CHAPTER 7

OTHER SITES

1.0 Introduction

1.1 Background

To be able to address the overall habitat requirements and potential threats to mulgaras (and ampurtas) it was desirable to assess as many locations as possible across their geographical range. Sites were also targeted outside the Northern Territory where possible, to balance the effort focussed on Uluru National Park and Sangster's Bore.

It was not possible to investigate these sites to the same degree of intensity as those at investigated at Uluru National Park or Sangster's Bore, and most sites were visited for less than one week. Most of the locations visited had previous records of mulgara and many were accessed through travelling with other researchers to their sites or combining with other biological or regional surveys. While this approach assisted in accessing these areas it added a constraint of working within other people's time frames and research requirements.

The aims of this study were to:

- Locate other mulgara populations;
- Determine if there were boundaries to these populations;
- Identify their preferred habitats;
- Assess the potential threats to mulgaras in these areas;
- Assess, where possible, whether populations were persistent or ephemeral.

1.2 The Study Areas

Seven areas were selected (Fig. 10, Chapter 4) including Kintore, Andado Station and Central Mt Wedge in the Northern Territory; Marymia and the surrounding Gascoyne region, Wanjarri Nature Reserve, Gibson Desert Nature Reserve and Queen Victoria Springs Nature Reserve in Western Australia; and Witjira National Park and the Anangu Pitjantjatjara Lands in South Australia.

2.0 Kintore

2.1 Introduction

Kintore is an Aboriginal community situated in the Northern Territory approximately 500 km west of Alice Springs near the border with Western Australia. The existence of mulgaras at Kintore came to my attention in 1992 when a mulgara which had been captured within the Community living area was reported to the Conservation

Commission of the N.T. (Schwarz per. comm.). Further discussions revealed that A̲nangu from Kintore were very familiar with mulgaras and that there was a persistent population existing close to the community.

I conducted a one-week field trip in October 1992 to survey the area and to talk to A̲nangu. The aim of this survey was to determine the distribution of the Kintore population, identify the preferred habitat, assess potential threats and to confirm the persistence of the population in the area.

2.1.1 Topography, vegetation and regional hydrogeology

Kintore lies at the base of the Kintore Range which is an isolated range surrounded by a broad spinifex sandplain. The spinifex sandplain is dissected by drainage lines from the range and receives runon from sheetflow. The sandplain in turn is surrounded by parallel dune systems with saltlake and drainage systems to the north and south west. The broad soil landscape is based on red earthy sands of the desert sandplains. These sands tend to be firm and non-mobile with the sand grains covered by kaolin clays and sesquioxides that bind them and produce a compactness in the soil not found in dune systems (Northcote and Wright, 1982).

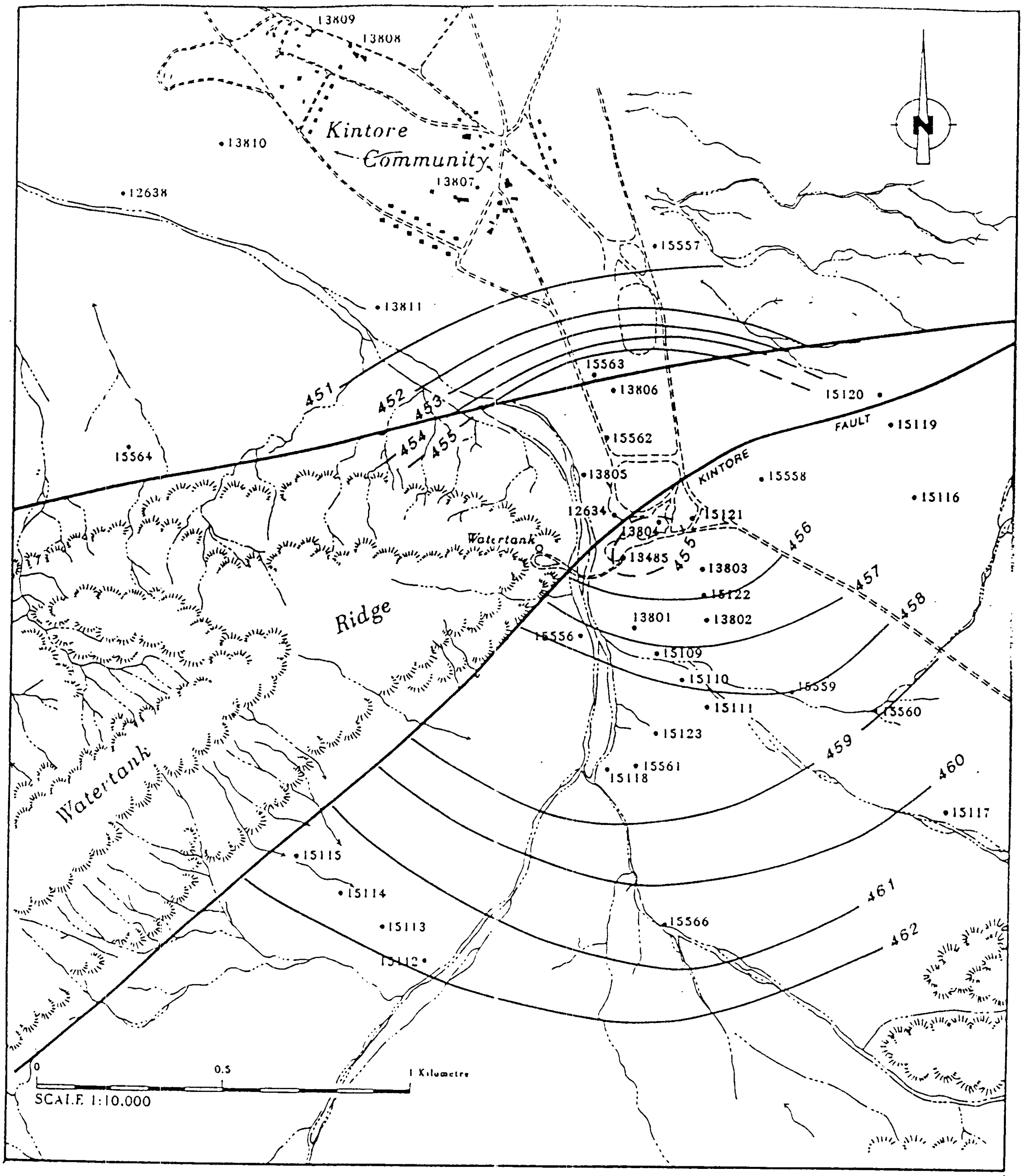
A substantial aquifer is located at the base of the Range adjacent to the community (NT Power and Water Authority) (Figure 33). The standing water in this aquifer is very close to the surface, ranging from 4.7 to 11.9 m below the ground surface even after five years of low rainfall (NTPAW bore data). Local residents stated that Kintore had been experiencing extremely dry conditions since 1988 and that much of the vegetation was dying (Schwarz pers. comm.).

2.2 Methods

Only three days of field work were conducted because of a death in the community. To commence the work, I was taken by A̲nangu to Desert Bore, approximately 12 km north east of Kintore. Further sites were then selected along roads and tracks at 2 km or 5 km intervals as detailed in Chapter 4. The roads and tracks surveyed were determined by A̲nangu and some areas were not accessible due to ceremonial restrictions in place at the time. The area surveyed is presented in Figure 34. A total of 16 sites was searched in the Kintore area.

Signs of mulgaras, introduced predators and herbivores were recorded. Two Elliott trap transects were set in identified mulgara habitat for a total of 150 trap nights. Habitat attributes were recorded as detailed in Chapter 4, but no wheelpoint data were collected.

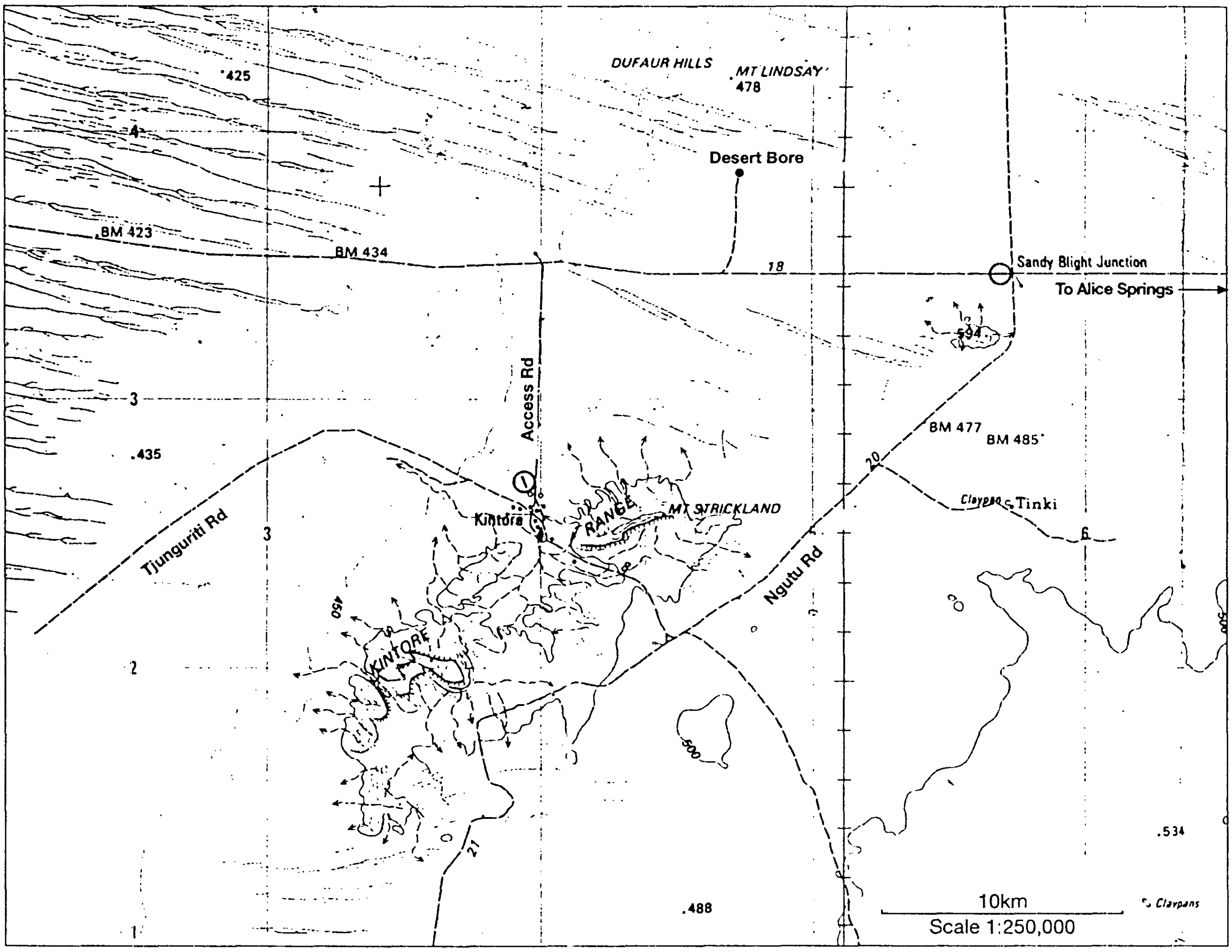
Figure 33: Location of Kintore aquifer and potentiometric contours (from Domahidy, 1990)



LEGEND

======	*Track*
—— · · · —►	*Watercourse*
• 15109	*Bore and registered number*
————	*Fault*
———— 464	*Potentiometric contours in metres AHD*
— — — —	*Inferred potentiometric contours*

Figure 34: Kintore study area



2.3 Results

2.3.1 Distribution

No mulgaras or other species were captured in the 150 trap nights. Mulgara sign was recorded on 50% of the sites surveyed and the total sign recorded per site is presented in Figure 35. There was a high proportion of fresh sign, including fresh burrowing activity as indicated in Figure 36. Thirty-eight percent of the mulgara sign were tracks, with 41% burrows and 12% scats. This current activity was confirmed by the capture of an adult female with young by Anangu at Site 9. This degree of breeding activity was surprising given the prevailing extremely dry conditions.

Figure 35: Total mulgara sign detected on sites surveyed along roads around Kintore community

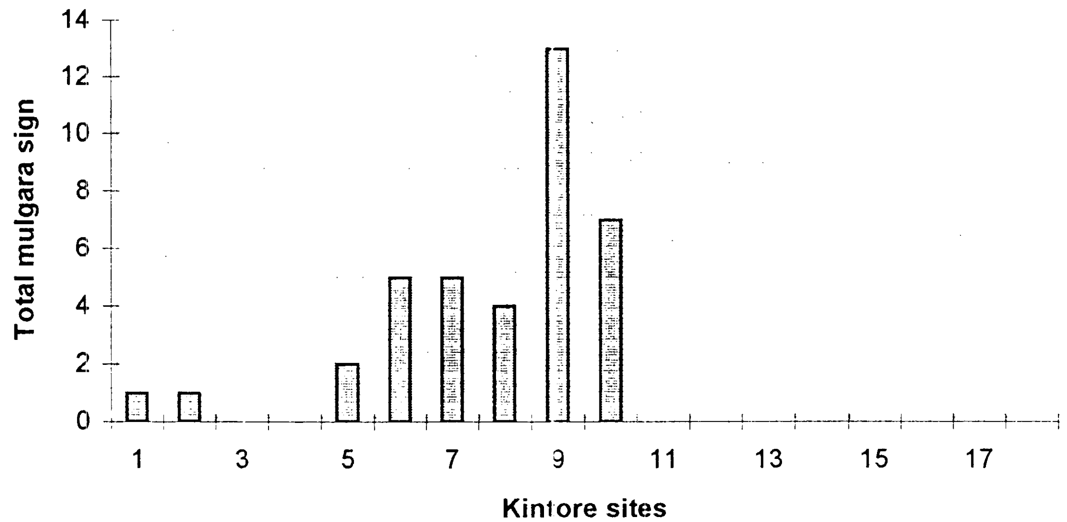
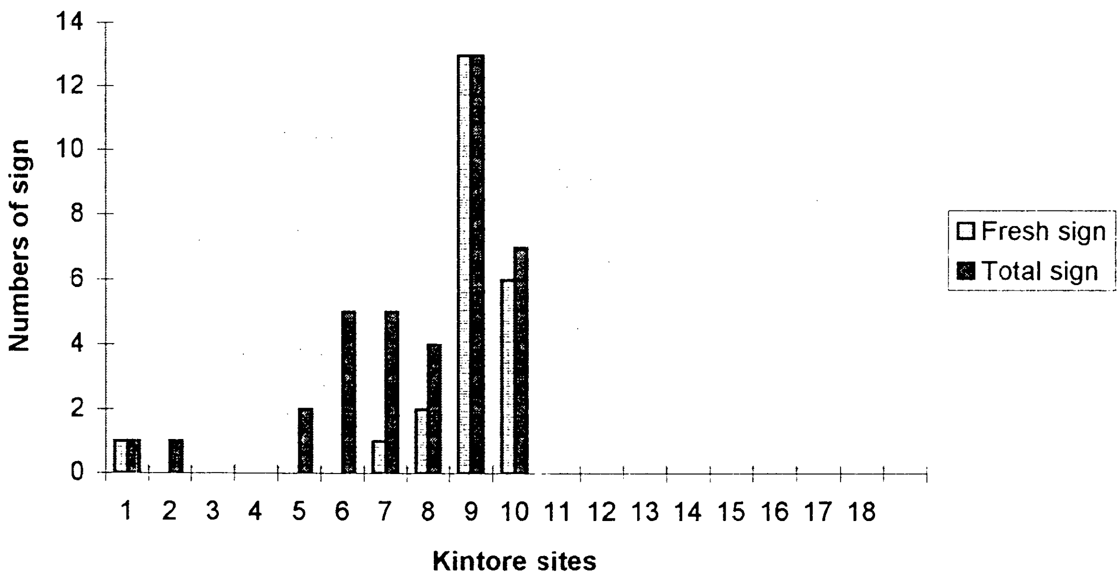


Figure 36: Frequencies of fresh and total mulgara sign per site at Kintore



[Site locations are presented in Appendix 2]

Mulgara sign appeared to be confined principally to an area around Kintore and Desert Bore with no sign being recorded east or west of the Community. Levels of sign were fairly consistent, particularly on the access road to Kintore, with the highest numbers being recorded around Desert Bore.

2.3.2 Introduced predators and herbivores

Low numbers of predators were recorded on the sites, with no stock or camel sign being recorded. A total of seven cat sign was recorded, but only at low numbers with only 1 sign being recorded per site. Only 1 fox track was recorded in the entire survey and 3 dingo tracks. Rabbit sign was located on only one site where 6 sign were recorded. Despite the low numbers of predator sign recorded during the survey, there did appear to be a relationship between sites supporting mulgaras and sites supporting predators. Regression analyses indicated a postive relationship between dingoes and mulgara presence and a negative association between mulgaras and cats.

The Poisson regression was:

Total mulgara sign= 0.597 + 1.954 dingo - 1.602 cat

with the deviance of 46.66, $p<0.001$ and 15 degrees of freedom. The Wilk-Shapiro index was 0.89.

Both cat and dingo contributed significantly to the equation ($p<0.001$). Subset regressions indicated that the presence of dingo and cat explained 17% of the variance in total mulgara sign.

2.3.3 Habitat analysis

A positive correlation was found between the number of total mulgara sign and the presence of sandy loam soil ($p<0.05$). No other correlations were detected. A series of regressions was tested to further examine possible relationships between habitat attributes and the abundance of mulgara sign. These analyses confirmed the association between numbers of mulgara sign and sandy loam soil but also recognised relationships between mulgara numbers and clayey sand soil, senescent spinifex and the presence of a tree stratum.

The best-fit Poisson regression was:

Total mulgara sign = -1.637 + 4.377 sandyloam + 2.144 clayeysand- 2.052 old rings + 0.006 tree stratum

Deviance is 39.72, $p< 0.001$ with 13 degrees of freedom.

All variables contributed significantly to the equation with sandy loam and old rings ($p<0.001$), and clayey sand and tree stratum ($p<0.05$). The Wilk-Shapiro index was 0.89. Sandy loam soil accounted for the largest reduction in the deviance.

The best stepwise regression identified sandy loam soil as explaining 18% of the variance in the number of total mulgara sign.

2.4 Discussion

A<u>n</u>angu information (Chapter 2) and the data collected during this field trip indicate that a persistent population of mulgaras resides in the vicinity of the Kintore Community. This mulgara population was breeding in the area, despite there having been five extremely dry years (Schwarz pers comm). On the basis of this admittedly limited information, the population appears to be restricted during drought periods to an area influenced by runon and drainage effects from the nearby Kintore Range and associated subsurface aquifers.

The sites which had clayey sand and sandy loam soils supported *Triodia basedowii*, while the sandier soils supported a mixture of *Triodia pungens* and *Plectrachne schinzii*. Sites further to the east were identifiable by a species shift to soft spinifex, particularly *P. schinzii*. This area was reminiscent of the *P. schinzii* sandplains in the Tanami Desert to the north.

The mulgaras at Kintore appear to have a preferred habitat within an area of lower elevation (~478 m) than the surrounding areas (~512 m), which contains clayey sand and sandy loam soils, *Triodia basedowii* and a mallee open woodland. The majority of these sites were on the access road into Kintore, which appeared to be influenced from runon and drainage lines from the Range. The heavier soils, and taller and more substantive woodland strata, suggest a higher moisture regime. The other positive sites were closely associated with the aquifer supplying the Desert Bore.

The negative association with senescent spinifex indicates the influence of fire regimes, and suggests a preference for younger more actively growing spinifex. Much of the spinifex in the study area appeared to be dead and substantial areas have not been burnt for many years. In these areas the spinifex has become senescent and the ring structure is breaking down.

Kintore had experienced extremely dry conditions from 1988 to 1992, which implies that the surveyed mulgara distribution delineated the core population, and that the habitat model represents refuge habitat. The topographical influence of the Range appears to be very important, as do the heavier soils and presumably higher moisture regimes indicated by the tree stata and changes in spinifex species.

There were few predators recorded during the study which may be a reflection of the dry conditions. Cats are a preferred food source for A<u>n</u>angu at Kintore and are frequently and actively hunted. The analysis of the influence of the presence of predators on the distribution of mulgara activity suggests the presence of dingoes as a positive factor while cats had a negative influence. This may be due to there being higher numbers of cats than dingoes in the area; potentially cats are eating and competing more with the mulgaras. Any dingoes present are likely to be hunting cats as well as mulgaras and may be assisting the mulgaras by preying upon cats.

3.0 Simpson Desert (Andado Station and Purnie Bore in Witjira National Park)

3.1 Introduction

The Simpson Desert covers an area of approximately 200 000 km^2 and incorporates parts of the Northern Territory, Queensland and South Australia. The region lies between the latitudes of 23° and 27° south and longitudes 135° and 139° east (Gibson and Cole, 1988). A biological survey was conducted on the Northern Territory portion by the Conservation Commission of the N.T. during 1985. Fifteen records of mulgara, now thought to be *D. hillieri* (ampurta), were recorded during the survey (Appendix 1). Four animals were trapped in Elliott traps, one animal was seen and the remaining records were from tracks and scats. The primary landzones occupied by ampurta in the northern Simpson Desert were the fringing dunefields (Gibson and Cole, 1988). These fringing dunefields are dominated by cane grass *Zygochloa paradoxa* with variable *Acacia* patches on the dune crests and *Triodia basedowii* on the lower slopes. The dunes are often adjacent to dry watercourses, stony ridges or salt lakes. The swales and plains in these areas are generally covered with ephemeral grasses or open space but in some areas support *Triodia basedowii* (Gibson and Cole, 1988).

An ANZSES expedition surveyed areas in the western portion of the Simpson Desert in South Australia in 1990 and 1991. Based around Witjira National Park, the 1990 survey had two main sites: Site 1 on the Finke floodout track and Site 2 around Purnie Bore. There were 6 subsites at Site 1 which were trapped using Elliott box traps. Four ampurta were captured in 80 trapnights at Site 1/6 and no ampurtas were captured at any of the other subsites. Site 2 was established with 7 subsites and two animals were captured, one at each of two sub-sites which were sampled for 60 trapnights. Site 2 was resampled in 1991 by ANZSES teams but no ampurtas were recorded on the site, or elsewhere during the survey. A single track was recorded in a drainage valley north of Lake Griselda (Head pers. comm., DENR database).

The CCNT biological survey records and ANZSES records are the only contemporary records for ampurtas in the N.T. and S.A., despite numerous other surveys conducted in potentially suitable areas of South Australia (Copley pers. comm.). The primary aim of my field work was to assess the habitat in which ampurtas had been recently recorded and to ascertain whether animals were still in these areas. The work was conducted over one week in September 1992 with Pip Masters assisting, and we were later joined by Toby Ginger, his wife and his sister from Finke.

3.1.1 Climate

The Simpson Desert is primarily within the 200 mm isohyet but aridity increases to the south-east where the central Simpson lies within the 74 mm isohyet (Slatyer, 1962). Rain falls predominantly in the summer but is unreliable and patchily distributed. The mean annual rainfall for Charlotte Waters is 130 mm, Finke is 195 mm and Jervois is

338 mm. Mean maximum and minimum temperatures fluctuate substantially between summer and winter, ranging from 38° C to 5 ° C (Gibson and Cole, 1988).

3.1.2 Topography and vegetation

The Simpson Desert is characterised by longitudinal sanddune formations, which for the most part run straight and parallel for hundreds of kilometres. Between the dunes the swales often include claypans and saltpans. The dunes trend in a north-westerly / south-easterly direction and run parallel to the prevailing winds (Madigan, 1936). The area of sanddunes begins in the west at the Finke and Macumba Rivers, and extends south to Lake Eyre. The Mulligan River, Eyre Creek and Warburton River define the desert margin in the east and south-east. The Adams Ranges, Marshall River and MacDonnell Ranges form the northern boundary of the desert, but the sandridges fade out into flat sandplains for several hundred kilometres at the northern end. There is a southeasterly decline in elevation to sealevel at Lake Eyre and the major drainage systems reflect this decline (Wiedemann, 1971).

Purdie (1984) described 32 landsystems in the Simpson Desert which were grouped into six major landzones: sandplains, dunefields, fringing dunefields, dissected residuals, floodplains and gibber plains. Sixty four percent of the desert is covered by dunefields with a further 9.2% being made up of fringing dunefields, which lie adjacent to the dunefields or bordering water course, floodplains and lake systems.

The soils in the Simpson Desert are characterised by red siliceous sands on the dunes with clayey sands, ironstone gravel or siliceous sands overlying laterite in the swales. The sands may be up to two metres over the top of clay or earth pan (Gibson and Cole, 1988).

The vegetation of the Simpson Desert is divided into three major complexes: the sanddune system which supports a *Triodia basedowii -Zygochloa paradoxa* complex; the *Astrebla -Atriplex vesicarium-Bassia* spp. complex on the brown soils associated with the gibber plains and outcrops; and the *Eucalyptus* sp. - *Atriplex* sp. complex on the river floodplains (Crocker, 1946; Wiedemann, 1971).

The sanddune systems in the Andado area are typified by fine quartz sand on the dune crests and clayey sands on the lower slopes and swales. Nutrient status of these sands is very poor (Wiedemann,1971). Cane grass, *Zygochloa paradoxa,* typically occupies the upper slopes and crests of the dunes, whereas *Triodia basedowii* occupies the mid-lower slopes and swales. Some swales are covered in gibber and claypans and do not support spinifex. Cane grass tolerates the mobility of the sand on the dunes, while spinifex is restricted to the more stable compacted clayey sands.The cane grass grows up to 3m in diameter and height. Wiedemann (1971) found most of the spinifex to be very old with broken ringed hummocks.

Wiedemann (1971) identified seven zones within the dune system: swale hard clayey sand, lower slope clayey sand, mid-slope clayey sand, mid slope spinifex mound, upper slope loose sand, steep slope loose sand, and crest mobile sand.

3.1.3 Regional hydrology

The Simpson Desert lies over the junction of several intracratonic Paleozoic basins emerging from the West Australian Pre-Cambrian shield (Sprigg, 1963). Five major watercourses run into the area including the Todd, Hale, Plenty, Hay Rivers and Illogwa Creek. They are for the most part dry rivers but, after exceptional rains flood out into the desert. There are also many small areas of local drainage and several major saltlake systems including the Plenty River Saltlakes and the Lake Eyre Basin further to the south (Gibson and Cole, 1988).

Much of the artesian water in the area is saline, though some good quality water is available in paleodrainage channels (Shaw and Milligan, 1969). Some of the artesian waters come to the surface as hot springs in areas such as Dalhousie Springs and Purnie Bore. Historically a number of bores were allowed to run permanently and one of these led to the establishment of a wetland system at Purnie Bore. Most of these bores have now been closed off, but the Purnie Bore has been allowed to remain flowing so as to maintain the wetland system.

The old Andado Road from the station north to Allambie Station follows an extensive area of sand dunes overlying Quaternary alluvium which expresses itself in numerous small claypans and depressions (Stewart, 1968). Ground water resources are held in a subsurface sandstone layer and every bore in the area has produced water. The standing water level in the area, especially those in the Quaternary alluvium, is shallow (around 20-30 m) and of good quality (Stewart, 1968).

3.1.5 European land use

There has been a history of pastoralism on the fringes of the Desert and mining exploration leases extend over vast areas. Oil drilling appears to be the only major industry to date, with tourism now a major factor.

3.2 Methods

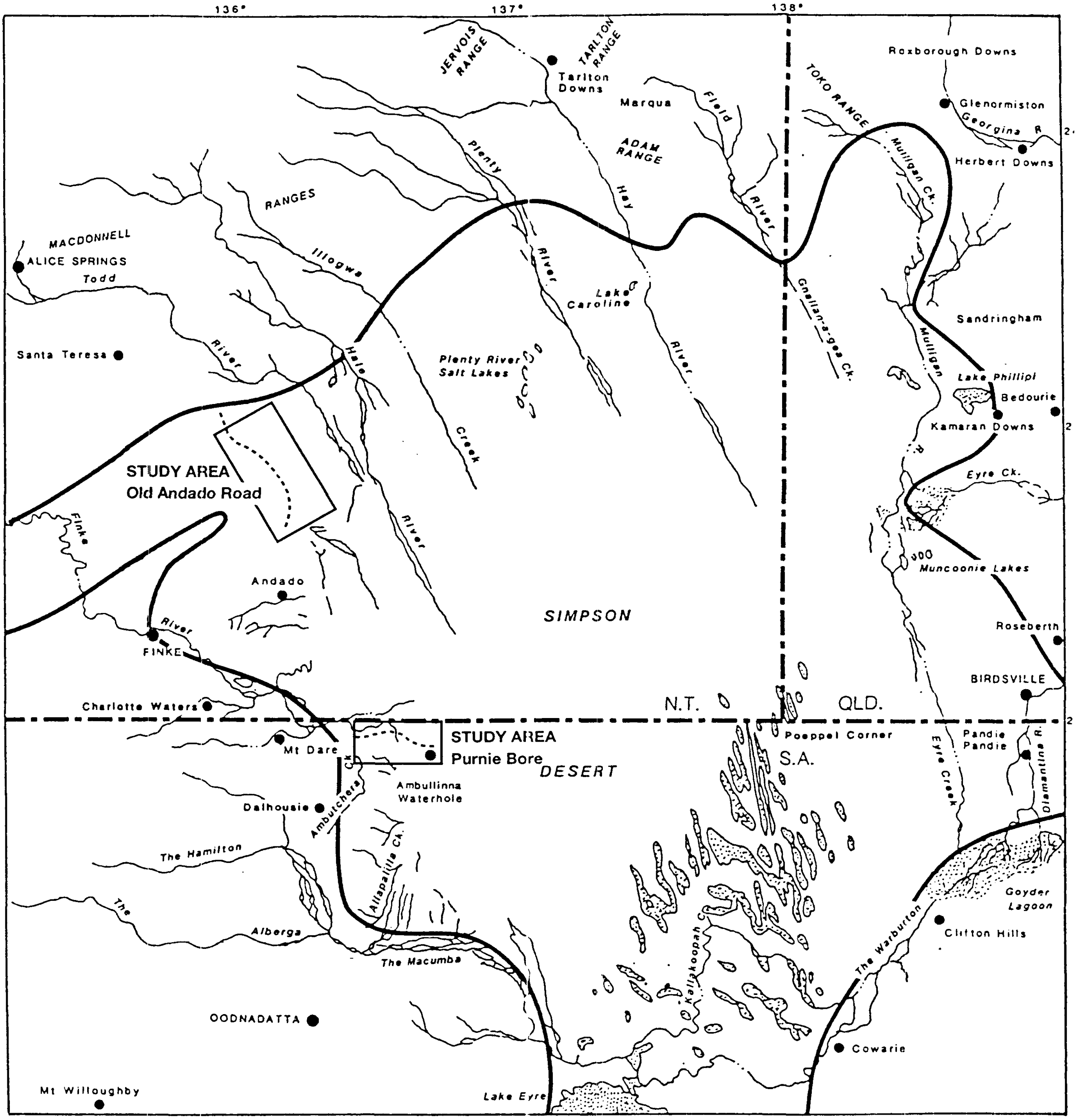
Two areas were selected for the study based on the CCNT and ANZSES surveys (Fig. 37). The first area was situated on the old Andado Road (24° 35 E , 135° 16 N) in the Northern Territory, based on a locality recorded during the CCNT biological survey (Gibson and Cole, 1988). Twenty sites were searched for ampurta sign in this area. The second location was within the 1990 ANZSES survey area which included the Finke floodout road and Purnie Bore. Nine sites were searched within this area.

3.2.1 Area 1: Old Andado Road

Ten sites were searched along an east-west transect from site 1 that intersected 10 parallel dunes. Further site searches were conducted southward down the old Andado Road at approximately 10 km intervals, with some additional sites where the habitat appeared promising. Two parallel dunes and intervening swale (incorporating the road) were surveyed at each of these sites. At the southern end of the road, the landform changed to open gibber plain and after two sites no further searches were conducted until another dune system was reached. A total of 20 sites was searched along the Andado roads.

Opportunistic searches were conducted at Charlotte Waters, in transit from Andado to Witjira National Park.

Figure 37: Simpson Desert study area



The extent of the sand dune system

N

0 50 100
kilometres

Site locations approximate and not to scale

3.2.2 Area 2: Witjira National Park

At Witjira National Park, nine sites were surveyed, four along the Finke floodout track near ANZSES Site 1 and five sites in the vicinity of ANZSES Site 2 at Purnie Bore. Opportunistic searches were conducted along the old Finke Road on the return journey to Finke.

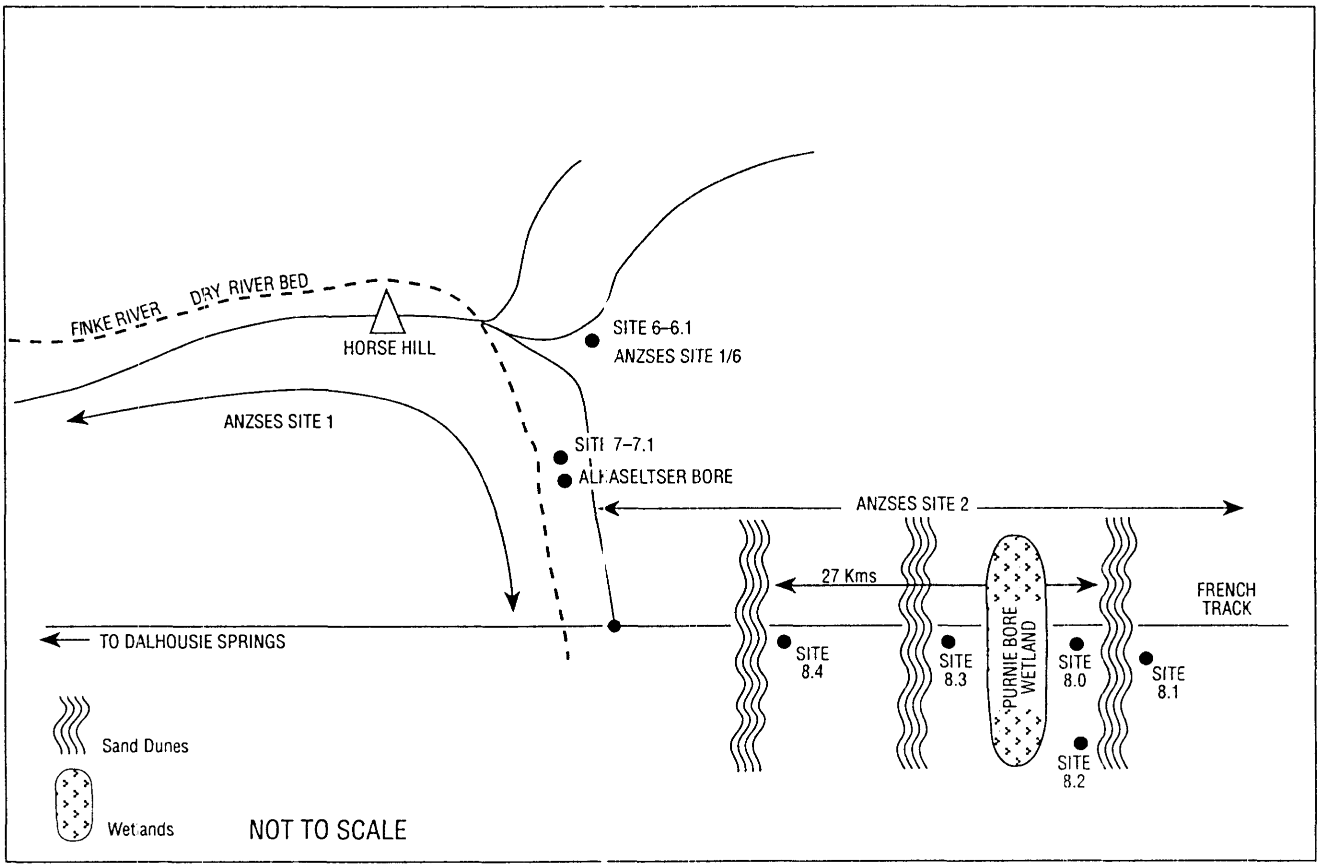


Figure 38: Witjira National Park sites

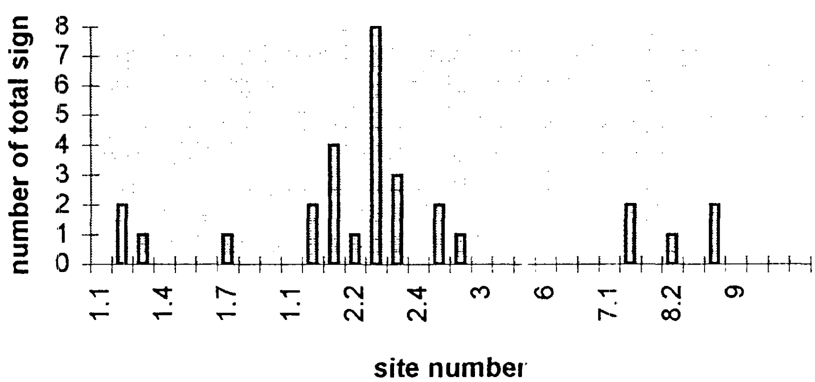
Each site was searched randomly for 20 minutes for sign of ampurtas, predators and introduced herbivores. Broad landform, soil and vegetation classification were assessed for each site as detailed in Chapter 4. No wheelpoint assessments for percentage vegetation cover were conducted.

3.3 *Results*

3.3.1 Distribution

A total of 33 sites was sampled for sign of ampurta, predator and introduced herbivores. The total ampurta signs recorded per site are presented in Figure 39. Sites 1 to 2 were located on the old Andado road, with sites 3 and 4 also on Andado Station. Site 5 was Charlotte Waters, and Sites 6 to 8 were within Witjira National Park (Purnie Bore). Sites 9 to 11 were along the old Finke Road. Thirty-nine percent of sites surveyed had ampurta sign, with 50% of the Andado road sites being positive and 33% of the Purnie Bore sites. Sign frequency on sites was low with only one site on the Andado road recording more than 5 sign, and most positive sites recording only 1 or 2 sign.

Figure 39: Total ampurta sign detected on sites at the old Andado road and Purnie Bore study areas



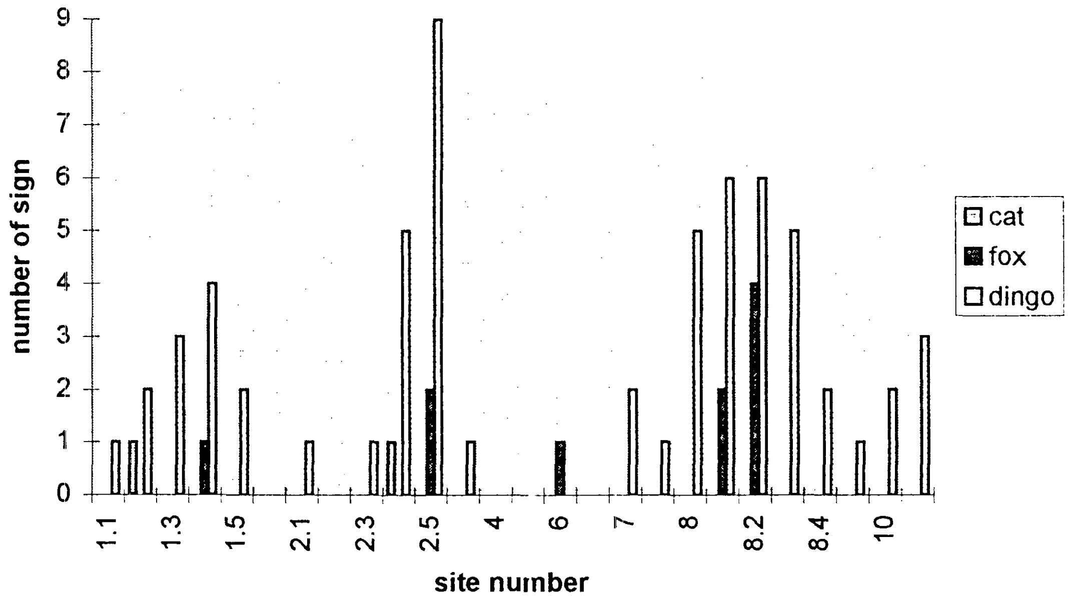
[Site locations presented in Appendix 2]

The majority of sign was recorded over 31 kilometres of the Andado track, i.e. sites 2 to 2.5. It is possible that further sign could have been located to the north of Site 1 but no sign was located further to the south, most likely because of the change in landform. While no sign was recorded on the Finke floodout road (in contrast to the 1990 ANZSES survey), ampurta sign was scattered across sites around Purnie Bore. The brief study identified that ampurtas were still resident in the areas previously surveyed, but was too limited to be able to identify the colony boundaries or population size.

3.3.2 Introduced predators and herbivores

Figure 40 presents the dingo, fox and cat sign recorded on the sites. Dingo sign was generally common and widespread across the study sites, with the highest level of 9 sign being recorded on an Andado site. Fox sign was recorded on 5 sites with the highest level of sign (4 sign) being recorded on a site at Purnie Bore. Low levels of cat sign were recorded on two of the Andado sites.

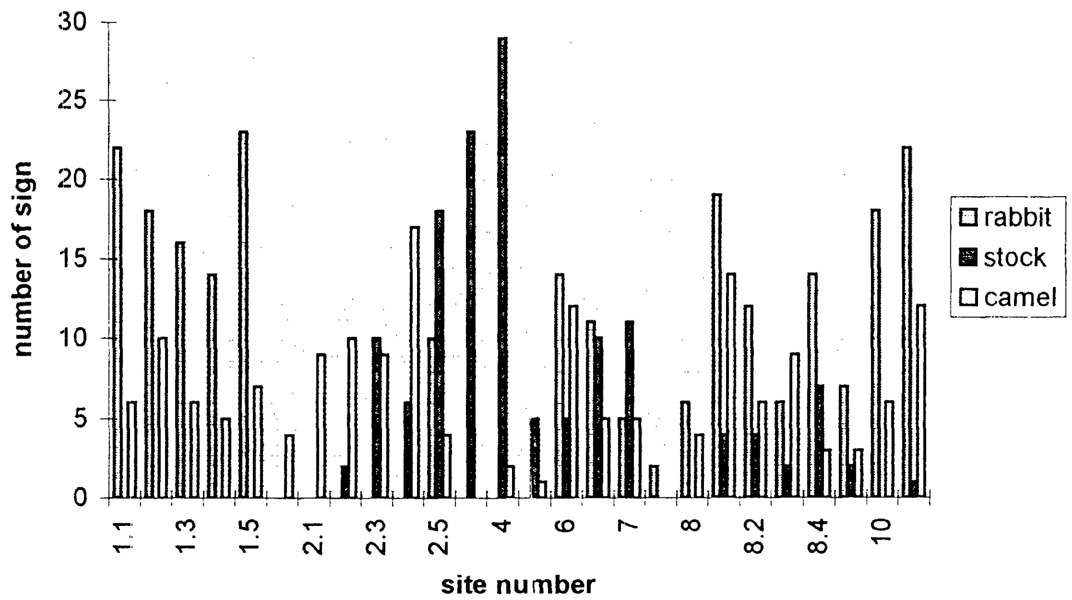
Figure 40: Introduced predator sign detected on sites at the old Andado road and Purnie Bore study areas



[Site locations presented in Appendix 2]

Figure 41 presents the rabbits, cattle and camel sign also recorded on each site. Sign of all three introduced species was found at most sites and at high levels. With regard to cattle this is not surprising as the Andado road leads to and runs through pastoral properties. Witjira National Park was also until recently a pastoral property and there are obviously still numbers of cattle in the Park. Rabbit and camel numbers were generally high. Generally rabbits and camel sign were located within the dunefields and at some locations cattle were also utilising the dunes. Ampurta sign was recorded in the presence of all three introduced species.

Figure 41: Introduced herbivore sign detected on sites at the old Andado road and Purnie Bore study areas



Spearman Rank correlations were used to investigate potential relationships between the number of ampurta sign recorded on sites and the number of predator or introduced herbivore sign. No significant correlations were found between ampurtas and predators or herbivores. There was, however, a significant positive correlation between dingoes and rabbits and between dingoes and foxes ($p<0.05$).

Poisson regressions and stepwise regressions were examined but no regression models were found to be significant. Site 2.5 where 1 ampurta sign was recorded at Andado was a very degraded dune with high levels of rabbit (10) and cattle (18) activity. Similarly the ANZSES site 6/1 on which 4 ampurtas had been captured in 1990 was heavily stocked with rabbits (11) and cattle (10), no ampurta sign was recorded on my study visit.

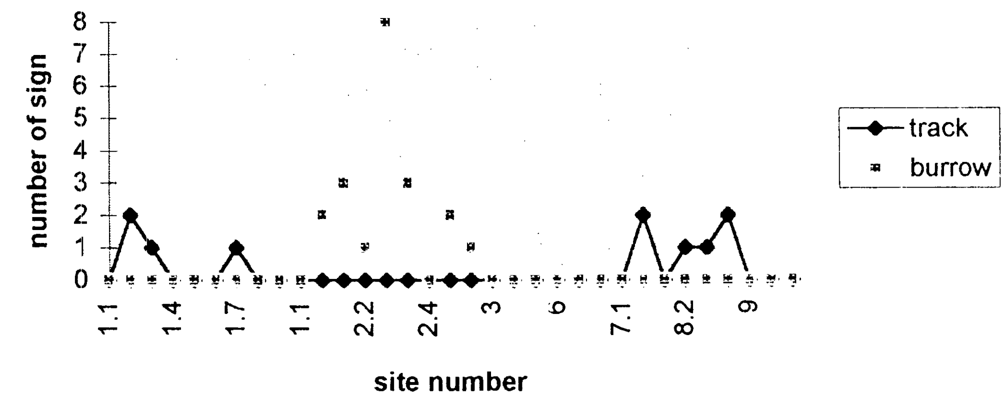
Ampurta sign was low across all sites relative to Uluru National Park and Sangster's Bore sites. This could have been a reflection of the habitat degradation by rabbits, cattle and camels, or it could be that ampurtas are typically found in low numbers in these areas and that they are unaffected by the grazing impact. Further longer-term studies would be required to clarify this situation. This finding is of particular interest, however, as these sites were the only ones within my whole study that had substantial grazing impact.

3.3.3 Habitat use

Figure 42 presents the types of ampurta sign recorded at each of the site. Sites on which ampurta track sign was recorded did not have ampurta burrows and vice versa.

Further examination of the data reveals that the type of sign recorded at each site was dependant on its position on the dune or swale.

Figure 42: Comparision of the number of ampurta tracks and burrows detected per site at the old Andado road and Purnie Bore study areas



A total of 31 ampurta sign was recorded of which 10 records were tracks, 18 burrows, 2 disused burrows and 1 digging. No fresh burrowing activity or scats was located. Table 17 presents the type of sign recorded relative to the position on the dune. Seventy-percent of the tracks recorded were located from the mid-slope to the crest of the dune, in contrast to the burrows of which 83% were recorded at the base of the dunes or in the swales.

Table 17: Type of ampurta sign recorded and position on the sand dune or swale

site no.	track	burrow	old burrows	digging	position on dune
1.2	2	0	0	0	mid-slope/ cane grass
1.3	1	0	0	0	crest/cane grass
1.7	1	0	0	0	crest/cane grass
2	0	2	0	0	mid-slope/trba
2.1	0	2	1	1	base dune/trba
2.2	0	1	0	0	base dune/trba
2.21	0	8	0	0	base dune/trba
2.3	0	2	1	0	base dune/trba
2.41	0	2	0	0	swale/trba
2.5	0	1	0	0	mid-slope /cane grass
8	2	0	0	0	crest&slope /trba&cane
8.1	1	0	0	0	crest/cane grass
8.2	1	0	0	0	swale/trba
8.4	2	0	0	0	swale/trba

* trba = *Triodia basedowii*

Broad habitat descriptors based on landform, soil texture and vegetation classification as detailed in Chapter 4 were analysed to investigate which parameters best explained the presence or absence of ampurtas. Insufficient data on the presence of paleodrainage lines and aquifers, or of fire history, was available for the sites to allow them to be incorporated in the analyses.

Triodia basedowii was the only habitat variable found to have a significant correlation ($p<0.05$) with the numbers of ampurta sign. This single factor correlation was confirmed by regression analyses.

The best-fitting Poisson regression was:

Total ampurta sign = -0.78012 + 1.527 *Triodia basedowii*

Deviance of 53.59, $p<0.007$, with 31 degrees of freedom. *T. basedowii* contributed significantly to the equation at $p<0.001$.The Wilk-Shapiro index was 0.76.

The addition of other variables did not substantially decrease the deviance, and those that had a slight decreasing effect on the deviance such as duneslope and clayey sand were not individually significant to the equation (Student's t-test, $p>0.05$).

A stepwise regression with logarithmically transformed ampurta data confirmed *T. basedowii* as being the only factor affecting numbers of ampurta sign; it accounted for 16% of the variance. All other habitat parameters were rejected by the regression.

As indicated by Wiedemann (1971) the dunefields can be readily separated into cane grass and spinifex (*T. basedowii*) habitats. The regression analysis suggests that ampurtas prefer the spinifex-occupied mid-slope and swales, as opposed to the upper slopes and crest which support cane grass. All of the non-dunefield regions sampled carried no spinifex vegetation. The strong association of ampurtas with spinifex may be affected by the fact that 64% of the sign recorded were burrows, which as indicated in Table 19 were strongly associated with the lower slopes and swales. This is presumably due to the higher clay content in the sand and more compact nature of the soil which would be prefered for the construction of burrows.

3.4 Discussion

Ampurta sign was located in two of the three localities at which it had been recorded by the ANZSES and CCNT surveys. No sign of ampurta was found along the Finke floodout road or at the site on which the ANZSES expedition had previously caught 4 animals. The ANZSES records indicated that the ampurtas captured in 1990 were in an emaciated condition and suggested that the population was responding to a decline in rodent numbers subsequent to a plague after previously good seasonal conditions. The ANZSES expedition returned to Purnie Bore in 1991 during dry conditions and found no sign of ampurtas. However, in 1992, while still in apparently dry conditions, ampurta sign was located at several sites around Purnie Bore.

The data from the four brief surveys of this part of the Simpson Desert (CCNT in 1985, ANZSES 1990 and 1991 and this survey) indicate that persistent ampurta populations are located somewhere in the region though not necessarily at the sites

Plate 6: Site where ampurta sign was recorded on the old Andado Road, N.T.

Plate 7: Site where mulgara sign was recorded near the Kelor mine waste dump at Marymia, W.A.

surveyed. Further research would be required to identify the location of persistent populations.

The Purnie Bore area is associated with the Finke River drainage and the Lake Eyre basin, and the Andado road sites lie over the top of water-bearing alluvium sands. The alluvium areas sampled change to quaternary sands with no ground water to the east and west, though the Hale River drainage line runs parallel and to the east of this alluvium area (Stewart, 1968). Data available for these areas indicate that the positive ampurta sites were associated with shallow water tables and drainage lines.

Sign recorded during this survey indicate that, while ampurtas were using the dunes and associated cane grass, they were primarily relying on the base of the dunes and spinifex-covered swales for their burrows. Whilst the association with the dunefields as opposed to the gibber plains and brown soil plains is not surprising, the preference for spinifex over cane grass appears to be contrary to previous reports for these areas. Both the CCNT biological survey and the ANZSES surveys recorded ampurtas as associated with cane grass on dune crests. Gibson and Cole (1988) stated that ampurtas appeared to prefer the sand dune crests dominated by cane grass in spite of the presence of *Triodia basedowii* on the lower slopes of the dunes and in the swales.

The difference in findings may be explainable by the fact that neither the ANZSES survey (Head pers. comm.) nor the CCNT survey (Gibson and Cole, 1988) recorded the presence of mulgara burrows. It is possible that animals were being captured whilst foraging on the dune crests amongst the cane grass rather than on the lower slopes and swales when they were entering or leaving their burrows. These observations concur with those made by Dickman (pers. comm.) in south-west Queensland.

4.0 Western Australia

4.1 Introduction

Three field trips were conducted in Western Australia. For the first, in 1991, I accompanied David Pearson from the W. A. Department of Conservation and Land Management (CALM) to several of his research sites, where he had previously recorded mulgaras. The second trip in May 1993 was in response to an invitation by Resolute Mining Company to assist their consultant group Ecologia Ltd. in surveying for mulgaras within their mining lease area, after a mulgara was captured during preliminary EIS work. This field trip was conducted exclusively within the Marymia lease area. The outcome of this field work resulted in the recommendation that a regional survey be conducted in the Marymia region. This survey was conducted in October 1993, with three teams being supplied by CALM, Ecologia and Resolute. I participated in two of the three teams.

1.1 Study sites

The location of the study sites is shown in Figure 10 (Chapter 4). In 1991, surveys were conducted at Wanjarri Nature Reserve, Gibson Desert Nature Reserve and Queen

Victoria Spring Nature Reserve. Sites included Pearson's (1990) study sites plus additional sites in the vicinity. In 1993 sites were based around Marymia minelease and the Gascoyne region in a special regional survey for mulgaras.

1.2 Topography, vegetation and hydrogeology

The Gibson Desert study site was on a red sandplain dominated by *Plectrachne schinzii* with scattered *Triodia basedowii*. Estimates of aerial cover were around 35% in 1990 with sparse tree and shrub overstorey. The area had not been burnt since at least the 1970's (Pearson, 1990). A paleodrainage channel runs through the Reserve to the northwest of the study site.

The Queen Victoria Spring Nature Reserve sites were established on a *Triodia* sp. grassland on deep yellow sands. The area is primarily an open sand plain with occasional low dunes. A large paleodrainage system runs southwards through the reserve and has a surface expression in Ponton Creek. Further to the south from Pearson's fire study area, the Queen Victoria Spring lies in a claypan amidst a deep yellow sand dune field. Both areas remained unburnt for more than 30 years. The overstorey was predominantly mallee and a diverse shrub layer. The mulgara caught at Queen Victoria Spring Nature Reserve by Pearson in 1987 was the most southerly record in Western Australia in contemporary history (Pearson, 1990).

Wanjarri Nature Reserve is an old pastoral station which was purchased by CALM in 1971. It is situated on a broad sandplain interrupted by breakaways and dominated by spinifex, predominantly *T. basedowii*. There is a saltlake 16 km south of the Reserve. The sandplains with occasional dunes are part of a peneplane interrupted by low breakaways (CALM, no date). The spinifex has a mallee overstorey, interspersed with mulga or *Hakea* and *Grevillea*. A creekline runs through the Reserve and there is good ground water with a reliable standing water depth of around 35 m (CALM, no date). The Reserve is regularly baited for dingoes as it lies within a pastoral district.

Marymia mining lease is held by Resolute Pty Ltd and is an active gold mine. The lease area is located approximately 200 km north of Meekathara. The first mulgara recorded was caught in early 1993 as part of an EIS being prepared for a new mine location called PPP. The location was on a laterite-covered hillslope, principally vegetated with *Acacia* and *Eremophila* shrubland interspersed with islands of *Triodia basedowii*. The minesite lies on a ridgeline of the Murchison/Gascoyne greenstone belt, a range that forms the headwaters for the western Gascoyne Rivers and adjoins the Little Sandy Desert on its western edge (Connell pers.comm.). One of the creeklines flowing through the PPP site area forms a part of the Gascoyne catchment area.

The borefield for the minesite lies on an isolated section of the Great Sandy Desert which is an upland sandplain with occasional dunes. The plain is burnt frequently with the most recent fire in 1990 being very extensive. The standing water level for the borefield area ranges between 26 m to 30 m (Resolute Pty Ltd, unpubl). Lake Gregory and associated paleodrainage systems are located around 50 km to the southeast and the Canning Stock Route, which follows a paleodrainage line, is located 150 km to the east. Rainfall figures for nearby Three Rivers Station indicate that 1986, 1990 and

1992 were good rainfall seasons with 1992 receiving over 300 mm, predominantly in the winter. However 1987,1989, 1991 and 1993 were all dry years with less than 200mm being received per year (Manson, 1994).

4.2 Methods

Elliott and pitfall trapping was conducted in the Gibson Desert Nature Reserve and Queen Victoria Spring Nature Reserve as part of David Pearson's research. I placed additional Elliott trap and pitfall lines at several locations which appeared suitable for mulgaras. Mulgara sign searches were conducted on all sites and introduced predator and herbivore sign was recorded simultaneously.

Habitat characteristics were recorded on sites as detailed in Chapter 4 and wheelpoint percentage cover data were collected at selected sites.

Gibson Desert Nature Reserve

Pitfall trapping was undertaken over 5 nights on D. Pearson's study sites (Pearson, 1990), with pitfall buckets of 160mm and 250mm diameter and 600mm deep. Three additional Elliott traplines were set in other locations in the reserve and 11 sites were surveyed for mulgara sign. A total of 1935 combined pitfall and Elliott trap nights were sampled during this study.

Wanjarri Nature Reserve

An overnight visit was made to Wanjarri Nature Reserve to view the site where a mulgara had been captured earlier in February 1991 (Connell pers. comm.). Sign searches were conducted at three sites, one of which was the previous capture site.

Queen Victoria Springs Nature Reserve

Pitfall trapping was conducted over 5 nights by D. Pearson (1990), encompassing 7 plots of mixed-aged spinifex. Two additional sites were trapped with Elliott traps for 3 nights resulting in a total of 3210 combined pitfall and Elliott trap nights being sampled. Another 4 sites were surveyed for sign but were not trapped.

Additional sites were established at the Queen Victoria Spring to the south of Pearson's study site. Four Elliott traplines were sampled and 2 pitfall lines established resulting in a combined total of 3750 trap nights being sampled for this part of the study. An additional 14 sites in the vicinity of the Spring and at Ponton Creek were searched for sign.

Marymia

In June 1993 four sites were established within the PPP proposed mine area. Fifty Elliott traps were laid at 50m intervals on each site, and were maintained for 6 days in accordance with the methods used by Ecologia Ltd (Connell pers. comm.). An additional site was included at PPP with 35 Elliott traps set for only 3 nights. A trapping site was set up on one of the sandplain/dune sites with 40 traps for 6 days, and a site was trapped adjacent to the Keloar mine waste dump with 50 traps for 3 days.

Mulgara, introduced predator and herbivore sign were recorded on 45 sites using standard search techniques. Habitat parameters were recorded for each site as outlined in Chapter 4.

Regional Survey
The regional survey was conducted by three teams over a two week period in late October, 1993. Habitats similar to those at Marymia were selected by Landsat imagery and aerial photographs. The survey covered a broad area of approximately 200 x 300 km centred on Marymia (see Fig. 43).

The survey sites included a range of landforms from spinifex sandplains to laterite slopes and spinifex steppe. The land tenure of these areas included mining leases, pastoral properties and National Parks.

4.3 Results

4.3.1 Mulgara distribution

Gibson Desert Nature Reserve

No mulgaras were captured in 1935 trap nights; however, mulgara sign was located on 4 sites. A total of 11 sites were searched and all sites with mulgara sign were within close proximity to each other. The two sites with the highest number of sign (3 sign) were 600 m apart, with another site at 1 km to the south west having 2 sign recorded. The fourth site on which 1 burrow was located was 2 km away from the sites with the highest number of sign. All of the sign was represented by old burrows and there was no indication of fresh activity.

Queen Victoria Spring Nature Reserve

A total of 24 sites were searched for mulgara sign but no sign was located, nor were any mulgaras captured during the 6960 trap nights sampled in the reserve.

Wanjarri Nature Reserve

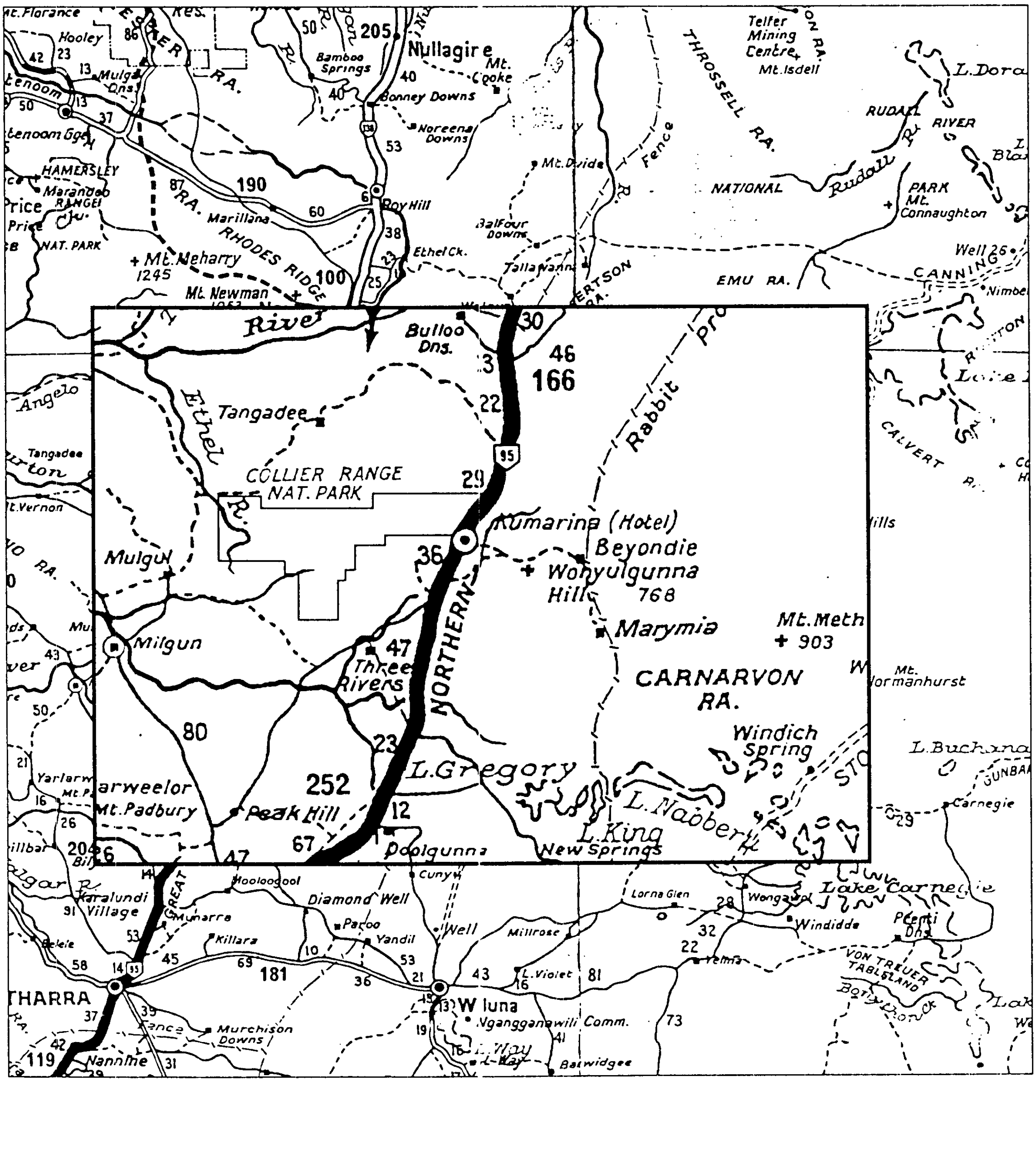
Mulgara sign was detected on 3 of the 4 sites sampled. All of the sign was fresh, and comprised tracks, scats and freshly dug burrows. Four fresh tracks and scats were located on the site were G. Connell had captured a mulgara earlier in the year (Pearson pers. comm.).

Marymia

Eleven mulgaras were captured in 1695 Elliott trap nights at the proposed PPP mine site. Rodent activity, particularly *Pseudomys hermannsburgensis, Notomys alexis and Mus musculus*, was high with 22.5% total trap success. All mulgaras were eartagged and a number of animals, particularly males, were recaptured several times.

Two males were captured at different sites on consecutive nights and it is estimated that they each travelled a minimum of 1.5kms per night. To move between the sites

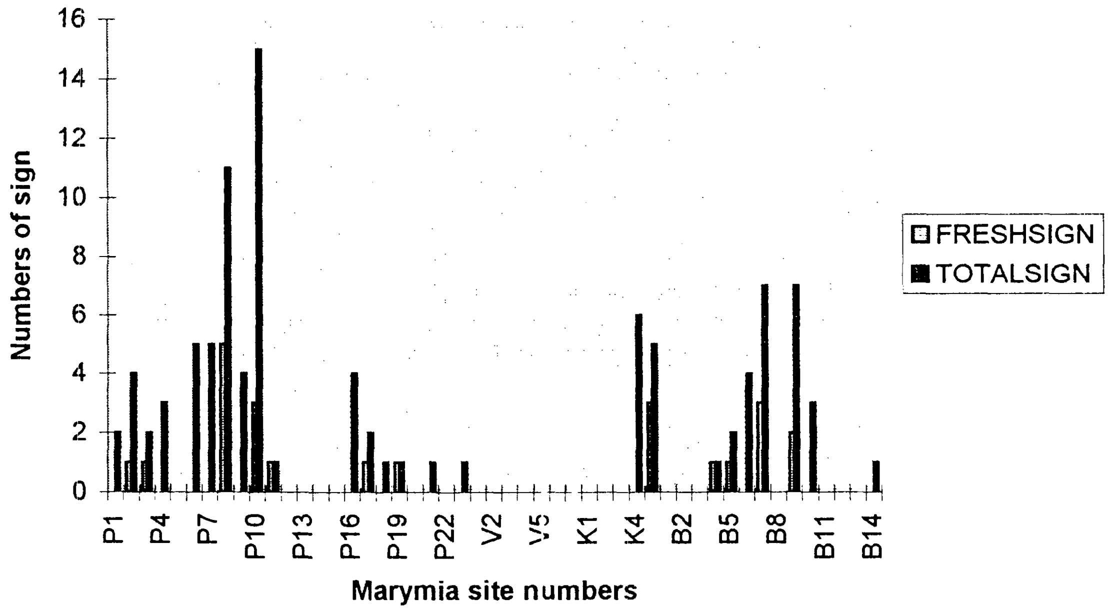
Figure 43: Western Australian regional survey area based around Marymia, Collier Range National Park and Carnarvon Range



they would have had to cross bare rocky slopes with no ground cover and cross an open creekline.

Forty-five sites along transects at PPP, on the borefield tracks and near the current mine site were surveyed for mulgara sign (Fig 44). Mulgara sign was recorded at 23 sites. Most of the signs recorded at PPP were burrows, digs and scats, as the soil was covered with laterite and unsuitable for identifying tracks.

Figure 44: Fresh and total mulgara sign detected on sites at the proposed PPP mine site, around the current mine site and along the borefield road at Marymia



[Site numbers and locations are presented in Appendix 2.]

Mulgara activity was relatively high particularly compared to other W.A. sites. This may have been a response to good local rains in 1992. The two areas of activity, PPP and the borefield, were separated by approximately 25 km. The 11 mulgaras from PPP were within an area of approximately 3 km^2 and sites searched on the borefield were spread over approximately a distance of 50 kms.

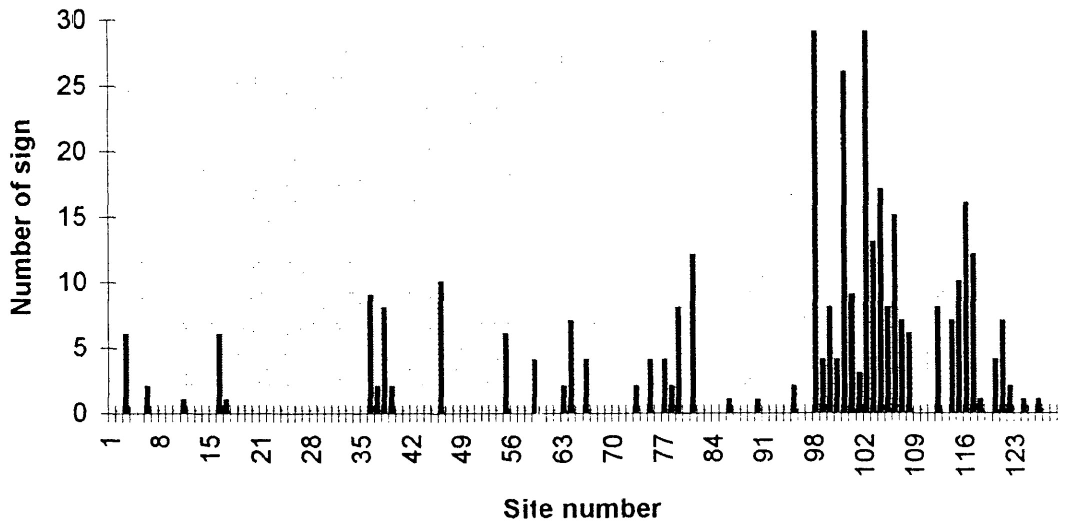
The mulgaras at PPP were burrowing and residing on a laterite slope with clay loam soils overlain by fine ironstone gravel. The *Triodia basedowii* was confined to islands within a sparse *Acacia* shrub steppe. This is the only site I have located during my research where mulgaras have occurred in this type of habitat.

WA regional survey

The major concentration of mulgara sign was recorded on sites on Marymia lease or adjacent mining leases. Other sites recording mulgara sign were located north of

Marymia in the Little Sandy Desert, east around Carnarvon Range Proposed National Park and about 100 km to the west in Collier Range National Park. The location of the survey sites is presented in Appendix 2. Of the 132 sites surveyed, 49 sites recorded mulgara sign (Fig. 45). Three of the sites at Marymia showed very high level of sign (26-29 total mulgara sign). These sites were at the proposed PPP mine site and adjacent to the waste dump at the current Keloar mine.

Figure 45: Total mulgara sign detected on sites during the Western Australian regional survey



[Site locations and numbers are presented in Appendix 2.]

4.3.2 Introduced predators and herbivores

Dingo, cat, fox and rabbit sign were compared against total numbers of mulgara sign. Two sites supporting unusually high levels of mulgara sign were identified as outlier points and were omitted from the analyses.

A positive correlation was found between mulgara sign and dingo sign ($p<0.02$), but no other correlations were significant. This single relationship between mulgara and dingo was affirmed by the regression analyses in which dingo sign was the only factor found to significantly explain variation in the total mulgara sign.

The best fit Poisson regression was

$$\text{total mulgara sign} = 0.116 + 0.57 \text{ dingo}$$

Deviance of 174.56, $p <0.001$, 62 degrees of freedom. Dingo sign contributed significantly to the equation ($p<0.001$). The Wilk-Shapiro index was 0.71.

Subset regression indicated that dingo sign accounted for 7.5% of variance in mulgara sign. The presence of cats, foxes and rabbits were not significant influences on the abundance of mulgara sign.

Introduced predators and herbivores (regional survey)

Estimates of cat, dingo, fox and rodents abundance were ranked in classes, rather than individual sign counted as had occurred at all other survey sites.

A Spearman Rank correlation found no significant correlation between predators and mulgaras, nor between rodent abundances and mulgaras, and no regressions could be calculated.

One-way analysis of variance found no difference in abundance of sign between sites for any of the predators.

4.3.3 Habitat preferences

The habitat attributes for all 69 sites including Gibson Desert Nature Reserve, Queen Victoria Spring Nature Reserve, Wanjirra and Marymia sites were combined and analysed against total mulgara sign. After preliminary analyses two sites which had high levels of mulgara sign (>20 sign) were identified as outliers and removed from the statistical analysis.

A significant positive correlation was found between total mulgara sign and *T. basedowii* ($p<0.001$), and significant negative correlations were identified between total mulgara sign and abundant (70-100%) surface strew (stones and rocks), no spinifex cover and *Triodia* sp. ($p<0.05$). Regression analyses identified the presence of *T. basedowii* as a positive attribute for mulgaras, while spinifex that was estimated to have been burnt more than 30 years previously was a negative influence.

The best explanatory equation was:

$$\text{total mulgara sign} = -0.039 + 1.237\ \textit{T. basedowii} - 1.381\ [30\text{yrs}^{+}\ \text{fire}]$$

Deviance of 106.81, $p<0.001$, 61 cases. *T. basedowii* and 30yrs^{+} fire contributed significantly to the equation ($p<0.001$). The Wilk-Shapiro index was 0.82.

Subset regression using logarithmically transformed mulgara sign found that 30+yrs since fire was the main factor contributing to 20% of variance mulgara sign, with the height of spinifex between 0.26 and 0.75m contributing a further 15% to the variance.

The presence of *T. basedowii* as opposed to other spinifex species appears to be an important factor in determining the suitability of an area to mulgara in Western Australia. The height of the spinifex hummocks also appeared to be an important habitat criterion, as were the percentage of surface covered by stones or rocks and the years since fire. Spinifex that had not been burnt for at least 30years had a negative influence on mulgara presence. Information on the paleodrainage influences on these sites was not available. The sites on which mulgara signs were most abundant were all located at Marymia on the PPP mine site, an area of *T. basedowii* spinifex steppe covered by laterite stones (approximately 50-70% cover).

Habitat analysis for the regional survey

Altitude of the site was included in the analyses of the 132 sites; however, data on the presence of paleodrainage influences was not available and was not included in the analysis.

Positive correlations were found between total mulgara sign and altitude ($p<0.02$) and the presence of a tree strata ($p<0.05$). Negative correlations were found between the abundance of mulgara sign and years since fire ($p<0.005$), landform ($p<0.05$), spinifex form ($p< 0.002$) and soil texture ($p<0.02$). Regression analyses identified certain types of landform, land use, soil texture, altitude and spinifex presence and form as significant contributors to the number of mulgara sign recorded.

The best-fit Poisson regression equation was:

Total mulgara sign = -6.846 +0.546 10yr fire - 0.362 undulating plain +1.048 swale + 2.623 mining lease - 0.385 sandy surface + 1.20 small hummock + 0.884 full hummock + 0.583 first ring hummock + 0.738 clayey sand + 0.897 sandyloam + 0.0099 altitude + 0.00284 veg1.

Deviance of 407.39 (dropped by over 400 points), $p<0.001$ and 119 degrees of freedom. All the variables contributed significantly to the equation at either $p<0.001$ except for undulating plain, 0-10 years since fire and sandy surface which were less significant contributors ($p<0.02$). The Wilk Shapiro index was 0.76.

Best subset regressions models for logarithmically transformed mulgara sign indicated that the most important contributing factors were swale, mining lease, small hummocks, altitude and clayey sand. This combination of habitat attributes accounted for 43% of the variance in mulgara sign.

The regressions and Spearman Rank correlations identified soil type, particularly clayey sands and loamy sands, fire history and associated spinifex growth form, undulating plains and swales, the presence of a tree overstorey, altitude and an association with mining leases as being the important contributors to the presence of mulgara sign.

The association with mining leases possibly reflects a sampling bias but could also be a reflection of the geology and topography associated with the mining areas.

Percentage cover for regional survey

Percentage cover data were collected for 19 sites within the 132 regional sites. Mulgara sign was recorded in areas containing spinifex cover from 13-50% cover and shrub cover from 0-24%. No significant correlations were found between cover and mulgara sign. Both Poisson and subset regression analyses indicated spinifex cover and shrub cover were important contributors to mulgara habitat with 14% of the variance in mulgara sign in being explained by these two factors. The Poisson regression suggests a negative relationship with increasing cover.

The Poisson regression equation:

Total mulgara sign= - 0.993 + 0.05 spinifex cover + 0.052 shrub cover

Deviance of 82.92, 16 degrees of freedom, $p<0.001$. Both factors contributed significantly to the equation ($p<0.001$)

4.4 Discussion

Mulgaras have been intermittently recorded over much of their known range in Western Australia over the past 10 years. However, persistent populations or core habitats have yet to be identified. The results obtained from the two surveys in 1993 at Marymia were promising in terms of locating a substantial population. However, the population declined dramatically by the winter of 1994 (Manson, 1994) and to date has not resurged (Pearson pers. comm.). The question of where the mulgara population at Marymia derived from is unanswered. However, it is probable that the population was based on animals dispersing from the Little Sandy Desert, possibly from areas to the north or east.

Other promising locations to consider for locating persistent populations include Collier Range National Park and Carnarvon Range Proposed National Park. Gibson Desert Nature Reserve and the surrounding region is another area that potentially supports persistent mulgaras. However, the focus for searches should be located further to the north-west over the paleodrainage lines.

The habitat analyses of all the sites surveyed in W.A. suggest that the presence of *T. basedowii* and appropriate fire regimes are important factors in determining habitat suitability for mulgaras. Other less critical factors identified were the presence of heavier sandy soils (clayey sand and sandy loam) and to a lesser extent the presence of swales or undulating plains. Mulgaras also appeared to prefer sites with 50% or less spinifex cover and 24% or less shrub cover. Mining lease was a significant factor in the regional data which could have been a sample bias or a response to the regional geology or hydrogeology. Although the hydrogeology of the individual sites was not included in the analyses, Beard (1973) and Graaff *et al.* (1977) have mapped the hydrogeology of the Western Australian arid zone in some detail. Many of the sites where mulgara were recorded during these surveys lay over paleodrainage influences. This aspect will be considered in more detail in Chapter 8.

Introduced predators and herbivores were not principal factors in determining the presence or absence of mulgaras. The presence of dingoes was found in some instances to be a positive factor but accounted for only 7.5% of the variance in mulgara sign in the non-regional data (i.e. 1991 and 1993 Marymia data). The regional survey data (1993) showed no relationship between predators and mulgaras. This result may be influenced by the annual dingo baiting program which is carried out over much of the area surveyed. Baiting was being undertaken prior to and throughout the regional survey area in 1993.

5.0 Additional Sites

Sites which I visited but for which no habitat or predator data were gathered or analysed were Central Mt Wedge, N.T., and the Anangu Pitjantjatjara Lands in South Australia.

5.1 Central Mt Wedge

5.1.1 Introduction

Central Mt Wedge is a pastoral station situated at the western end of the Stuart Bluff Range and on the southern edge of the Tanami Desert. It is approximately 200 kilometres north west of Alice Springs (Fig. 10). The station boundaries lie over 4 salt lakes and extensive paleodrainage systems running southeast towards Lake Lewis. The station lies in the midst of the Ngalia Basin, an extensive drainage system fed by discharge from the ranges to the north and which drains to the southeast (Stewart, 1982).On two occasions, in 1988 and 1989, the station owner Mr Bob Waudby saw a mulgara at the same location running across a track near the saltlake. There had been good winter rainfalls during 1988 and 1989, and according to Mr Waudby, these were the only mulgaras that have been seen since the family took up the property in 1947.

In August 1991, I undertook a brief two-day survey with Dr S. Morton to investigate these sightings and to assess the potential of the area as a study site.

5.1.2 Methods

An area of approximately 10 km^2 was walked in the vicinity of the Waudby sightings. Mulgara sign and predator tracks were recorded. Four Elliott trap transects were set around the edge of the salt lake for a total of 175 trap nights. Notes on vegetation were taken while searching for sign. No specific site habitat data were collected.

5.1.3 Results

A total of 10 sites were searched for mulgara and Figure 46 presents the total mulgara sign recorded per site.

Table 18 : Predator sign detected on sites surveyed at Central Mt Wedge Station

site no.	cat	fox	dingo
1	0	1	0
2	0	0	0
3	0	0	0
4	0	0	0
5	1	1	1
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0

5.1.4 Discussion

The locality where Waudby sighted the mulgara is topographically diverse. The saltlake lies adjacent to the northern side of Mt Wedge.The saltlake is surrounded by a network of dune systems with wide swales which is further intersected by the Sidley Ranges which end in close proximity to the northwestern edge of the saltlake. This topographic diversity results in a number of surface and subsurface drainage lines running through the spinifex communities (Arakel, 1986). On a regional level, the entire Napperby geological 1:250 000 map sheet covers five paleodrainage basin systems. It is likely that there are numerous potential mulgara refuges on these systems.

The dominant vegetation type was *Triodia basedowii* with an overstorey of mallee (principally *Eucalyptus gamophylla)*. The spinifex species changed to *Triodia pungens* closer to the lake. Both spinifex types were senescing into rings but were carrying old seed heads. On the southern side of the lake, some areas supported full hummocks amongst clear open sand spaces and an overstorey of desert oaks (*Allocasuarina decaisneana)* and bloodwoods (*Eucalyptus opaca)*. Visual estimates of percentage spinifex cover varied from 20 to 50%. The area had not been burnt for some time, and I estimated that the spinifex was generally at least 40years old (based on my experience of spinifex form and fire history in Uluru National Park).

Mulgara scats were also collected within the bluebush (*Maireana* spp.) community fringing the drainage line from the lake.

The site appeared to be very promising as a study site. It was not utilised further in this study due to its remoteness and other logistical constraints. It would, however, be a useful site for further research or monitoring.

5.2 Anangu Pitjantjatjara Lands Biological Survey

The Anangu Pitjantjatjara Lands (AP) occupy around 96 000 km^2 of the north-western part of South Australia. This area includes the Everard, Musgrave, Mann and Tomkinson Ranges and the vast sandplains and dunefields to the south for over 150 km. As part of their land management program the AP council joined with the South Australian Department of Environment and Natural Resources to conduct a biological survey of the lands which commenced in 1992. I have participated in each of the surveys conducted bi-annually at different locations across the lands.

Over 96 sites were surveyed on the AP lands between 1992 and 1995, of which at least 42 were spinifex sandplain or dunefield sites potentially suitable for mulgara habitation. Soil types included sand, clayey sand, loamy sand and sandy loam and spinifex cover ranged from 20-50% with a variety of spinifex species.

No mulgaras were recorded either by trapping (Elliott and pitfall) or from sign. Low levels of predator sign were recorded at most sites. However, the data are not currently available for analysis. The major factor in common across all sites was the age of the spinifex. Most of the spinifex in the region is very senescent and older than 30+ years. Very little patch burning is currently undertaken in the region and as a result several extremely large summer wildfires have burnt through substantial portions of country. This has, however, been primarily in the vicinity of the ranges, and much of the spinifex further to the south has not been burnt for a very long time.

Anangu state that mulgaras disappeared from this part of the country in the 1930s-1950s (Chapter 2) and despite substantial trapping and search effort over much of the lands in the past four years, no sign of mulgaras has been located. It is possible that mulgaras have become locally extinct or very rare in this part of their range.