SUMMARY

The loss and decline of the medium sized (Critical Weight Range, CWR) mammals in the arid zone has been well documented and is the subject of substantial conservation research and management effort. Mulgaras (*Dasycercus cristicauda*, Krefft) are one of the medium size mammals within this group which are the subject of conservation concern. This study assessed the changes in the distribution and abundance of contemporary populations relative to what was known of their historical distribution and abundance. BIOCLIM was used to predict the original distribution and Aboriginal knowledge, historical records and scientific survey data were used to assess the changes in status.

Molecular genetic techniques were used by the South Australian Museum Department of Evolutionary Biology to verify the status of the two sub-species, *D. cristicauda cristicauda* (Krefft) and *D. cristicauda hillieri* (Thomas). The results are preliminary in their findings but were surprising in determining that the sub-species warrant recognition as discrete species. These species have been proposed as mulgara (*Dasycercus cristicauda*) and ampurta (*Dasycercus hillieri*). The two species appear to exist within the geographic ranges as known for the two sub-species. The name ampurta is proposed as one of the Aboriginal names recorded historically for the animals collected as *D. c. hillieri* (subject to approval from the appropriate Aboriginal and scientific organisations).

Study sites were selected in Northern Territory, Western Australia and South Australia to examine broad habitat requirements and potential threats to populations across their geographical range. Despite broad scale topographical and habitat differences a number of habitat attributes were found to be in common across all sites and formed the basis of a preferred habitat model. This model included clayey sand and sandy loam soils, a preference for *Triodia basedowii*, except in the Tanami where a tall hummock-form of *T. pungens* replaced *T. basedowii*, the presence of a tree or shrub layer and the influence of a paleodrainage or surface drainage system. The form and spacing of spinifex hummocks were very important aspects which appeared to provide the basis for a preference for the *T. basedowii* or tall hummock-form *T. pungens*. This combination of appropriate soil, spinifex type and drainage influence appeared to provide a refuge or core habitat within large areas of superficially suitable spinifex communities.

Fire was identified as a critical factor in the maintenance of these core habitats and was the greatest threatening process identified. Inappropriate fire regimes ie. too frequent fire or infrequent wildfires threaten the viability of these refuge habitats by allowing the spinifex to become unsuitable for mulgaras through becoming senescent or by the entire refuge being potentially burnt by a single fire thus removing spinifex cover and therefore suitable habitat for at least several years.

The potential impact of introduced herbivores and predators was examined, however no substantial threats were identified within the study areas. It is likely that dingoes,

foxes and cats play a moderating role on the mulgara populations but are not limiting the mulgara populations survival. This role is likely to shift, however, in the event of the restriction or loss of core habitat through fire or protracted droughts at which time their impact may become much more critical

Persistent populations of mulgaras were identified at Uluru National Park, Sangster's Bore and Kintore in the Northern Territory. No persistent populations were located in Western Australia, however, some populations were identified which warrant further study to determine their persistence. No mulgara populations were located in South Australia and their status in that state indicates that they may have become locally extinct. The IUCN/SSC Marsupial and Monotreme Action Plan (MMAP) recommendation of ranking mulgara as Vulnerable is supported by these findings. No persistent populations of ampurta were located during the study. The population/s in south-west Queensland were not included within my study area. Sign of ampurta were located at two sites in the Simpson Desert in the Northern Territory and South Australia, however, further research is required to determine the persistence, size and status of these populations. On available records the 1996 MMAP recommendation that this species be ranked as Endangered is supported.

Mulgaras (and ampurtas) appear to be dependent on refuge habitats which are patchily distributed within a broad spinifex landscape. One of the key factors that appears to influence the location of these refuge habitats is the influence of drainage systems, particularly paleodrainage systems. Techniques for locating areas of persistent greenness during droughts have been developed by researchers at CSIRO. These techniques could be used in conjunction with the habitat requirements identified in this study to overcome the difficulty of locating core populations of mulgara and ampurta across the vast area of the arid zone. Once located these core populations can provide the focus for management programs to promote the species and ultimately assist in their status of Vulnerable and Endangered being downgraded to less threatened categories.

CHAPTER 1

INTRODUCTION

1.0 Background

The arid zone occupies sixty-nine percent of the Australian continent and has historically supported a diverse terrestrial mammal fauna (Stanley, 1982). The past 100 years has witnessed a dramatic decline in arid zone biodiversity with more than one third of the 72 terrestrial mammal species becoming rare or extinct (Alsin, 1983, Burbidge *et al.*, 1988, Morton, 1990). This trend became apparent as early as 1923 when Wood-Jones reported the alarming decline in populations of many arid zone animals in South Australia. His concern has been vindicated with many species losses over the past seventy years and the continuing threat of further declines and extinctions.

The impact of extinctions upon the arid zone fauna is further highlighted when compared with those from mesic environments. Thirty - two percent of the terrestrial arid zone mammal species are listed as having become endangered since European settlement as opposed to 13 % of species from mesic environments (Morton,1990). This is despite the fact that the mesic areas support 62% of the entire Australian terrestrial mammal fauna (Morton, 1990). There is no doubt that the arid zone has been the site of one of the most dramatic species declines experienced in Australia.

One of the aspects which has puzzled researchers for some time is the apparent focus of these declines within the group of medium sized mammals (eg. Newsome,1975; Burbidge and Fuller,1979; Morton and Baynes, 1985). This led Burbidge and McKenzie (1989) to develop the concept of Critical Weight Range (CWR) and to describe the suite of arid zone species most susceptible to decline or extinction. They identified the weight range for the CWR group as 35 to 5,500g based on the rationale that arid zone mammals within this weight range have relatively high daily metabolic requirements but are not particularly mobile. This combination places them under pressure during droughts, especially in areas where introduced herbivores and land use changes have reduced the overall productivity of the country and where exotic predators are able to apply substantial pressure on isolated populations (Burbidge and McKenzie, 1989).

Since 1990 the Endangered Species Unit (ESU) of the Australian Nature Conservation Agency (ANCA) and the Commonwealth Endangered Species Advisory Committee have been focussing on the development of Recovery Plans to co-ordinate national research and management of vulnerable and endangered species. The Commonwealth Endangered Species Protection Act (1992) prescribes the Recovery Plan process as a key approach to securing the status, in the wild, of endangered and vulnerable native species and endangered ecological communities. The recovery plan is a comprehensive document which details, schedules and costs all the actions assessed as necessary to support the recovery of a species. If there is insufficient information known about a

species to prepare a Recovery Plan then a Research Plan can be undertaken which identifies the research and survey actions required to provide the necessary information to formulate a Recovery Plan (ANCA, 1995).

One of the CWR species identified as having insufficient information available to prepare a Recovery Plan was the mulgara, *Dasycercus cristicauda*. As a result the ESU provided funding for a Research Plan to be prepared to examine the status and ecology of the mulgara. As part of this effort this thesis will address a number of aspects which contribute to our knowledge of the current status of mulgara populations.

2.0 Mulgara

Mulgaras are carnivorous marsupials restricted to the arid zone and are currently listed as 'Vulnerable' (ANZECC, 1991). They are robust and fearlessly inquisitive animals (Wood-Jones, 1923). Mulgaras have thick brownish - fawn dorsal fur, with the chin and ventral surfaces being creamy white and a pale cinnamon coloured eye - ring. They have a compact head with round ears that stand well away from the head and a basally thickened rufous tail with a black crest on the tip (Wood-Jones, 1923). Fleay (1965, p2) was particularly enamoured of these animals, stating that studying them was:

> "one of the most charming and entertaining tasks I have ever undertaken. It left me without a doubt that the prize for general intelligence and bright personality among small pouched animals should go to this robust lively burrower of the arid regions."

Historically there have been two sub-species identified, *Dasycercus cristicauda cristicauda* (Krefft, 1866) and *Dasycercus cristicauda hillieri* (Thomas, 1905). *D. c. hillieri* was reported to be considerably paler but according to Finlayson (1935) could not be determined by mensuration. *D .c. cristicauda* have been previously recorded as located in the Northern Territory, Western Australia and western South Australia, with *D. c. hillieri* apparently restricted to north-eastern South Australia and south-western Queensland. Both sub-species have apparently declined in range since European settlement (Aslin, 1983; Woolley, 1990).

One of the aims of my research was to confirm the existence of the sub-species separation through genetic analysis. Blood samples were collected from animals captured on sites and sent to the South Australian Museum, Evolutionary Biology Unit (EBU). Analysis of the genetic material from these samples along with material from museum specimens and animals held by the Berry Springs Wildlife Park has led to the proposition of two species rather than sub-species (Adams pers. comm.[1]). Details of this work are reported in Chapter 3. The species split appears to follow the same geographic separation as was originally proposed for the sub-species. Spencer (1896), Finlayson (1961) and Wood-Jones (1923) also recorded names used by local Aboriginal language groups for these species. Based on these records and subject to approval by the appropriate Aboriginal and scientific organisations, I propose that

[1] Details of all personal communications are provided on page 162

Dasycercus cristicauda maintain the common name, Mulgara, and that the proposed *D. hillieri* be called Ampurta. Justification for this proposal can be found in Chapter 2. The field work for this project focussed on areas supporting *D. cristicauda*, and as a result the common name mulgara will be used throughout the thesis except where ampurta are specifically referred to.

3.0 Mulgaras as arid zone residents

3.1 Rainfall

The arid zone typically receives less than 250mm annual rainfall on the southern margin, decreasing to around 125mm in the south-east of the Northern Territory. In the north the average rainfall is less than 500mm with the major rain occurring in the summer when tropical air penetrates from further north. Further to the south the major rainfall is more likely to be in the winter. Rains can be locally isolated or large and substantial events (Nix, 1982). The Finke River, for example, experienced a major flood in 1967, considered to be the largest since 1895. In turn the 1967 floods were surpassed in March 1972 and again in January of 1974 when the annual rainfall was the highest recorded at the Alice Springs Telegraph station since 1873 (Baker *et al.*, 1983). It is this inconsistency of volume and timing of rainfall that is characteristic of the arid zone.

Mulgaras are well adapted for living in such an unpredictable environment. They are primarily nocturnal animals that live in burrows, but emerge during daylight to sun bask (Fleay, 1961; Gibson and Cole, 1988; Baker and Jarman, 1995). Wood-Jones (1923, p108) remarked that in captivity:

> "They are by no means nocturnal, being lovers of the sunlight, and having a truly lizard-like habit of lying perfectly flat in the hot sunshine. The degree of heat and the intensity of sunlight they delight in is very astonishing in a mammal. Particularly reptilian is their method of flattening their bodies whilst basking, and so too are the rapid quivering of the tail, and the short shaking movements of the limbs as the animal exposes itself to the direct rays of the sun."

They are highly adaptable in their use of food resources as their diet ranges from termites to mice and lizards (Masters pers. comm.). They are also able produce a highly concentrated urine to conserve metabolic water (Brown, 1984). Their tails are usually incrassated (basally thickened) with fat, which may serve as a buffer against uncertain and intermittent food supplies (Sabine *et al.*, 1968). Certainly during the winter months, I have observed mulgaras in poor condition which have very thin tails, suggesting that the fat reserves are being utilised during this time.

Some researchers have reported mulgaras to be capable of expanding their population rapidly in response to good conditions. Wood-Jones (1923, p107) reported that on:

> "several occasions (the mulgara) has multiplied in an astonishing manner during the passage of a mouse plague across Central Australia. At these times its services are of the greatest value, and in the mouse plague of 1904, although no

human ingenuity could check the increase of the mice, the appearance of these active little carnivores cleared them from certain districts in a remarkably short time."

Unlike rodents, however, female mulgaras are usually monoestrous, though they may undergo a second oestrus if they are unmated or suffer a premature loss of the first litter (Lee *et al.*, 1982). The females have 8 teats though they appear to have an average litter of 5-6 (Gibson and Cole, 1992. Masters pers. comm.). How the mulgaras were able to multiply as recorded by Wood-Jones is uncertain, though possibly high availability of food resources contributed to high rates of juvenile survivorship. Data presented in Part 2 of this thesis indicate that mulgara populations can respond to seasonal fluctuations by expanding and contracting their overall distribution.

3.2 Temperature

The temperatures in the arid zone range from in excess of 45°C during the day in summer to less than 0°C on winter nights. These temperature extremes require animals to be able to cope with substantial temperature shifts. In addition to staying below ground during the heat of the day, mulgaras are able to conserve energy by lowering their body temperature and consequently their metabolic rate. Some researchers (Schmidt-Nielson and Newsome, 1962; Kennedy and MacFarlane, 1971) believe this is in response to food shortages and low temperatures; however, Geiser and Masters (1994) found that mulgaras enter torpor spontaneously when the ambient temperature falls to 18°C regardless of food availability. This ability of mulgaras to enter torpor acts as a safety mechanism to reduce energy expenditure during very cold weather.

4.0 Aims of the research

There has been a well documented decline in biodiversity of the arid zone through the loss and reduction in range of a substantial number of the mammal species. As discussed previously there is concern that the extinctions of arid zone mammals have not ceased and is an ongoing process which requires urgent research and management attention. The focus of these declines has been particularly targetted at the medium sized CWR group of mammals of which mulgaras are a member. To date, however, there have been insufficient data available on the current status, distribution and requirements of the mulgara to be able to write a recovery plan. This thesis focusses on providing data to address some of these issues.

The characteristics of mulgaras as described by Wood-Jones, Fleay and others indicate that they are well adapted to the uncertain conditions presented by living in the arid zone. The puzzle that presents itself is why this 'intelligent', adaptable and robust animal appears to have declined in distribution to the extent that it is believed to be vulnerable to extinction. My research tries to shed some light on the factors which may be contributing to this decline and attempts to identify management issues which need to be addressed to prevent further decline or extinction of the mulgara.

The principal objectives were to assess the current conservation status of mulgaras, identify potential threats to the populations, and recommend appropriate management strategies to ensure the long term protection of the species.

To facilitate these objectives three principal questions were identified:

1. Have mulgaras declined in distribution or abundance over time?

2. Is the current recognition of two sub-species correct?

3. If the mulgara has declined in distribution, is it due to the restriction of populations to limited habitats or other threatening processes?

4. What management recommendations can be made to protect and enhance existing populations?

5.0 Study Outline

The research project was conducted from 1990 to 1995, with the majority of field work being undertaken from 1991 to 1993. The study was conducted within the arid regions of the Northern Territory, South Australia and Western Australia.

The project was funded by the Australian Nature Conservation Agency (ANCA) at Uluru National Park, and through ANCA'sEndangered Species program which was administered by the Conservation Commission of the Northern Territory.
The Research Plan is due to be finalised in 1996 and will be based on the findings of this project and a concurrent project being undertaken by Pip Masters (Conservation Commission of the Northern Territory/University of Sydney). Ms Masters is investigating the detailed biology and ecology of the species.

A number of other researchers and organisations have been involved in research and surveys for mulgaras in recent years. Dr C. Dickman and students from the University of Sydney have been undertaking research on mulgaras and other carnivorous marsupials in south-western Queensland. They have focused primarily on foraging strategies and the impact of feral predators. A consultant company, Ecologia, has been contracted by Resolute Mining Company and other mining companies in Western Australia to search for mulgaras as part of environmental impact assessments on mining leases. In response to discovery of a mulgara population on a mining lease at Marymia, Resolute contracted Ecologia to monitor and undertake some research on this population. As a result a study on home ranges on the population was conducted for an Honours thesis (Manson, 1994).

Professor P. Jarman and I were contracted by ANCA to produce a Conservation Strategy for mulgaras at Uluru National Park and adjacent areas. The final report was submitted in July 1995 and the results from that report will provide a substantial portion of this thesis.

State agencies assisted by providing me with information from other research programs and logistical support in the field. The major part of the Western Australian regional survey was conducted as part of a joint project between the W.A. Department of Conservation and Land Management, Resolute Mining Company, Ecologia

consultancy company and myself. All research undertaken on the Anangu Pitjantjatjara Lands was undertaken as part of a biological survey conducted by the Anangu Pitjantjatjara Council and the South Australian Department of Environment and Natural Resources.

A substantial number of the areas included in the research were on Aboriginal Land. Permission was given by the relevant communities and Land Councils, and traditional owners provided guidance and information in the field. Aboriginal people taught me how to track mulgaras and were responsible for much of my insight into the ecology of the arid zone. All Aboriginal information remains the property of the communities and land councils.

5.1 Constraints

To assess the current distribution of mulgara involved an extremely large geographical area. Due to the large distances involved and the financial and logistical difficulties involved in working in remote areas, a sampling strategy was required which would allow for a flexible approach. The field work was designed to select a number of sites in which the sampling effort would be stratified. This allowed for a primary survey site at which methodologies were tested and repeated sampling was feasible. The methods and approaches selected were then tested on a second study site. A series of opportunistic sites was then selected where broader scale information was collected to assess how well 'descriptive models' developed at the primary sites fitted across the range.