1	5	LS	
Rufous Whistler	24/9/95	1	2	MS	
Rufous Whistler	27/9/95	1	2	MS	
Rufous Whistler	25/9/95	1	7	VL	
Rufous Whistler	27/9/95	1		MS	as above
Rufous Whistler	27/9/95	1		US	as above
Rufous Whistler	27/9/95	1		VL	
Rufous Whistler	26/2/96	1		MS	Gully in Range
Shy Hylacola	25/9/95	3	7	VL	
Shy Hylacola	28/2/96	5	7	VL	
Singing Honeyeater	24/9/95	1	2	MS	
Singing Honeyeater	28/9/95	1	E2	MS	
Singing Honeyeater	26/9/95	5		MS	
Singing Honeyeater	22/7/95	1		US	
Singing Honeyeater	23/7/95	1		MS	
Singing Honeyeater	23/7/95	1		CR	Feeding on flowering Dryandra arborea
Singing Honeyeater	23/7/95	FW		CR	
Singing Honeyeater	27/9/95	1		US	as above
Singing Honeyeater	26/2/96	1		US	near Quadrat 1
Singing Honeyeater	29/2/96	FW		US	east side of Range
Spiny-cheeked Honeyeater	24/9/95	1	2	MS	
Spiny-cheeked Honeyeater	25/9/95	1		LS	Peter's camp 30 21'S, 119 41'E
Spiny-cheeked Honeyeater	25/9/95	1	5	LS	
Spiny-cheeked Honeyeater	26/9/95	4	4	CR	
Spiny-cheeked Honeyeater	28/9/95	1	5	LS	
Spiny-cheeked Honeyeater	23/7/95	1		MS	
Spiny-cheeked Honeyeater	27/9/95	1		VL	
Spiny-cheeked Honeyeater	27/9/95	1		MS	
Spiny-cheeked Honeyeater	28/9/95	1		US	cave at 30 22'S, 119 39'E
Spiny-cheeked Honeyeater	26/2/96	1		US	near Quadrat 1
Spiny-cheeked Honeyeater	29/2/96	1	1	CR	
Spotted Nightjar	24/2/95	1	1	CR	
Striated Pardalote	24/9/95	1	3	LS	
Striated Pardalote	24/9/95	1	E2	CR	
Striated Pardalote	25/9/95	FW	5	LS	
Striated Pardalote	26/9/95	FW	E2	LS	
Striated Pardalote	27/9/95	1	2	MS	

Striated Pardalote	27/9/95	1	3	LS	
Striated Pardalote	28/9/95	1	5	LS	
Striated Pardalote	28/995	1	E2	MS	
Striated Pardalote	26/9/95	1		MS	
Striated Pardalote	23/7/95	1		MS	
Striated Pardalote	27/9/95	1		MS	as above
Striated Pardalote	26/2/96	FW		US	near Quadrat 1
Tawny Frogmouth	23/7/95	1		MS	
Wedge-tailed Eagle	24/9/95	1			over Bungalbin Hill
Wedge-tailed Eagle	26/9/95	2		LS	Peter's camp 30 21'S, 119 41'E
Wedge-tailed Eagle	26/9/95	1	2	MS	
Wedge-tailed Eagle	23/7/95	1		CR	
Wedge-tailed Eagle	27/9/95	2		US	as above
Weebill	24/9/95	3	3	LS	
Weebill	24/9/95	4	E2	CR	
Weebill	26/9/95	FW	E2	LS	
Weebill	27/9/95	FW	2	MS	
Weebill	27/9/95	FW	3	LS	
Weebill	28/9/95	FW	5	LS	
Weebill	26/9/95	FW	5	LS	
Weebill	23/7/95	FW		MS	
Weebill	24/7/95	FW	2	MS	
Weebill	27/9/95	FW		VL	
Weebill	26/2/96	FW		US	near Quadrat 1
Weebill	28/2/96	1	7	VL	
Weebill	29/2/96	FW		US	east side of Range
Western Yellow Robin	28/2/96	1	7	VL	
White-eared Honeyeater	28/9/95	1	5	LS	
White-eared Honeyeater	28/9/95	1	E2	MS	
White-eared Honeyeater	25/9/95	3	7	VL	
White-eared Honeyeater	27/9/95	1	E2	LS	as above
White-eared Honeyeater	22/7/95	1		US	
White-eared Honeyeater	23.7/95	1		MS	
White-eared Honeyeater	29/2/96	FW		US	east side of Range
White-fronted Honeyeater	24/9/95	1	2	MS	
White-fronted Honeyeater	26/9/95	1	5	LS	
White-fronted Honeyeater	26/9/95	1	4	CR	

White-fronted Honeyeater	27/9/95	1	2	MS	
White-fronted Honeyeater	28/9/95	1	E2	MS	
White-fronted Honeyeater	27/9/95	1		US	
White-fronted Honeyeater	28/9/95	1		US	cave at 30 22'S, 119 39'E
Willie Wagtail	27/9/95	1	3	LS	
Willie Wagtail	27/9/95	1		LS	cave at 30 22'S, 119 39'E
Willie Wagtail	27/9/95	1		US	cave in cliff at 30 22.59'S, 119 39.28'E
Willie Wagtail	28/9/95	1		US	cave at 30 22'S, 119 39'E
Willie Wagtail	29/2/96	FW		US	east side of Range
Yellow-plumed Honeyeater	24/9/95	1	3	LS	
Yellow-plumed Honeyeater	25/9/95	1	5	LS	
Yellow-plumed Honeyeater	27/9/95	1	3	LS	
Yellow-plumed Honeyeater	28/9/95	1	5	LS	
Yellow-rumped Thornbill	27/9/95	FW		VL	
Yellow-rumped Thornbill	29/2/96	2		US	east side of Range
Yellow-throated miner	28/9/95	1	E2	MS	
Zebra Finch	27/9/95	2		VL	

MAMMALS

Canis lupus	29/2/96	1		LS	fresh Dingo tracks, 30 21'S, 119 41'E
Capra hircus	23/7/95			CR	old goat scats here ie E2 site
Cercartetus concinnus	25/9/95	1	1A	CR	female, 10.0g
Cercartetus concinnus	26/9/95	1	3B	LS	male, 12.0g
Cercartetus concinnus	26/9/95	1	4B	CR	male, 12.0g, testes width 14.3mm
Cercartetus concinnus	26/9/95	1	4B	CR	male,9.0g testes width 12.5mm
Cercartetus concinnus	28/9/95	1	4B	CR	recapture of above
Leporillus apicalis	28/9/95			US	old nest cave at 30 22'S, 119 39'E
Macropus robustus	24/9/95	1		CR	near Quadrat 1
Macropus robustus	27/9/95	1	E3	US	
Macropus robustus	23/7/95	2	E2	MS	
Macropus robustus	23/7/95	1		LS	
Macropus robustus	25/2/96	3	E3	US	incl. female with pouch young
Macropus robustus	25/2/96	3	E1	US	
Ningaui yvonnae	29/2/96	1	5A	LS	female, 7.6g, specimen not confirmed
Oryctolagus cuniculus	26/9/95	1	7	VL	
Oryctolagus cuniculus	27/9/95	1		MS	near Quadrat 2

Oryctolagus cuniculus	23/7/95	2		CR	E2 site
Pseudomys hermannsburgensis	25/2/96	1	3A	LS	male, 12.0g, specimen not confirmed
Pseudomys hermannsburgensis	27/2/96	1	5B	LS	female, specimen not confirmed
Pseudomys hermannsburgensis	28/2/96	1	6B	LS	female, 17.2g
Sminthopsis dolichura	27/2/96	1	1A	CR	female, 12.5g hind foot=10.4mm
Sminthopsis dolichura	25/2/96	1	1B	CR	male, 11.0g, mark #1
Sminthopsis dolichura	28/2/96	1	1B	CR	female, 12.0g, mark #2
Sminthopsis dolichura	29/2/96	1	4A	CR	male, 13.5g
Sminthopsis dolichura	28/2/96	1	4B	CR	female, 10.0g, mark #1
Sminthopsis dolichura	28/2/96	1	6B	LS	female, 7.0g
Sminthopsis dolichura	26/2/96	1	6A	LS	female, 9.0g
Tachyglossus aculeatus	23/7/95		E2	CR	fresh scratchings E2 site
Tachyglossus aculeatus	26/9/95			US	scratchings Site E3
Tachyglossus aculeatus	28/9/95	1		LS	
Tachyglossus aculeatus	26/2/96			US	fresh scratchings near Quadrat 1
Tachyglossus aculeatus	29/2/96	1		US	very fresh scat!
Trichosurus vulpecula	27/9/95			US	old scats in cave at 30 23'S, 119 39'E

REPTILES

Cryptoblepharus plagiocephalus	24/9/95	1	2A	MS	2.0g, 37.5mm
Cryptoblepharus plagiocephalus	26/9/95	1	2A	MS	0.5g, 34mm
Cryptoblepharus plagiocephalus	27/9/95	1	2A	MS	0.6g, 31mm
Cryptoblepharus plagiocephalus	26/9/95	1	2B	MS	R 127336 in WAM
Ctenophorus cristatus	28/2/96	1	7A	VL	sight record only
Ctenophorus cristatus	25/2/95	1		LS	E. ebbanoensis
Ctenophorus reticulatus	28/2/96	1	1B	CR	female, sight record
Ctenotus uber	24/9/95	1	1B	CR	5.3g, 57mm
Ctenotus uber	27/2/96	1	1B	CR	1.2g, 43mm, mark #1
Ctenotus uber	27/2/96	1	2A	MS	4.8g, 64mm, mark #1
Ctenotus uber	29/2/96	1	2A	MS	5.2g, 47mm
Ctenotus uber	26/9/95	1	2B	MS	5.2g, 60mm, specimen R126489
Ctenotus uber	26/9/95	1	3A	LS	5.4g, 64mm, specimen WAM 126485
Ctenotus uber	27/9/95	1	3A	LS	3.8g, 59mm, mark #1
Ctenotus uber	26/2/96	1	3A	LS	3.1g, 53mm, mark #3
Ctenotus uber	25/2/96	1	3B	LS	1.9g, 44mm, mark #1
Ctenotus uber	25/2/96	1	3B	LS	1.2g, 41mm, mark #2

Ctenotus uber	26/2/96	1	3B	LS	1.9g, 44mm, mark #1
Ctenotus uber	26/2/96	1	3B	LS	1.2g, 41mm, mark #2
Ctenotus uber	28/2/96	1	3B	LS	dead in pit
Ctenotus uber	28/2/96	1	3B	LS	0.2g, 31mm
Ctenotus uber	24/9/95	1	4A	CR	5.0g, 61mm
Ctenotus uber	27/2/96	1	4A	CR	1.8g, 44mm, mark #1
Ctenotus uber	29/2/96	1	4B	CR	4.0g, 59mm
Ctenotus uber	25/9/95	1	5A	LS	3.0g, 54mm, specimen not confirmed
Ctenotus uber	27/2/96	1	6B	LS	sight record only
Ctenotus uber	26/2/96	1	6A	LS	1.0g, 45mm
Ctenotus uber	27/2/96	1	6A	LS	1.2g, 36mm
Ctenotus uber	29/2/96	1	6A	LS	1.0g, 30mm
Ctenotus uber	26/2/96	1	7A	VL	1.1g, 43mm
Ctenotus uber	26/2/96	1	7A	VL	3.2g, 54mm
Ctenotus uber	28/2/96	1	7A	VL	1.6g, 47mm
Ctenotus uber	29/2/96	1	7A	VL	1.4g, 45mm
Ctenotus uber	28/2/96	1	7B	VL	0.3g, 33mm
Ctenotus uber	29/2/96	1	7B	VL	5.4g, 63mm
Ctenotus uber	27/9/95	1	3A	LS	62mm
Cyclodomorphus branchialis	24/9/95	1	1A	CR	5.4g, 76mm
Cyclodomorphus branchialis	26/2/96	1	6B	LS	1.5g, 45mm
Cyclodomorphus branchialis	27/9/95	1		LS	as above
Cyclodomorphus branchialis	27/9/95	1		LS	E. corrugata
Demansia psammophis reticulata	29/9/95	1		LS	photo, Marie Lochman
Diplodactylus assimilis	26/2/96	1	7A	VL	3.0g, 47mm
Diplodactylus granariensis	25/2/96	1	2B	MS	4.1g, 59mm
Diplodactylus granariensis	26/2/96	1	3A	LS	3.1g 39mm
Diplodactylus granariensis	26/9/95	1	3B	LS	4.5g, 51mm
Diplodactylus granariensis	27/2/96	1	3B	LS	3.6g, 46mm
Diplodactylus granariensis	25/9/95	1	5B	LS	4.2g, 49mm
Diplodactylus granariensis	28/9/95	1	5B	LS	female, 4.8g, 61mm, gravid 3 eggs
Diplodactylus granariensis	25/2/96	1	7A	VL	5.9g, 64mm
Diplodactylus granariensis	25/2/96	1	7B	VL	4.2g, 50mm
Diplodactylus granariesis	26/9/95	1	3B	LS	3.0g, (no tail) 51mm
Diplodactylus maini	25/9/95	1	3A	LS	2.8g, 51mm, specimen WAM 126491
Diplodactylus maini	27/9/95	1	3A	LS	dead in pit
Diplodactylus maini	27/9/95	1	3A	LS	4.0g, 52mm, specimen WAM 126484

Diplodactylus maini	27/9/95	1	3A	LS	3.0g, 49mm, gravid with 2 eggs
Diplodactylus maini	26/2/96	1	3A	LS	2.0g, 38mm
Diplodactylus maini	26/9/95	1	3B	LS	2.2g, 48mm, specimen WAM 126483
Diplodactylus maini	27/9/95	1	5B	LS	5.0g, 55mm
Diplodactylus pulcher	26/9/95	1	1B	CR	2.0g, 52.7mm
Diplodactylus pulcher	26/9/95	1	1B	CR	3.0g, 52mm
Diplodactylus pulcher	26/9/95	1	1B	CR	3.0g, 53mm
Diplodactylus pulcher	28/9/95	1	1B	CR	3.0g, 51mm
Diplodactylus pulcher	26/2/96	1	2A	MS	3.2g, 55mm
Diplodactylus pulcher	26/9/95	1	2B	MS	2.5g (no tail), 56mm
Diplodactylus pulcher	26/9/95	1	2B	MS	2.5g, 46mm
Diplodactylus pulcher	26/9/95	1	2B	MS	4.0g, 53mm
Diplodactylus pulcher	27/9/95	1	2B	MS	3.0g, 53mm
Diplodactylus pulcher	27/9/95	1	2B	MS	2.2g, 45mm
Diplodactylus pulcher	27/9/95	1	2B	MS	3.5g, 55mm
Diplodactylus pulcher	27/9/95	1	2B	MS	4.5g, 60mm
Diplodactylus pulcher	27/9/95	1	2B	MS	4.2g, 53mm
Diplodactylus pulcher	26/9/95	1	3A	LS	3.0g, 49.5mm
Diplodactylus pulcher	27/9/95	1	3A	LS	4.0g 50mm
Diplodactylus pulcher	24/9/95	1	3B	LS	3.8g, 43mm
Diplodactylus pulcher	25/9/95	1	3B	LS	3.6g, 46mm
Diplodactylus pulcher	25/9/95	1	5A	LS	53mm
Diplodactylus pulcher	27/9/95	1	5A	LS	5.5g, 61mm, single vert. stripe
Diplodactylus pulcher	25/9/95	1	5B	LS	4.0g, 47mm
Diplodactylus pulcher	26/9/95	1	5B	LS	4.0g, 52mm
Diplodactylus pulcher	26/9/95	1	5B	LS	3.6g, 53mm
Diplodactylus pulcher	27/9/95	1	5B	LS	5.0g, 60mm
Diplodactylus pulcher	28/9/95	1	5B	LS	3.0g, 45mm
Diplodactylus pulcher	26/2/96	1	5B	LS	48mm
Diplodactylus pulcher	25/9/95	1	1B	CR	3.6g 53mm
Egernia formosa	27/2/96	1	3A	LS	3.0g, 52mm
Eremiascincus richardsonii	26/2/96	1	3A	LS	6.2g, 59mm
Eremiascincus richardsonii	25/2/96	1	3B	LS	2.0g, 46mm, mark #1
Eremiascincus richardsonii	25/2/96	1	3B	LS	1.6g, 46mm, mark #2
Gehyra variegata	27/2/96	1	5A	LS	2.8g, 49mm
Gehyra variegata	26/9/95	1	5B	LS	2.0g, 46mm
Gehyra variegata	27/2/96	1	5B	LS	

Gehyra variegata	25/2/96	1	6A	LS	2.2g, 40mm
Gehyra variegata	26/2/96	1	6A	LS	2.0g, 36mm
Gehyra variegata	27/2/96	1	6A	LS	1.9g, 33mm
Gehyra variegata	28/2/96	1	7A	VL	sight record only
Heteronotia binoei	24/9/95	1	1A	CR	2.0g, 43mm
Heteronotia binoei	26/9/95	1	1A	CR	2.0g, 45mm
Heteronotia binoei	27/2/96	1	4B	CR	2.2g, 48mm
Heteronotia binoei	27/2/96	1	6B	LS	1.9g, 36mm
Heteronotia binoei	28/2/96	1	7A	VL	sight record only
Heteronotia binoei	27/9/95	1		LS	Euc corrugata at 119 39'E, 30 23'S
Heteronotia binoei	27/9/95	1		LS	E.corrugata
Menetia greyii	28/9/95	1	1A	CR	<1.0g, (no tail) 28mm
Menetia greyii	26/9/95	1	2A	MS	wt ? 27mm dead in pit
Menetia greyii	26/9/95	1	2A	MS	<1.0g, 31mm
Menetia greyii	29/2/96	1	2A	MS	0.1g, 18mm
Menetia greyii	26/9/95	1	2A	MS	<1.0g, 23mm
Morethia butleri	26/9/95	1	4B	CR	male, 2.5g, 50mm, orange throat
Morethia butleri	27/9/95	1	5B	LS	2.0g, 50mm
Morethia butleri	25/9/95	1	2A	MS	2.7g, 52mm, mark #1
Morethia butleri	25/9/95	1	2A	MS	2.0g, 48mm, mark #2
Pogona minor	03/1/96	1	1	CR	active in camp 1.00AM
Pygopus lepidopodus	28/2/96	1	7A	VL	77mm
Ramphotyphlops australis	27/9/95	1	1A	CR	4.2g, 220mm
Ramphotyphlops australis	28/9/95	1	4B	CR	6.0g, 215mm
Ramphotyphlops australis	28/9/95	1	5B	LS	15.0g, 295mm
Ramphotyphlops bituberculatus	27/9/95	1	3A	LS	0.6g, 125mm, specimen WAM 126493
Ramphotyphlops bituberculatus	27/9/95	1	3A	LS	3.0g, 215mm, specimen not confirmed
Ramphotyphlops bituberculatus	28/9/95	1	5A	LS	10.0g, 390mm, specimen WAM 126492
Ramphotyphlops hamatus	26/9/95	1	3B	LS	2.9g, 225mm
Rhinoplocephalus monachus	27/9/95	1	1B	CR	7.0g, 270mm
Rhinoplocephalus monachus	24/9/95	1	5B	LS	8.0g, 280mm
Tympanocryptis cephala	24/9/95	1	1A	CR	4.7g, 48mm
Tympanocryptis cephala	24/2/95	1		MS	2.4g, 35mm
Tympanocryptis cephala	23/9/95	1		LS	E. ebbanoensis ~ 30 21'S, 119 41'E
Tympanocryptis cephala	25/2/95	1	E1	US	Gorge' site
Tympanocryptis cephala	29/2/96	1		LS	30 21'S, 119 41'E
Underwoodisaurus milii	26/9/95	1	1A	CR	15.0g, 88mm

Underwoodisaurus milii	25/2/96	1	7A	VL	2.0g, 45mm
Varanus tristis	28/2/96	1	1B	CR	4.0g, 75mm, mark#1
Varanus tristis	29/2/96	1	1B	CR	recapture of #1
Varanus tristis	29/2/96	1	3A	LS	4.3g, 74mm
Varanus tristis	27/2/96	1	6B	LS	32.0g, 129mm
Varanus giganteus	25/9/95	1		MS	1.3m long, in 'Gorge'
Varanus giganteus	27/9/95	1		LS	E. ebbanoensis at 119 38'E, 30 2

APPENDIX 6

Vertebrate fauna records for woodlands surrounding the Helena and Aurora Range.

Explanation of column headings and codes.

Number
Number of individuals captured or sighted.

FW few
MY many

Comments
General locality details (see Appendix 4 for coordinates of some localities).

TAXON	NUMBER	DATE	COMMENTS
BIRDS			
Australian. Ringneck	1	24/2/95	Marda Dam T/off
Australian. Ringneck	2	25/9/95	track Salmon Gum
Australian. Ringneck	2	27/9/95	track mallee
Australian. Ringneck	1	27/9/95	track woodland
Black-faced Cuckoo Shrike	3	25/9/95	Mug tree Rock Hole
Black-faced Cuckoo Shrike	1	27/9/95	track Salmon Gum
Black-faced Cuckoo-shrike	1	27/9/95	track Gimlet
Brown Falcon	1	22/7/95	JK 8A site
Brown Falcon	1	25/9/95	track Salmon Gum
Brown Falcon	2	26/9/95	nest with C/3
Budgerygah	FW	26/9/95	track E. corrugata
Budgerygah	16	25/9/95	track Salmon Gum
Chestnut Quail-thrush	1	24/2/95	track Salmon Gum
Chestnut Quail-thrush	1	27/9/95	track Salmon Gum
Chestnut Quail-thrush	1	26/9/95	track E. corrugata
Chestnut Quail-thrush	1	27/9/95	track woodland
Chestnut Quail-thrush	2	27/9/95	track Eucalypt woodland
Crested Bellbird	1	22/7/95	Salmon Gum bogsite
Crested Bellbird	1	23/7/95	Mug tree Rock Hole
Crested Bellbird	1	26/2/95	track Salmon Gum
Crested Bellbird	1	25/9/95	track Salmon Gum
Crested Bellbird	1	27/9/95	track Salmon Gum
Crested Bellbird	1	27/9/95	Marda T/off
Currawong	1	27/9/95	track mallee
Currawong	2	27/9/95	track Salmon Gum
Currawong	1	27/9/95	track woodland
Currawong	2	25/9/95	track woodland
Currawong	1	25/9/95	track Salmon Gum
Dusky Woodswallow	2	25/7/95	Salmon Gum
Dusky Woodswallow	2	26/2/95	track Salmon Gum
Dusky Woodswallow	2	29/2/95	Track Salmon Gum
Dusky Woodswallow	FW	27/9/95	track woodland
Emu	1x2 B/10	24/9/95	near wetland
Galah	20	25/9/95	Mulga patch
Galah	8	27/9/95	track Salmon Gum
Galah	10	27/9/95	track Salmon Gum
Galah	1	27/9/95	track Salmon Gum
Galah	9	27/9/95	Mug tree Rock Hole
Grey Butcherbird	1	25/9/95	track Salmon Gum
Grey Shrike-thrush	1	22/7/95	JK 8A site
Grey Shrike-thrush	1	22/7/95	Salmon bog site
Grey Shrike-thrush	1	24/7/95	Salmon bog site
Grey Teal	FW	24/9/95	Salmon bog site
Jacky Winter	1	27/9/95	Marda T/off
Kestrel	1	24/2/95	Marda Dam T/off
Little Crow	1	27/9/95	track Salmon Gum
Little Woodswallow	1	26/9/95	track E. corrugata
Magpie	1	24/7/95	Salmon bog site
Magpie	4	29/2/95	track Eucalypt woodland
Magpie	2	27/9/95	track mallee
Major Mitchell	2	22/7/95	JK 8A site
Major Mitchell	1	27/9/95	Falcon's nest site
Pacific Black Duck	2	24/9/95	swamp near 30 19.50S 119 41.10E
Pallid Cuckoo	1	23/7/95	Mug tree Rock Hole
Pied Butcherbird	1	22/795	Salmon bog site
Pied Butcherbird	1	27/9/95	track woodland
Pied Butcherbird	1	25/9/95	track Salmon Gum
Purple-crowned Lorikeet	FW	22/7/95	Salmon bog site
Purple-crowned Lorikeet	FW	24/7/95	Salmon bog site

Purple-crowned Lorikeet	2	26/2/95	track Salmon Gum
Purple-crowned Lorikeet	2	25/9/95	Salmon Gum T/off
Purple-crowned Lorikeet	FW	27/9/95	track Eucalypt woodland
Red Wattlebird	1	22/7/95	JK 8A site
Red Wattlebird	FW	22/7/95	Salmon bog site
Red Wattlebird	1	27/9/95	track Salmon Gum
Red-backed Kingfisher	2	27/9/95	track Salmon Gum
Red-backed Kingfisher	1	27/9/95	track Gimlet
Red-backed Kingfisher	1	25/9/95	track Salmon Gum
Red-backed Kingfisher	1	25/9/95	Salmon Gum T/off
Red-backed Kingfisher	1	27/9/95	track Salmon Gum
Red-capped Robin	6	27/9/95	Marda T/off
Rufous Songlark	1	27/9/95	track woodland
Rufous Tree-creeper	1	24/7/95	Salmon bog site
Rufous Tree-creeper	2	24/2/95	track Eucalypt woodland
Rufous Tree-creeper	1	24/2/95	track Salmon Gum
Rufous Tree-creeper	1	27/9/95	track Salmon Gum
Rufous Tree-creeper	1	27/9/95	track Gimlet
Rufous Tree-creeper	FW	26/9/95	track E. corrugata
Rufous Tree-creeper	1	27/9/95	track woodland
Rufous Tree-creeper	1	25/9/95	Salmon Gum T/off
Rufous Treecreeper	1	22/7/95	Salmon bog site
Rufous Whistler	1	27/9/95	track Salmon Gum
Spiny-cheeked Honeyeater	1	22/7/95	JK 8A site
Spiny-cheeked Honeyeater	1	23/7/95	Mug tree Rock Hole
Splendid Fairy-wren	1	23/7/95	Mug tree Rock Hole
Square-tailed Kite	1	24/7/95	Salmon bog site
Striated Pardalote	FW	22/7/95	JK 8A site
Striated Pardalote	FW	22/7/95	Salmon bog site
Striated Pardalote	1	23/7/95	Mug tree Rock Hole
Striated Pardalote	FW	25/9/95	track Salmon Gum
Striated Pardalote	1	27/9/95	track mallee
Tree Martin	5	24/7/95	Trailer site
Tree martin	4	26/2/95	track Salmon Gum
Wedge-tailed Eagle	1	26/2/95	track Salmon Gum
Wedge-tailed Eagle	1	27/9/95	track Salmon Gum
Wedge-tailed Eagle	3	27/9/95	
Weebill	FW	22/7/95	JK 8A site
Weebill	FW	23/7/95	Mug tree Rock Hole
Weebill	FW	25/9/95	track Salmon Gum
Weebill	FW	27/9/95	track Salmon Gum
White-eared Honeyeater	1	23/7/95	Mug tree Rock Hole
White-eared Honeyeater	1	27/9/95	Marda T/off
Willie Wagtail	1	25/9/95	track Salmon Gum
Willie Wagtail	1	25/9/95	nesting C/3
Willie Wagtail	1	27/9/95	Marda T/off
Yellow-plumed Honeyeater	FW	22/7/95	Salmon bog site
Yellow-plumed Honeyeater	FW	24/7/95	Salmon bog site
Yellow-plumed Honeyeater	FW	26/2/95	track Salmon Gum
Yellow-plumed Honeyeater	FW	29/2/95	track Salmon Gum
Yellow-plumed Honeyeater	1	27/9/95	track Salmon Gum
Yellow-plumed Honeyeater	4	26/9/95	track E. corrugata
Yellow-plumed Honeyeater	1	27/9/95	track woodland
Yellow-plumed Honeyeater	1	25/9/95	track Salmon Gum
Yellow-throated Miner	FW	22/7/95	JK 8A site
Yellow-throated Miner	8	23/7/95	Mug tree Rock Hole
Yellow-throated Miner	1	25/9/95	Track Salmon Gum
Yellow-throated Miner	1	27/9/95	track Salmon Gum
Yellow-throated Miner	4	27/9/95	track Eucalypt woodland

MAMMALS

Macropus robustus	1	24/2/95	Marda Dam T/off
Oryctolagus cuniculus	2	24/2/95	track Salmon Gum

Macropus fuliginosus	1	27/9/95	track Salmon Gum
Macropus robustus	1	27/9/95	track Salmon Gum
Macropus rufus	1	27/9/95	track Gimlet

REPTILES

Ramphotyphalops australis	1	22/7/95	Salmon bog site
Varanus giganteus	1	25/2/95	wetland site
Ctenophorus cristatus	1	29/2/95	track Eucalypt woodland

APPENDIX 7.

Invertebrate collections for the Helena and Aurora Range Sept/Oct. 1995. (Quadrats 6 and 7 not sampled spring 1995)

	QUADRAT (Numbers are quadrat No.)					COMMENTS
	1	**2**	**3**	**4**	**5**	
CHILOPODA					5	
Lithopodia						
Scolpendrida						
Scolpendridae						
Scolpendra laeata			3		5	
S. morsitans			3			very large centipedes
						centipedes
Cormocephalus turneri			3			
Arthrorhabus paucispinus					5	
SCORPIONIDAE						
Buthidae						
Lychas alexandrinus	1				5	
Lyshas sp. 3						possibly new species
Isometroides vescus	1					
ARANEAE						
Araneomorphae						
Lamponidae						
Lamponina sp	1					
Lamponia sp			3			
Lycosidae						
Lycosidae sp1 2 juv		2				
Lycosidae sp2 1 juv				4		
Lycosidae sp3 2 juv					5	
Lycosidae sp4 4 juv		2				
Lycosidae sp 1 male				4		
Lycosidae sp 1 female			3			
Lycosidae sp5 1 juv				4		
Lycosidae sp6 3 juv		2				
Lycosidae sp7 3 juv			3			
Lycosidae sp8 2 juv			3			
Lycosidae sp9 1 juv						From litter
Lycosidae sp10 1 juv					5	
Lycosa sp 1 male					5	
Lycosa sp 1 male			3			
Lycosa sp 1 male						vagrant at night
Lycosa sp 1 male				4		
Araneidae						
indet sp. 1 juv					5	
indet.sp. 2 juv						Mulga branch litter
Gastercantha minox 1 female						many species in webs in shrubs
Corinnidae						
Supunna albopunctatum 1 male						
species group 1		2				
Ctenidae						
Ctenidae 2 juv			3			
Ctenidae 1 juv			3			

Gnaphosidae						
Aristerus sp			3			
Gnaphosidae sp1 1 male		2				
Gnaphosidae sp2 2 male			3			
Gnaphosidae sp3 1 male		2				
Gnaphosidae sp4 1 male		2				
Gnaphosidae sp5 1 male					5	
Gnaphosidae sp6 1 male			3			
Eilica sp 1 female	1					
Hemicloea sp 1 female						under Euclayptus bark
Miturgidae						
Miturgidae sp1			3			
Miturgidae sp2 1 male				4		
Miturgidae sp3		2				
Miturgidae sp4 2 juv				4		
Miturgidae sp5 2 juv			3			
Nicodamidae						
Nicodamus mainae 2 males					5	
N. mainae 2 males			3			
Oxyopidae						
Oxyopidae sp1				4		
Oxyopidae sp2 1 male			3			
Oxyopidae sp3					5	
Oxyopidae sp4				4		
Oxyopidae sp5 1 male						from Acacia acuminata
Oxyopidae sp6						from Acacia acuminata
Prodidomidae						
Molycrinae 1 female	1					
Molycrinae 1 male					5	
Molycriinae 1 female						low shrubs
Molycriinae 1 female	1					
Pholcidae						
Pholcidae 1 male					5	
Pholcidae 1 male		2				
Salticidae						
indet. sp. 1 female		2				an extremely small adult
Fissidentatisi sp1 1 male *			3			
Fissidentatisi sp2 1 male *		2				
Fissidentatisi sp3 1 female *			3			
Fissidentatisi sp4 1 male *	1					
Fissidentatisi sp5 1 male *					5	
Fissidentatisi sp6 1 male *						
Fissidentatisi sp7 1 female *					5	*Undescribed genus*
Menomerus sp 1 male						vagrant in rocks
Stiphidiidae						
Corassoides sp 1 male			3			
Corassoides sp 1 male					5	
Corassoides sp 1 male			3			
Thomisidae						
Thomisidae sp 1 juv					5	
Thomisidae sp 1 juv						from Dodonea

Stephanopsis sp 1 juv				5	
Theridiidae					
Steatoda native sp male			4		
Zodariidae					
Zodariidae 1 female		2			
Zodariidae 1 male		2			
Zodariidae 2 juv			4		
Zodariidae 1 female			4		
Zodariidae 2 female 1 juv		2			
Zodariidae 4 juv			3		
Zodariidae 1 juv				5	
Zodariidae 2 female	1				
Zodariidae 1 juv			4		
Zodariidae 1 male		2			
Zodariidae 1 female		2			
Zodariidae 2 juv			3		
Zodariidae 2 juv					from litter
Zoridae					
Zoridae 1 female				5	
Zoridae 1 female		2			
Zoridae 1 female				5	
Mygalomorphae					
Nemesiidae 1 male				5	
Nemesiidae 1 male				5	
Nemesiidae 1 male	1				
Nemesiidae 1 male				5	
Nemesiidae 1 male		2			
Nemesiidae 1 male			3		
Barychelidae 1 male		2			
Idiopidae 1 male			4		
Tetragnathidae 4 juv					from Neurachne sp. & bushes

	QUADART (numbers are quad. No.)					COMMENTS	NO. COLLN'S.
INSECTS							
BLATTODEA							
Cockroaches							
Blattidae							
Anmesia sp	1			4			5
Desmozosteria sp	1				5		7
Pseudolmpra sp					5.	& upper camp, possibly new species	3
Megazosteria patula		2			5	also from swamp area	3
Zoniopiocata sp			3				4
Polyzosteria mitchelli	1	2	3	4	5	& general	8
Polyzosteria sp		2					2
Platyzosteria grandis				4		lower camp & general	4
Ellipsidion sp					5	lower camp & general	2
Blaberidae							
Ataxigamia tatei				4		lower camp	4
Laxta sp		2			5		3
ORTHOPTERA							
Gryllidae							
Gryllidae sp1			3				2
Gryllidae sp2			3			& swamp area	2
						Hg light common	2
Tettigonidae sp1							
Tettigonidae sp2						Hg light common	2
Tettigonidae sp3						Hg light common	2
Conocephalus sp						upper camp	1
Myrmecophilus testaceus		2					1
Buforina sp1		2	3				2
Buforina sp2		2			5		4
Buforina sp3					5		3
Buforina sp4							2
Buforina sp5						lower camp area in Neurachne sp.	4
Coryphistes ruricola		2				& general in Neurachne sp.	2
Genus not det sp31		2	3	4	5	& swamp area	2
Urnisa sp1			3				2
Urnisa sp2		2					3
Orthoptera sp6						mulga woodland	2
Orthoptera sp7	1						2
Orthoptera sp8						general vagrant	3
Orthoptera sp9						general vagrant	2
Orthoptera sp10					5		1
Orthoptera sp11			3				2
Orthoptera sp12						general vagrant	2
Orthoptera sp13	1						2
Orthoptera sp14				4			2
Orthoptera sp15	1						2
Orthoptera sp16	1						2
Orthoptera sp17		2					2
Orthoptera sp18				4			1
Orthoptera sp19			3				1
Orthoptera sp20						Mulga Woodland	2

MANTODEA

Amorphoscelidae							
Cliomantis sp male						Lower camp in Acacia acuminata	2
Cliomantis sp male						Lower camp in Acacia acuminata	1
Paraxypilus sp male						Lower camp in Mulga	2
Paraxypilus sp female						Lower camp in Mulga	2
Paraxypilus sp female						Lower camp Hg light	1

PHASMATODEA

Phasmatinae							
Ctenomorphodes tessulatus			3			& general area in Mulga	4

NEUROPTERA

Chrysopidae							
Chrysoptera sp							3
Dendroleontini							
Glenoleon sp possibly new							1

Coleoptera see seperate list

MECOPTERA

Bittacidae							
Harpobittacus sp							

DIPTERA

Tabanidae sp1	1	2	3	4	5		2
Asilidae sp1	1	2	3	4	5		1
Bathypogon sp1	1	2	3	4	5		1
Bathypogon sp2	1	2	3	4	5		2

TROCHOPTERA

Leptoceridae sp1							4

LEPIDOPTERA

Butterflies							
Danaus chrysippus						Lesser Wanderer	
Junonia villida						Medow Argus	
Papilio demoleus						Chequered Swallowtail frequent sightings	
Eurema smilax						Small Grass Yellow	
Delias aganippe						Wood White seen flying at hill tops & on Santalum acuminatum	
Cossidae							
Xyleutes sp						lower camp Hg light	4
Sphingidae							
Hippotion scrofa						lower camp Hg light	1
Geometridae							
Onechroma sp						lower camp Hg light	2
Chlorocoma sp1						lower camp Hg light	2
Chlorocoma sp2							2

Xyloryctidae					
Cryptophasia sp					3
					1
Noctuidae sp1					
Noctuidae sp2					2
ODONATA					
All specimens collected area from the swamp					
Zygoptera - Damselflies					
Austrolestes sp					4
Ischneura sp				these species don't compare with named specimens in WA Museum	2
Xanthagrion sp					2
Anisoptera - dragonflies					
Hemicordula tau					1
Diplacodes sp					5
HEMIPTERA					
Homoptera					
Eurybranchidae				Lower camp Hg light	1
Membracidae				general on Acacia spp	3
Corixidae					
Agraptocorixa parvipunctata				lower camp Hg light common	5
Notonectidae					
Anisops gralis				lower camp Hg light common	3
Species 1	2		2		2
Heteroptera					
Reduviidae					
Havanthus rufovarius				lower camp under stone	1
Havanthus rufovarius		3			3
Havanthus rufovarius				lower camp vagrant	2
Stenolemus sp			5	a very delicate sp	1
Reduviidae sp1				lower camp Hg light	4
Reduviidae sp2		3			2
Reduviidae sp3		3			1
Peirates sp1	2				1
Peirates sp1		3			2
Peirates sp3	2				1
Lygaeidae					
Dieuches sp				upper camp vagrant	4
Scutelleridae					
Choerocorus paganus				on Dodonea sp	12
Coreidae					
Myctis profana				on Dodonaea and Eremophila	4
Cydnidae					
Adrissa sp				general graound vagrant	3

Pentatomidae							
Poecilomentis apicallis						general on Senna	4
Poecilomentis patruellis						under bark of Eucalyptus spp.	2
Aplerotus maculatus						upper camp on Dodonaea	2
Pentatomidae sp2						general on Dodonaea	2
Pentatomidae sp3						general on mulga trunk	3
Pentatomidae sp4						general on Gimlet trunk	3
Miridae							
Miridae sp1						swept from Senna nd Acacia	3
sp2						swept from Senna	4
sp3						swept from Senna	2
sp4						swept from Senna	2
COLEOPTERA							
Carabidae							
Calosoma oceanicum						at Hg light common	2
Scaraphites sp1					5		1
sp2			3				1
sp3		2					1
sp4	1						1
Euryscaphus sp	1					an unusual brown sp	1
E. waterhousei		2					1
Gigadema bostocki	1	2	3	4	5		3
Gnathoxys humeralis			3				2
Scopodes sp			3				1
Simodontus sp		2			5		3
Philoscaphus tuberculosus			3		5		2
Dytiscidae							
Eretes australis						at Hg light	4
Necterosoma sp						at Hg light	2
Hydrophilidae							
Limoxenus mastersi						at Hg light	3
							1
Scarabaeidae							
Cryptodus sp						at Hg light	1
Colpochila sp						at Hg light	4
C. laminatus						at Hg light	2
Melolonthinae sp1						at Hg light	1
Melolonthinae sp2						at Hg light	1
Semanopterus tricostatus						at Hg light	1
Geotrupidae sp						at Hg light	1
Buprestidae							
Temognatha flavocincta						Mallee flowers Eucalyptus	1
Castiarina carminea						Mallee flowers E. ebbanoenis	1
C. parallela						Leptospermum flowers	1
C. rufa						Leptospermum flowers	3
Elateridae							
Agrypnus sp						at Hg light	1
Conoderus sp						at Hg light	3
Cleridae							
Eleale sp1						Mallee flowers	1

Eleale sp2					Mallee flowers	1
Phlogistus sp					Mallee flowers	2
Natalis sp					at Hg light	1
Mordellidae						
sp1					Melaleuca flowers	2
sp2					hakea flowrers	3
Tenebrionidae						
Chalcopterus sp					Mulga bark	1
Meloidae						
Zonitus sp Yellow					Mallee flowers	5
Zonitus sp Yellow					Hg	2
Zonitus sp Purple					Leptospermum flowers	14
Anthicidae						
Anthicus sp					in litter	1
Chrysomelidae						
Ditropidus sp					Eucalyptus leaves	1
Paropsis sp1					Eucalyptus leaves	2
Paropsis sp2					Mulga leaves	3
Curculionidae						
Cubicorrhynchus sp				5		1
Leptopius sp			3			1
Polyphrades sp			3	4	and in Mallee flowers (13)	15
Oxyops sp1					Mallee flowers	3
Oxyops sp2					Mallee flowers	1
Haplonyx sp						
Curculionidae sp1		2				
Curculionidae sp2				5		
Curculionidae indet					Mallee flowers	1
HYMENOPTERA						
Wasps						
Mutillidae						
sp1	1					1
sp2		2				2
sp3		2				1
sp4			3			1
sp5			3			1
sp6			3			1
sp7			3			1
Ichneumonidae						
Ophion sp						1
Ichneumonidae					at Hg light	
sp1					at Hg light	1
sp2					at Hg light	2
sp3					at Hg light	2
sp4					at Hg light	2
sp5					at Hg light	1
sp6					at Hg light	1
Evanidae sp1					at Hg light	2

Tiphiidae						
Hemithynnus sp					Mallee flowers	4
APOIDEA						
Colletidae						
Leioproctus sp					on Leptospermum sp.	2
Hylaeus elegans					Mallee flowers	4
					Leptospermum	4
Stenotritidae						
Stenotritis sp					At rest on Allocasuarina	1
Halictidae						
Homalictus sp					Eremophila	2
Nomia sp					Eremophila	4
Nomia sp					Mallee fls	2
Megachilidae						
Megachilidae sp1					Mallee fls	1
Chalicoderma sp					Melaleuca	2
Anthophoridae						
Amegilla sp					Ptilotus	1
?Parasphecodes sp					Eremophila	1
Exoneura sp					From burrow in Sandalwood	5
Apidae						
Apis mellifera					common througout study area	
Apoidea not determined						
sp1					Eremophila	2
sp2					Eremophila	2
sp3					Mallee	1
sp4					Eremophila	2
sp5			3			1
sp6					Mallee	2
sp7					Mallee	1
sp8					Eremophila	2
Formicidae 1						
Myrmecinae						
Myrmecia infima					Cassia	1
Myrmecia fucosa					Swamp area from Eremophila	3
Ponerinae						
Rhytidoponera metallica			3	4 5		4
R. violacea		2	3		& general	5
Rhytidoponera sp1			3			1
sp2		2	3			3
sp3			3			1
sp4			3			1
sp5					general large +11mm	1
Odontomachus sp	1					3
Cerapachys sp		2				3
Ponerinae indet	1					2
Ponerinae indet					Specimen a winged male	1

Pseudomyrmecinae						
Tetraponera sp	1				and general on Cassia	4
Myrmicinae						
Aphaenogaster barbigula					from colony at lower camp These ants have large nest holes very common in the general area	6
Crematogaster sp1 & sp3					From Mallee flowers	3
sp2					From Quandong fruit	2
sp4					From quandong fruit	4
Podomyrma sp1					From Mallee flowers	4
Podomyrma adelaidae					From trunk of Eucalyptus sp.	3
P. adelaidae					From trunk of E. capillosa, workers & winged female	4
Formicidae 2						
Dolichoderinae						
Iridomyrmex purpureus					This ant common in all areas	25
Iridomyrmex sp1	1		3			
Iridomyrmex sp2		2		4	5	6
Iridomyrmex sp3	1	2		4	5	12
Formicinae						
Polyrachis sp1		2			and from Mallee flowers	1
Polyrachis sp2					vagrant in area of hill above the lower camp	1
Calomyrmex sp1		2				2
Calomyrmex sp2					vagrant in Neurachne sp. in area lower camp	4
Melophorus sp1	1				and from Olearia sp in area lower camp	4
sp2	1					1
sp3			3			1
sp4			3			3
sp5			3		5	4
sp6	1		3			3
sp7					Swept from Acacia sp phyllodes	1
sp8					Swept form Cassia sp	1
sp9					Swept from Cassia sp, female	1
sp10		2				2
Camponotus sp1	1					1
sp2					Swept from Acacia acuminata	2
sp3	1		3			4
Camponotus sp4			3			2
sp5					on Eremophila in swamp area	2

APPENDIX 8.

Helena & Aurora Range Invertebrates collected during February 1996.

	QUADRAT							NO. COLL'S
	1	2	3	4	5	6	7	
CHILOPODA								
Scolpendridae								
Scolpendra laeata					1			1
S. morsitans			1		1		1	3
Ethmostigma curtipes				1				1
Cormocephalus turneri			1			1		2
Scuterigeridae								
Allotheura sp.					2			2
								9
SCORPIONIDA								
Buthidae								
Lychas alexandrinus	1				1		1	3
Isometroides vescus			1					1
Scorpionidae								
Urodachus novaehollandiae		2						2
								6
ARANAEAE								
Araneomorphae								
Lamponidae								
Lamponina sp male	1							1
Lycosidae								
Lycosa sp1 male			1					1
" sp2 female				1				1
" sp3 male				1				1
" sp4 males		1		3				4
" sp5 males				1			1	2
Lycosa forresti males			1	1	1			3
								13
Corinnidae								
Supunna albopunctatum sp group						1m	1fm	2
Gnaphosidae								
Genus ? male							1	1
Aristerus sp		1						1
Encoptarthria sp			1					1
Ctenidae								
sp juv			1					1
Miturgidae								
sp female				1				1
Salticidae								
Sandalodes sp female							1 lower camp	1
Deinopidae								
Deinopis sp males		1	1					2
Hersiliidae								
Tampopsis sp juv		1						1
Theriidae								
Lactrodectus hasselti juvs				1			1f	2

Araneidae									
Eriophora sp male							1		1
Zodariidae									
Genus 1	1m	1j	1f			1m			4
Genus 2			1m	2j					3
Genus 3				1f			2f		3
	1m								1
Zoridiae									
Mygalomorphae									
Nemesiidae									
Aname sp		2m	2m	1m					5
Tetragnathidae									
Nephila edulis								1f 1m lower camp	2
									45
									15
									60
INSECTS									
BLATTODEA									
Polyzostera mitchelli			1		1				2
Platyzostera coolgardiensis		1							1
Zonioploca sp			1						1
									4
MANTODEA									
Orthodera sp	3		1						4
Paraxypillus sp	1						2		3
									7
ORTHOPTERA									
Tettigonidae									
Species 1								1 at light	1
" 2								1 at light	1
" 3					1				1
Acridiidae									
Species 1								1 vagrant	1
Goniaea sp			1						1
									2
HEMIPTERA									
Cydnidae									
Adrissa sp							2		2
Pentatomidae									
Poecilometis apicalis								5 Salmon gums	5
Poecilometis sp		1	3						4
Elvisurinae									
Coleotichus costatus			1					On Eremophila	1
Reduviidae									
Ectomocoris sp	2								2
									14

COLEOPTERA									
Carabidae									
Species 1							1		1
Gigadema bostocki		2	1						3
Parroa apicalis						1			1
Carenum sp							1		1
									6
Tenebrionidae									
Helea sp							2		2
Homotrystis (carbonaria)				1					1
									3
Chrysomelidae									
Paropsis sp rugose black				1					1
									1
Elateridae									
Pseudotetralobus sp								3 at light	3
									3
Curculionidae									
Adelognatha									
Polyphrades uniformis								5 on acacia leaves	5
Polyphrades sp			7						7
									12
HYMENOPTERA									
Vespidae									
Abiopa sp								2 vagrant at camp	2
Tenthredinidae									
Saw-fly larvae								2 from Eucalyptsp	2
Mutillidae									
Ephutomorpha rugicollis								1 vagrant at camp	1
Ephutomorpha sp 2							2		2
" " 3	1								1
Apoidea									
Anthrophora sp								1 in Eremophila	1
Formicidae									
Ponerinae									
Rhytidoponera metallica	1								1
Rhytidoponera sp							1		1
Dolichoderinae									
Iridomyrmex purpureus								This species noted in all areas	
Iridomyrmex sp 1							6		6
Technomyrmex sp			1						1
Formicinae									
Polyrachis sp	1			4					5
Melophorus sp	1								1
Camponotus gasseri				1					1
									25