THE DIET OF THE BLACK-BACKED JACKAL (*CANIS MESOMELAS*) AND CARACAL (*FELIS CARACAL*) IN THE EASTERN CAPE, SOUTH AFRICA

Submitted in fulfilment of the requirements for the degree of Master of Science at Rhodes University, Grahamstown, South Africa

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Dedication

This thesis is dedicated to the memory of my father,
who sadly passed away before the completion of my studies.
Much loved and respected by all who knew him,
he was above all else, a true gentleman and a man of honour.
His morals and ideals have been, and continue to be, my guiding light.

I miss him.

ABSTRACT

The black-backed jackal (*Canis mesomelas*) and the caracal (*Felis caracal*) are considered by most farmers in the Eastern Cape to be responsible for excessive livestock losses (sheep and goats) and are, as such, hunted extensively within the Province.

Stomach content analyses of individuals killed during predator control operations indicate that caracal are opportunistic hunters of small to medium-sized mammals, preying predominantly on antelope within farmland.

Black-backed jackal are opportunistic omnivores, preying predominantly on livestock and antelope in farmland, while invertebrates and antelope constitute the major food items within a game reserve.

The diet of caracal was found to be largely influenced by the age of individual animals with old and young animals being the predominant killers of livestock, whereas black-backed jackal diet is influenced primarily by the social structure exhibited by the species, with male animals exhibiting a marked summer peak in livestock killing, due to the increased energetic demands of parental care associated with a long term pair bond.

Two caracal (a sub-adult male and adult female), were radio-tracked within farmland for a total of twelve months, yielding the smallest recorded homerange sizes for the species to date (2.1km^2 and 1.3km^2 respectively). No livestock losses were recorded within these homeranges for the duration of the study. These data suggest a relatively high abundance of caracal within Lower Albany and further illustrate that individual animals are capable of preying solely on natural prey species over an extended period, when occurring within livestock farming areas.

The analysis of local hunt club records and questionnaires revealed a higher incidence of local black-backed jackal (15.2 PD/Kill), than caracal (34.7 PD/Kill), with a marked seasonal peak in kills, for both species, occurring during summer months.

The use of hound packs was found to be more effective in reducing the overall abundance of caracal than black-backed jackal, as this technique was seen to eliminate more adult female caracal than black-backed jackal, during the respective breeding season of each species.

Local hunt club owners and farmers were more accurate in identifying problem black-backed jackal (74%), than caracal (59%).

Recommendations are presented for minimizing stock losses through the application of selective control of specific problem animals, the use of various control measures and encouraging natural prey abundance.

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CHAPTER ONE
INTRODUCTION

The black-backed jackal (*Canis mesomelas* Schreber 1778), and the caracal (*Felis caracal* Schreber 1776), are at present, declared problem animals in the Eastern Cape and indeed, throughout the Republic of South Africa (Lensing 1993, Miller 1993, Olivier 1993, Visagie 1993). Janse van Rensburg (1965), estimated that approximately 28 000 sheep are lost annually within South Africa, due to predators. Rowe-Rowe (1975), estimated that 0.05% of sheep flocks in a farming area in KwaZulu-Natal, were killed annually by predators, while Lawson (1989), estimated that up to 3.0% of the total KwaZulu-Natal sheep flock is lost annually due to the actions of predators.

Due to these factors, the Problem Animal Control Ordinance No. 26 of 1957, entitles individuals or recognised clubs to hunt black-backed jackal and caracal at any time and employing any method. Both species, but especially the black-backed jackal, have in the past, been the subject of numerous studies.

1.1. *CANIS MESOMELAS*

The black-backed jackal, one of five canid species in South Africa, has a wide distribution and habitat tolerance, although it is more common in the drier parts of its distributional range (Skinner and Smithers 1990). This species occurs in two distinct areas on the African continent (Fig. 1.1), (Skinner and Smithers 1990). The northern population inhabits parts of Ethiopia and Sudan and is found over most of Somalia, Uganda, Kenya and Tanzania.

The southern population of black-backed jackal inhabits parts of Angola, Zimbabwe and Mozambique, while the species is widespread throughout Namibia, Botswana, Swaziland and Lesotho. Similarly, in South Africa, the black-backed jackal is common and widespread, occurring throughout the Eastern, Western and Northern Cape Province (Stuart 1975, 1981, Stuart *et al.* 1985), KwaZulu-Natal (Rowe-Rowe 1992), the Transvaal and Orange Free State (Skinner and Smithers 1990).

The taxonomy of the black-backed jackal was reviewed by Meester *et al.* (1986), who assigned all individuals in the southern African sub-region to *Canis mesomelas mesomelas*.

The species has an extremely wide habitat tolerance and is found in well-wooded areas, coastal areas and arid regions along the Namibian coastline (Stuart 1975, Nel and Loutit 1986, Avery *et al.* 1987), although avoiding forest biomes (Skinner and Smithers 1990).

The black-backed jackal is an opportunistic omnivore. Major prey items of this species include insects (Hall-Martin and Botha 1980, Smithers 1983), carrion (Grafton 1965, Rowe-Rowe 1976), vegetable matter (Stuart 1976), birds (Stuart 1976, Nel and Loutit 1986; Avery *et al.* 1987) and mammalian prey, comprising wild ungulates (Bothma 1971b, Rowe-Rowe 1976), rodents (Rowe-Rowe 1982), domestic livestock (Bothma 1971b, Rowe-Rowe 1975, 1976) and even seals (Nel and Loutit 1986, Hiscocks and Perrin 1987).

The relative percentage of these prey items in the diet of black-backed jackal depends largely on prey abundance, habitat and climatic conditions at any given time.

The behaviour exhibited by black-backed jackal when foraging is described by Ferguson (1980), who observed individual animals in the Kalahari Gemsbok National Park. The author found black-backed jackal to predominantly make use of their keen senses of smell and hearing in locating insects, rodents, birds and carrion. Furthermore, the author discovered that when two or more jackals participated in hunting relatively larger prey items such as springhare (*Pedetes capensis*) and springbok (*Antidorcas marsupialis*), the overall hunting success improved. A similar phenomenon was reported by Lamprecht (1978), who found that black-backed jackal improved their overall success rate when animals combined their skills in hunting large prey such as Thomson's gazelle (*Gazella thomsonii*).

The characteristic killing and feeding technique of black-backed jackal has been described for livestock by Rowe-Rowe (1983b, 1986), in an attempt to avoid the mis-identification of predators responsible for stock losses, by farmers. The black-backed jackal typically kills livestock such as sheep and goats by biting the windpipe and suffocating its prey. The carcass is then opened on the flank between the hip and the ribs, with the kidneys, heart, liver and a small portion of muscle usually being consumed in a neat fashion.

Apart from work conducted in Tanzania by Moehlman (1978), research on the social behaviour, habits and homerange characteristics of the black-backed jackal, has been concentrated in Southern Africa.

Bothma (1971c), undertook the first mark-recapture experiment on black-backed jackal, in order to learn more about the movement patterns of the species in the Western Transvaal. The author reported that juvenile black-backed jackal, under the age of three months, show very little movement away from the den area, whereas sub-adult and adult animals were reported to cover distances of up to 103 km from the point of tagging. The author thus concluded that in certain instances, a single animal may well be responsible for stock losses over an extensive area.

Homerange sizes for mated black-backed jackal pairs reportedly vary from 1.3 km^2 (Ferguson *et al.* 1983), to 841 km^2 in size (Ferguson 1980), although the average homerange size varies from approximately 18 km^2 (Rowe-Rowe 1982) to 25 km^2 (Hiscocks and Perrin 1988). Sub-adults and unmated adults generally have larger homeranges than mated pairs (Rowe-Rowe 1982, Ferguson *et al.* 1983), whereas immature black-backed jackal pups have much smaller homeranges and usually live within the homerange of a mated pair (Ferguson 1980).

The black-backed jackal is described as a social species, with adult animals forming long-term pair bonds (Moehlman 1978, Ferguson 1980, Skinner and Smithers 1990). Mated black-backed jackal pairs are territorial, with little or no overlap occurring amongst pairs (Ferguson 1980, Rowe-Rowe 1982). Where food and water resources are clumped and surrounded by habitat homogeneity however, as is the case along the Namibian coastline, exclusive territoriality amongst mated pairs may often become non-existent (Ferguson *et al.* 1983, Hiscocks and Perrin 1988).

Black-backed jackal density is extremely variable, depending primarily on food availability (Rowe-Rowe 1984). Recorded densities range from one animal per 2.5-2.9 km^2 in Giant's Castle Game Reserve (Rowe-Rowe 1984), to as high as twenty-two animals per one km^2 around seal colonies along the Namibian coast (Hiscocks and Perrin 1988).

The black-backed jackal is predominantly a nocturnal animal in areas where it is persecuted (Ferguson 1980). In remote regions however, it is often active throughout the day, with pronounced activity peaks around 08h00 and 19h00 (Ferguson 1980, Hiscocks and Perrin 1988). Ferguson (1980), further reports black-backed jackal to show a third, albeit less intensive activity peak, during the hours immediately after sunrise.

Fairall (1968) and Rowe-Rowe (1978), reported black-backed jackal births to peak during July to October in the Kruger National Park and Drakensberg respectively. A similar peak in black-backed jackal births in the Cape Province, was reported by Bernard and Stuart (1992). Sexual maturity is usually reached at the age of three years (Ferguson 1980; Rowe-Rowe 1982), with an average of four to five pups being born per litter. Rowe-Rowe (1986), found however, that pup survival is directly dependent on food availability, with an average of two pups surviving to maturity. Young animals are usually weaned at 12 - 14 weeks of age, after which they accompany the adults in search of food (Ferguson 1980). Young animals usually remain in the vicinity of their den for up to six months, whereafter they either remain as helpers to the adults, or disperse to establish their own territories (Skinner and Smithers 1990).

The age group structure of the black-backed jackal population in the Giant's Castle Game Reserve was recorded by Rowe-Rowe (1984). The population consisted of 25% mated adult pairs, 25% young of the year and 50% sub-adults and unmated individual adults. The author further calculated the sex ratio for the black-backed jackal in the Natal Drakensberg, to be close to parity.

Lombard (1971), using tooth wear, cementum annuli, eye lens mass, baculum length and mass and body/cranial measurements from known-age animals, developed an ageing system for the black-backed jackal, consisting of six age classes.

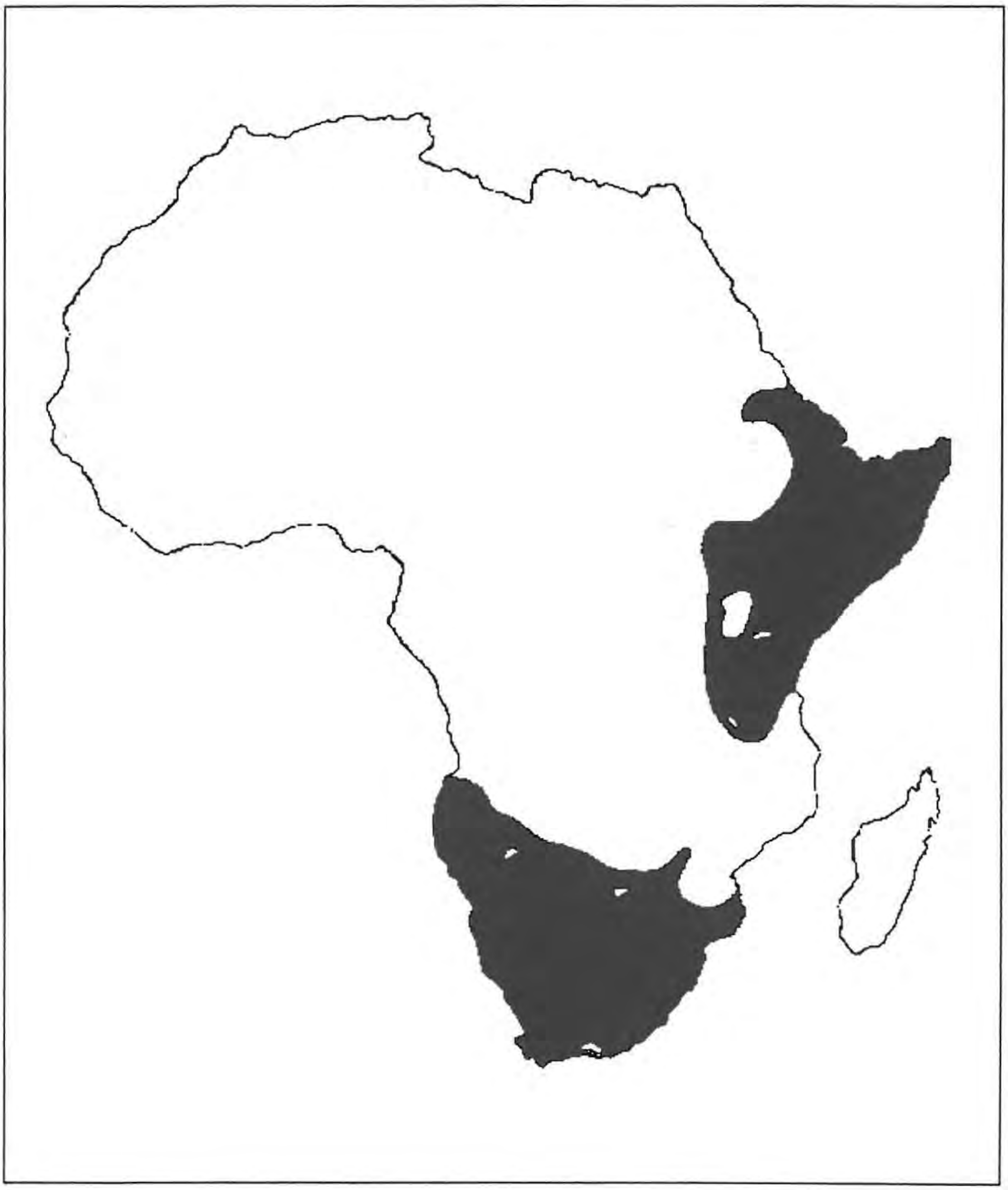

Figure 1.1. The distribution of *Canis mesomelas* in Africa (Skinner and Smithers 1990).

1.2. *FELIS CARACAL*

The caracal, although not as extensively studied as the black-backed jackal, has received growing attention locally, since the early 1980's. Apart from early observational records (Pocock 1939, Williams 1967, Smithers 1971), this predator received scant attention locally, until Stuart (1977), published a report on the carnivores of the Cape Province. Since then, many aspects of caracal ecology have been studied, primarily as a result of depredation amongst livestock. The majority of data on this species, in fact, emanates from livestock farming areas of the Eastern, Western and Northern Cape.

The caracal is one of seven felids which occurs in Southern Africa (Skinner and Smithers 1990) and is by far the most common and widespread of these species, being found throughout the country (Stuart 1977, 1982, Stuart *et al.* 1985). Apart from South Africa, the caracal is known to occur throughout most of the African continent (Stuart 1984), (Fig. 1.2), and as far afield as Saudi Arabia, the Middle East and the Indian sub-continent (Harrison 1968, Prater 1965, Seshadri 1969, Stuart 1982). Although the caracal is common and a declared problem species in South Africa, it is considered to be rare and/or endangered throughout the non-African sector of its distributional range (Stuart 1982).

Similarly to the black-backed jackal, the caracal has a very wide habitat tolerance, occurring in savannah woodland (Skinner and Smithers 1990), coastal sandveld (Stuart 1982) and montane grassland (Pringle and Pringle 1979), although preferring the arid to semi-arid karroid regions of Southern Africa (Skinner and Smithers 1990). Some confusion seems to exist as to whether the species occurs in the forested regions of the sub-continent. Skinner and Smithers (1990) claim that the caracal is absent from the forest biomes, while Grobler *et al.* (1984) and Rowe-Rowe (1992), claim that this predator is in fact found in both natural forests and commercial plantations within South Africa.

The caracal is a predominantly solitary, nocturnal animal, although small family groups consisting of a mother and her kittens may sometimes be encountered during daylight hours (Skinner and Smithers 1990). As opposed to the black-backed jackal, caracal do not form long term pair bonds and males take no part in rearing the young. Breeding can occur throughout the year, although there is a peak in births during summer (Bernard and Stuart 1987, Grobler 1986, Rowe-Rowe 1992, Stuart 1982). Gestation lasts approximately 80 days (Bernard and Stuart 1987), with the typical litter size in the wild being given as one to three kittens (Bernard and Stuart 1987, Stuart 1982). Adult animals exhibit distinct sexual dimorphism, with males generally being larger than females in terms of body and cranial measurements (Stuart and Stuart 1992).

The recorded homeranges of male caracal are usually larger than those of female animals and often also overlap a number of female territories (Skinner and Smithers 1990). The recorded homerange size for male caracal varies from approximately 5 km^2 in the Cradock district (Moolman 1986), to between 48 km^2 (Stuart 1982) and 65 km^2 (Norton and Lawson 1985), for the Western Cape. Female homeranges are recorded as varying from slightly less than 4km^2 (Moolman 1986), to approximately 27 km^2 (Stuart 1982).

The diet of caracal is not as varied as that of black-backed jackal, with this predator living predominantly off small and medium-sized mammals (Skinner and Smithers 1990). Caracal have also been recorded taking arthropods (Palmer and Fairall 1988), birds (Stuart 1982) and carrion (Rowe-Rowe 1976). Larger prey items, such as livestock and various antelope species, are killed with a bite to the throat or the nape of the neck, after a careful stalk and powerful rush (Grobler 1986). The caracal is therefore described as an opportunistic hunter-killer.

Figure 1.2. The distribution of *Felis caracal* in Africa (Skinner and Smithers 1990).

Summary

A number of important points emerge from the aforementioned studies. Firstly, apart from the gut analyses of five black-backed jackal shot in the Addo Elephant National Park (Hall-Martin and Botha 1980), nothing is known about the feeding behaviour and overall ecology of this predator in the Eastern Cape. Similarly, although the dietary composition and movement patterns of the caracal have been described for the semi arid Karoo (Moolman 1986) and Bedford district (Pringle and Pringle 1979), nothing is known about the feeding habits of this species in the well-watered and livestock farming areas of the Eastern Cape coastal plain.

Secondly, it is apparent from the literature that the black-backed jackal and to a lesser extent the caracal, are extremely adaptable and opportunistic in dietary terms. This phenomenon appears to be largely influenced by relative prey abundance. Individuals of both species, culled within reserves, have been shown to feed predominantly on rodents, rock hyraxes, insects, carrion and wild ungulates (Grafton 1965, Grobler 1981), whereas animals culled in agricultural areas tend to have a larger proportion of livestock in their diets (Rowe-Rowe 1975, Roberts 1986). This is however, by no means a reliable generalization. Rodents, for example, were found by Bothma (1971a,b), to be a major prey item for black-backed jackal in agricultural areas, whereas Rowe-Rowe (1982), found rodents to be of importance only in reserve areas. Furthermore, certain individual animals, or groups within the population, may take to stock killing in areas previously unaffected by predators, as suggested for caracal by Pringle and Pringle (1979). No information exists locally however, as to whether confirmed livestock killers are predominantly of any sex, or whether any seasonal changes occur in their diets.

The third important point to note is that no information has been documented as to the efficiency and effectiveness of the control measures in use in the Eastern Cape, in eliminating specific problem animals.

On the one hand therefore, farmers in the Eastern Cape claim that black-backed jackal and caracal are responsible for major losses of livestock and commercial game species such as bushbuck (*Tragelephus scriptus*) and blue duiker (*Philantomba monticola*). On the other hand, local conservation authorities argue that these accusations are often exaggerated, or if true, that the numbers of these predators are sufficiently low, so as to preclude them from causing any significant damage.

The present study was therefore initiated, primarily to determine the dietary composition of so-called 'problem animals', culled in predator control operations in the region. Data on confirmed stock killers, when found, were also analyzed in order to determine whether these individuals were of a particular sex or age class. Secondary objectives were to determine the seasonality (if any) of prey items in the diet of black-backed jackal and caracal and the movement patterns and size of caracal homeranges. Finally, data on hunt returns were analyzed in order to evaluate the effectiveness of hound packs in the region, in eliminating problem animals. The overriding emphasis of the present study therefore, was to find local answers to local questions, thus better enabling authorities to make informed decisions on the management of these species.

CHAPTER TWO

STUDY AREA

The Eastern Cape is the second largest province in South Africa, covering approximately 167 200 km^2, or roughly 14% of the total area of the country (Anon. 1994).

Lying on the south eastern coast of the African continent, the Eastern Cape is bounded by the Indian Ocean in the east, the Umtamvuna River in the north, with the Grootswartberg and Sneeuberg Mountains forming the western most extremity of the province (Fig. 2.1).

Physically, the Eastern Cape can be divided into four zones, consisting of a coastal region, the midlands, a belt of folded mountains to the west of Port Elizabeth and the escarpment or plateau edge (Fig. 2.2) (Nicol 1988). Altitude ranges from sea level, to over 3 000m in the southern extension of the Drakensberg (Nicol 1988).

Geologically, the Eastern Cape comprises five rock formations, namely, the Gamtoos and Alexandria Formations, the Cape Supergroup, the Uitenhage Group and the Karoo Sequence. Common rock types include shale, limestone, dolerite, sandstone and mudstone (Rust 1988).

The Eastern Cape contains four major river systems, namely the Mbashe River, the Great Kei River, the Great Fish River and the Sundays River (Fig. 2.1).

Using the modified Koppen system, with rainfall and temperature being the two most important selection criteria, the Eastern Cape can be divided into seven distinct climatic zones (Kopke 1988). A brief synopsis of this classification system reveals that the Eastern Cape has a subtropical coastline which experiences both mild summers and winters and a semi-arid interior which experiences cold winters and hot summers (Kopke 1988, Lubke *et el.* 1988a). Temperatures range from below 0°C in the interior during winter months, to average summer temperatures of between 28 and 30°C along the coast (Lubke *et al.* 1988a).

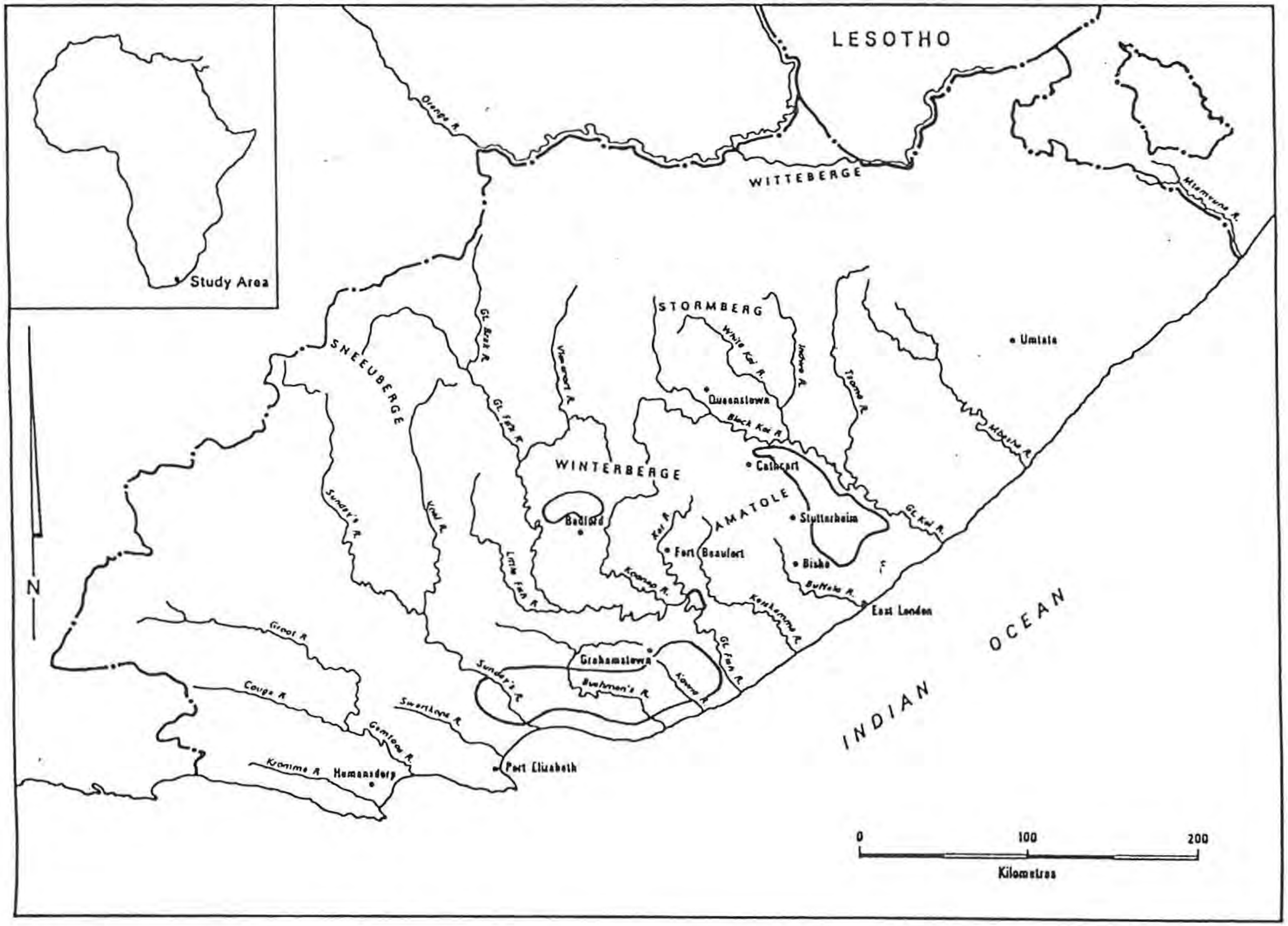

Figure 2.1. The Eastern Cape, illustrating study areas □, physical boundries and major centres.

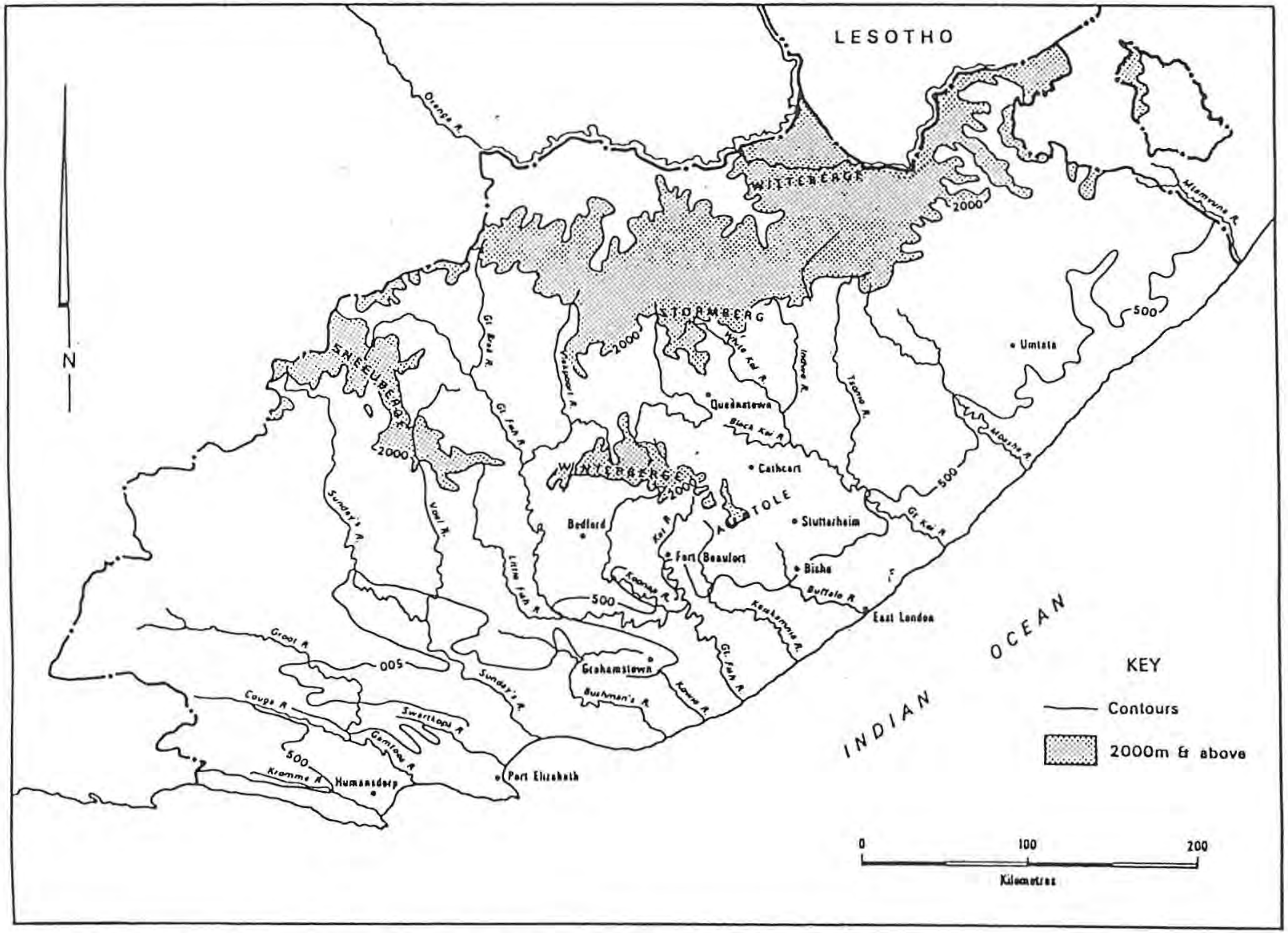

Figure 2.2. The Eastern Cape, illustrating the coastal plain, midlands and major mountain ranges.

Annual rainfall varies from over 1 500mm per anum in the Amatola Mountains, to an average of between 500 and 700mm per anum over most of the semi-arid interior (Fig. 2.3). Peak rainfall shifts from the winter months for the coastal areas around Port Elizabeth, to a summer peak east of the Winterberg Mountains (Lubke *et al.* 1988a). The area lying between these summer and winter rainfall zones and nearest the coast, receives peak precipitation in the spring, while the interior, south of the Winterberg Mountains, receives peak autumn rainfall (Kopke 1988). Furthermore, rainfall decreases in frequency and dependability as one moves from east to west, with drought occurring at an ever-increasing frequency.

The Eastern Cape supports a wide variety of vertebrate species, both in farmland and nature reserves (Long 1982, Lubke *et al.* 1988a, Skinner and Smithers 1990), containing approximately 44% of the terrestrial mammal species recorded in South Africa (Swanepoel 1988).

The vegetation of the Eastern Cape is described by Lubke *et al.* (1988b), as being extremely diverse and phytogeographically complex. All the major vegetation types of South Africa are represented in the region and include savanna, fynbos, forest, karoo and thicket.

Fynbos is restricted to the western part of the region, being confined predominantly to mountainous areas. In the drier interior, karroid vegetation predominates and has, in fact, invaded large areas of previous grassland, due largely, to overgrazing (Lubke *et al.* 1988b). Subtropical thicket occurs over most of the Eastern Cape, extending down the coast and penetrating up river valleys (Lubke *et al.* 1988b). The afromontane forests and grasslands which occur in the region, are restricted to areas of higher altitude and rainfall, while large tracts of coastline are vegetated with coastal forest (Lubke *et al.* 1988a).

The Eastern Cape therefore, can be described as a transition zone between the Cape Flora and the Subtropical Flora, wherein the major vegetation biomes meet and overlap (Lubke *et al.* 1988b).

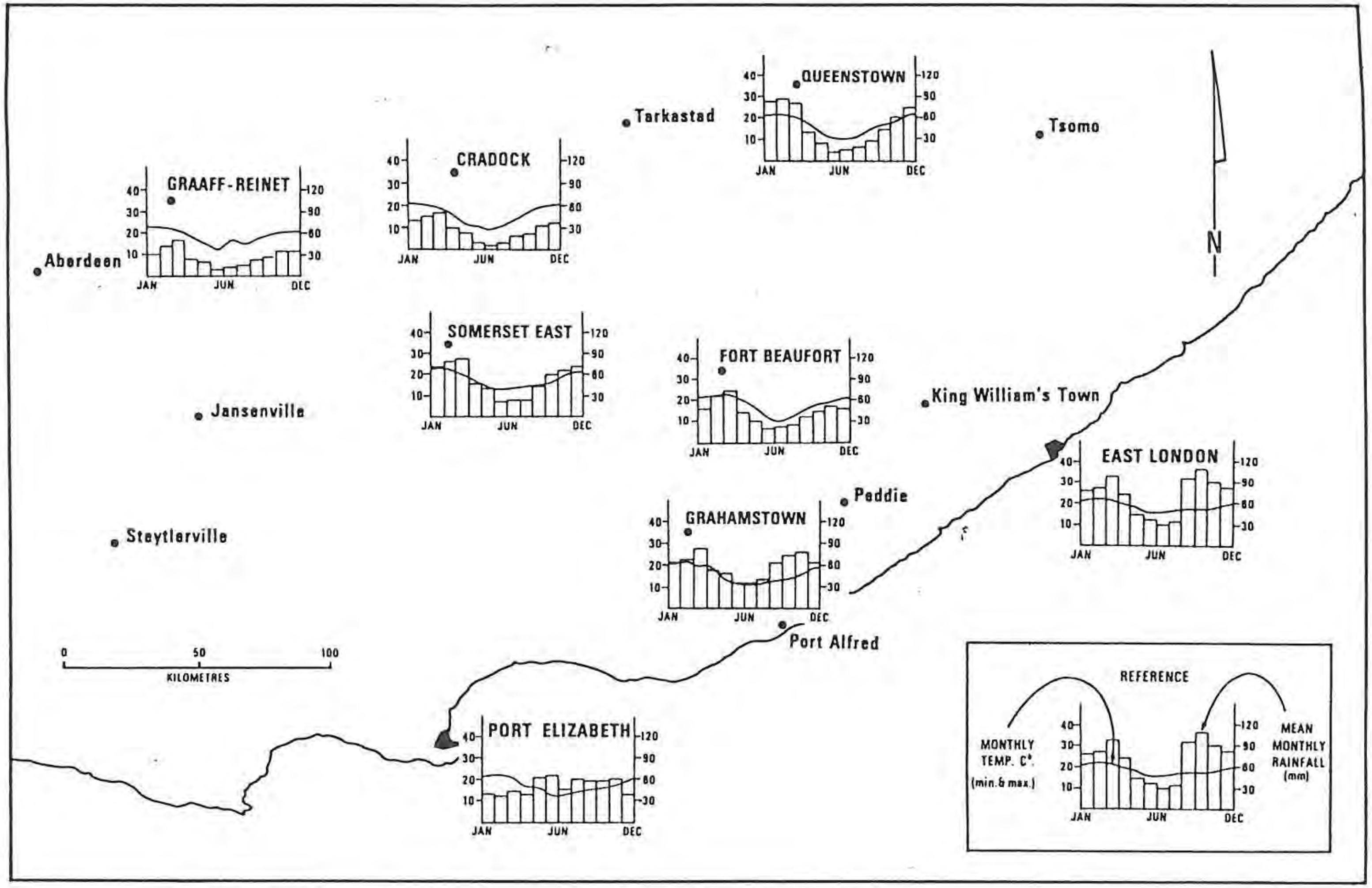

Figure 2.3. Temperature and rainfall data for selected localities in the Eastern Cape (with permission, Lubke et al. 1988a).

The primary agricultural pursuit in the Eastern Cape is extensive livestock farming, with the predominant animal products being wool, mohair and red meat (Roux and Van Der Vyver 1988). In 1988 the angora goat industry had its nucleus in the Eastern Cape, comprising 80% of the national industry.

Although nutrition has been shown to be the major limiting factor in livestock production in the region, there were an estimated eight million small stock units in the Eastern Cape (excluding the former homelands) during the 1976 agricultural survey (Roux and Van Der Vyver 1988). The areas of highest stocking density occurred in the Border, Albany and Bedford sub-regions, with the average small stock unit per hectare being 2.2, 1.6 and 1.8 respectively (Roux and Van Der Vyver 1988).

The primary crops which are produced in the region include maize, wheat, pineapples, chicory and oranges (Roux and Van Der Vyver 1988). Crop production however, is limited largely by an overall low soil fertility in the region, high pH values, raised salinity, low infiltration rates and subsequent high run-off rates.

In recent years, the utilization of certain game species for trophy hunting, the venison market and gameviewing/ecotourism, has increased. Between 30 and 33 species are now available for hunting purposes, on approximately 500 000 - 800 000 hectares of state and private land (Le Roux, *pers. comm.*). The total value of the game industry in the Eastern Cape, including hunting, game sales and ecotourism, is estimated at millions of rands annually (Le Roux, Pieterse, *pers. comm.*), although exact figures are not available, due to a lack of communication and transparency within the industry.

As both the black-backed jackal and the caracal are known to prey on small antelope and the young of larger antelope species (Skinner and Smithers 1990), conflict often arises when game farmers perceive these predators to be preying on potentially valuable assets.

Data for this project were collected from four regions within the Eastern Cape, namely:

1) The area between the Great Kei and Nahoon Rivers, commonly referred to as the Border Region.
2) The Double Drift/Andries Vosloo Reserve Complex.
3) The Albany Region, situated east of Grahamstown and lying between the Great Fish and Bushmans Rivers.
4) The Bedford district and adjacent Winterberg Mountains.

The Border Region consists primarily of grassland/thornveld, with valley bushveld/subtropical thicket occurring in the river valleys.

The Double Drift/Andries Vosloo Kudu Reserve Complex is situated along the Great Fish River, with valley bushveld being the predominant vegetation type.

The Albany region consists primarily of valley bushveld, coastal forest and grassland (Long 1982).

The Bedford Region is a mountainous area, although plains occur to the south of the town itself. The area is classified as bushveld/mixed grassveld (Stuart 1982).

Summary

Although a detailed description of the physical and climatic characteristics of the Eastern Cape falls beyond the parameters of this study, the extreme natural variation which occurs within the region, has hopefully been illustrated. It is this unpredictability and low natural fertility which limits the agricultural potential of the region. These factors, combined with the ever-increasing profits which are being made from the wildlife industry, greatly contribute to the conflict between man and predator in the Eastern Cape.

CHAPTER THREE
CARACAL DIET

3.1. INTRODUCTION

As it is considered to be one of the species responsible for major stock losses in farming areas, the caracal (*Felis caracal*) is hunted throughout most of South Africa. Studies conducted in the Eastern and Western Cape on the diet of caracal, have reported the frequency of occurrence of livestock in the diet to range from 16.8% (Stuart and Hickman 1991), and 23% (Moolman 1986), to as much as 68% (Pringle and Pringle 1979).

The primary means of caracal control in the Eastern Cape, remains the use of hound packs, which locally, kill an estimated 200 to 300 of these predators every year (*pers. obs.*). It is the scale of this extermination which prompted local Nature Conservation authorities to seek further information relevant to the conflict between farmers and caracal.

Prior to the present study, only Stuart and Hickman (1991), have commented on the occurrence of seasonal trends in the diet of caracal, while no information exists on the possible influence that sex or age of individual animals may have on the diet. It was considered quite conceivable that increased energetic requirements, due to reproductive demands or the displacement of old or young animals by territorial individuals, would be manifested in the diets of certain sections of the caracal population. Such manifestations, it was felt, would enable authorities to suggest alternative measures to the year-round extermination presently practised, such as heightened control during specific seasons. It was felt that such measures would serve the dual purpose of targeting specific problem animals, or sections of the population most likely to cause harm, at a time when these measures would be most effective, as well as causing minimum ecological impact.

Furthermore, by asking hunt club owners for data pertaining to their perceptions of supposed problem animals, it was hoped that some light would be shed on the extent of the knowledge these landowners had about caracal and their ability to correctly identify specific problem, or non-problem animals.

3.2. MATERIALS AND METHODS

Stomach samples were obtained using a variety of collection procedures, the primary method being the use of hound packs. Additional methods included the capture of animals in cage traps and the occasional shooting of individual animals.

A number of problem animal control clubs (hereafter referred to as hunt clubs), were approached for assistance in the collection of stomach samples, in the Albany, Bedford and Border regions (Fig. 3.1). Potential hunt clubs were initially identified by the Algoa Regional Services Council, based on previous experience and expertise. Thereafter, the final selection of hunt clubs was based on the accessibility of said clubs and the willingness of club members to participate in the project.

The owners of selected hound packs were each supplied with numbered plastic jars containing a 4% formalin solution, numbered tags for the jaws of killed animals and data sheets on which to record the following information:

1) Species (Black-backed jackal or caracal)
2) Sex
3) Date
4) Locality
5) Approximate age of animal (kitten/pup, adult, old)
6) Reproductive status if female
7) Suspected livestock killer, or unsure (comments welcome)

The whole stomachs of animals killed during control operations were placed in jars, while the skulls of individuals were cleaned of flesh and labelled with corresponding tags. Samples were collected from hunt clubs on a routine basis and subsequently refrigerated until analysis.

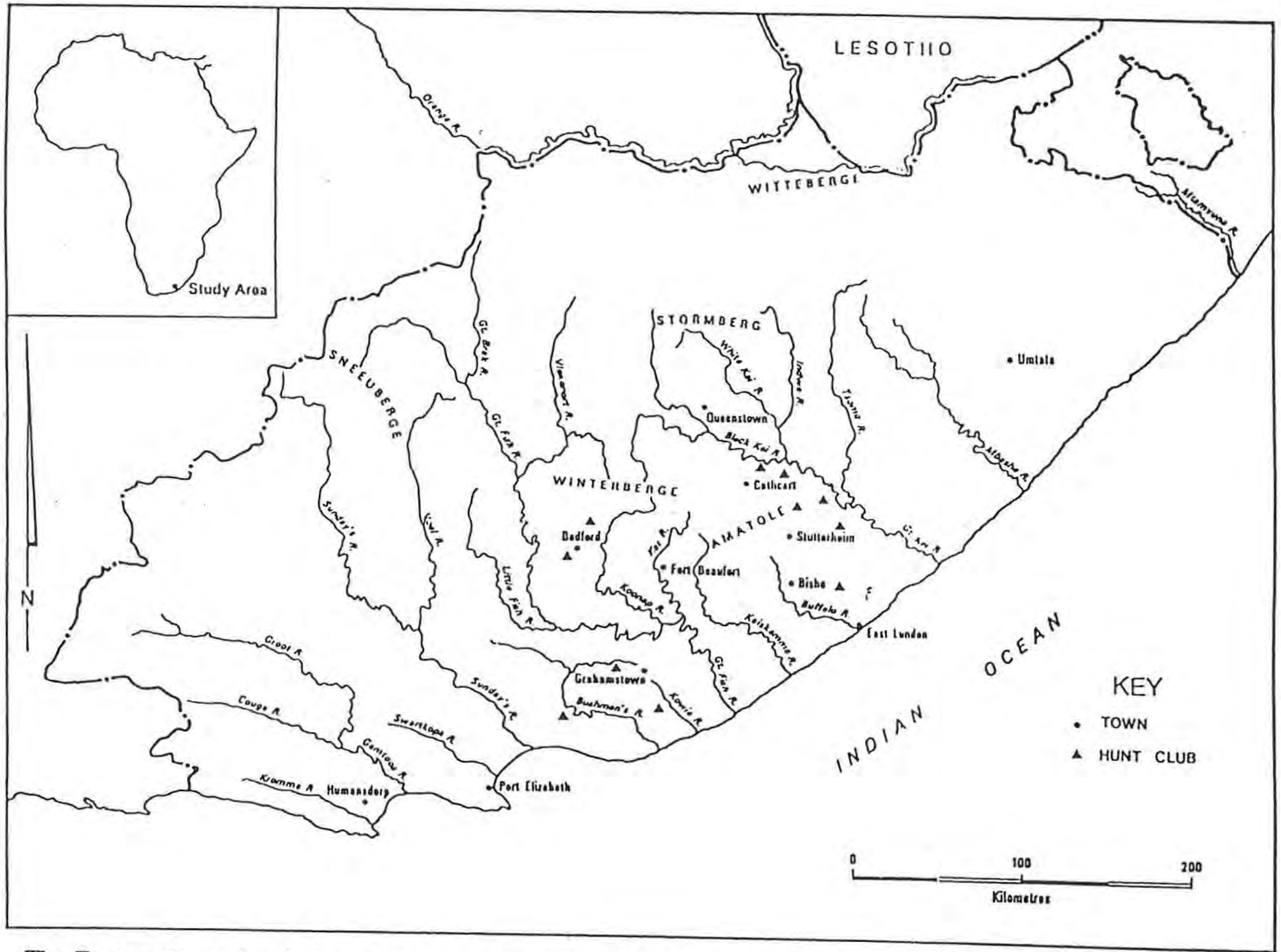

Figure 3.1. The Eastern Cape showing the location of hunt clubs in the study area.

In the laboratory, samples were examined, following the procedure described by Bothma (1966, 1971b), Grafton (1965) and Rowe-Rowe (1976).

The stomach was removed from the collecting jar and any excess formalin was washed off with running water. The stomach was then cut open, the approximate fullness (%) of the stomach recorded and the contents removed. The contents were then placed in a shallow tray and divided into separate animal, plant and non-food components. The volume of these individual components was then determined by water displacement. Items were recorded both in terms of volume and frequency of occurrence in the diet (Bothma 1971b, Hyslop 1980).

Carrion was identified by the presence of fly larvae and maggots (Putman 1983) and/or by the putrid condition of the meat (Bothma 1971b, Grafton 1965), which was identified by the 'liquefaction' of tissue (Putman 1983). Non-food items were considered to be those ingested unintentionally, such as grit (Bothma 1971b), and were not considered in the final dietary analysis. Any vegetable matter was considered to be a food item (Bothma 1966). Items which had a percentage volume, or a frequency of occurrence of less than 0.5%, were listed as trace components (Bothma 1971b).

Medium and large-sized vertebrate prey was identified by constructing cross-sectional profiles of body hairs (Douglas 1989). Hairs were removed from the examination tray, rinsed in 70% alcohol and allowed to dry on filter paper. Lengths of plastic tubing, with a 4mm internal diameter, were cut and sealed at one end. Approximately 10 to 20 hairs were then placed in the tube and molten candle wax was poured to the brim. After cooling, the tube was inserted through a hole in a metal dissecting stand and cross-sections were cut with a hand-held razor blade. The cross-sections were then placed on a microscope slide and examined under a dissecting microscope. Hair samples were positively identified by comparing cross-sections to a comprehensive reference collection compiled by the author from known samples (Fig. 3.2). All cross-sections were numbered and stored for re-examination.

Due to their small diameter and fine structure, cross-sections could not be cut of rodent hair (excluding springhare, *Pedetes capensis*). Rodents were identified, using characteristic

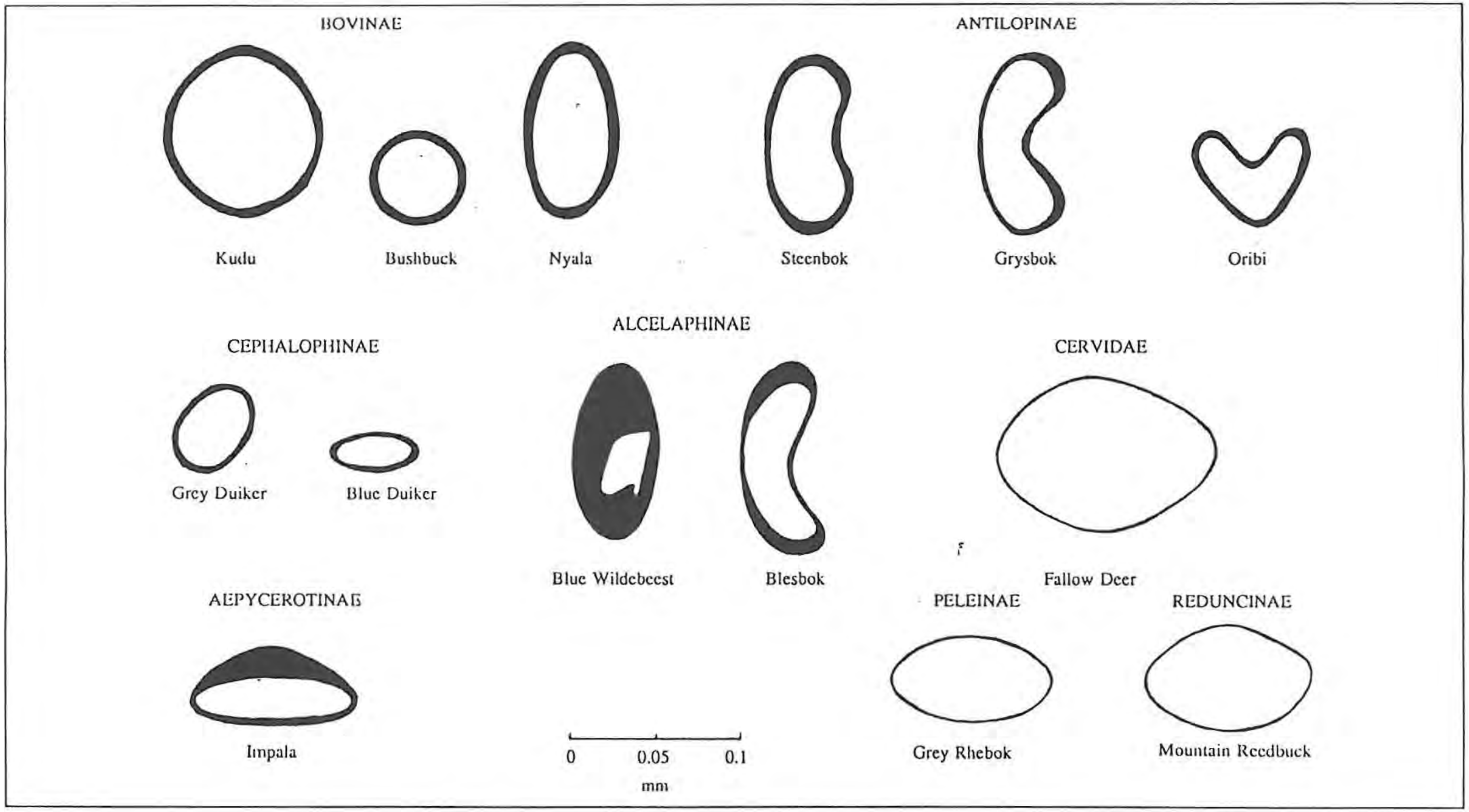

Figure 3.2. Cross sections of the hair of various antelope species occurring within the study area.

indicators, such as colour and pattern of body fur, teeth and various body parts which occurred in the stomach sample.

Lagomorphs were identified using hair cross-sections and/or hair colour, as were rock hyrax (*Procavia capensis*).

In addition to cross-sections of hair, vertebrate prey items were further identified by comparing ingested body parts, such as feet, ears and bone fragments, with samples in the Albany Museum collection.

Hair colour (Rowe-Rowe 1983a, Skinner and Smithers 1990), hair length (Keogh 1983) and hair thickness (Douglas 1989), were also used in identifying mammalian prey items.

Where possible, individual caracal were assigned to age classes by using tooth eruption patterns and cranial measurements, as the absence of whole carcasses precluded the use of body measurements and mass as ageing criteria. Due to skull damage, caused when the individual animals were killed, only four common cranial measurements were used, namely total length (TL), zygomatic width (ZW), width at bullae (BW) and jaw length (JL) (Stuart 1982) (Appendix I).

Caracal were assigned to one of three age classes, ranging from birth to ten months of age (hereafter referred to as young caracal), from ten months to two and a half years of age (hereafter referred to as adult caracal) and from two and a half years and older (hereafter referred to as old caracal). As no quantitative data are available (Stuart 1982), female caracal older than ten months of age, were subjectively assigned to an age class (either adult or old), making use of tooth wear characteristics and hunters' comments. Samples not accompanied by a skull or a data sheet, were not assigned to an age class.

For the purpose of seasonality, caracal were assigned to either 'summer' or 'winter' categories, with 'summer' consisting of the six warmest and wettest months (October-March) and winter consisting of the six coldest and driest months in the Eastern Cape (April-September) (Stone 1988).

The accuracy of farmers' predictions, regarding the status of any given caracal (stock-killer or non stock-killer), was tested in terms of whether the prediction was manifested in the stomach contents examined. If a farmer labelled a specific animal as a stock killer and no livestock was found in the stomach, the farmer was considered to have been mistaken and *vice versa.*

Where sample sizes were sufficiently large (Freund 1981, Radloff *pers. comm.*), statistical analyses in the form of Chi-square tests were done on various data sets. Due to relatively small sample sizes in some categories however, many results could only be described qualitatively.

3.3. RESULTS

No caracal samples were obtained from the Double Drift Game Reserve, thus precluding any comparative analysis between the diets of animals killed in farmland and those killed in a reserve.

A total of 79 stomach samples were obtained from caracal killed by hound packs in predator control operations. A total of 40 male and 39 female samples were examined, of which ten stomachs were found to be empty, representing 12.6% of the total sample.

In terms of age classes, the caracal sampled consisted of 16 young, 35 adult and 13 old animals, while five animals were of unknown age. The ten empty stomachs came from three young animals, four adult and three old animals.

3.3.1. General diet

A total of 14 196ml of stomach contents were examined from 69 stomachs (Table 3.1). The four major dietary components, in terms of percentage of total volume (PTV) and percentage of total occurrence (PTO), were wild artiodactyls (33.8% PTV; 23.8% PTO), domestic livestock (19.2% PTV; 16.3% PTO), rock hyraxes (*Procavia capensis*) (21.2% PTV; 16.3% PTO) and lagomorphs (10.8% PTV; 8.7% PTO). The remaining dietary items consisted of wild birds, smaller carnivores, a single occurrence of vervet monkey (*Cercopithecus aethiops*), carrion, plant remains and various unidentified items (Table 3.1).

Table 3.1. Prey species of *Felis caracal* as determined by stomach content analysis (n = 69).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME (ml)	PTV	OCCURRENCE	PTO
Antelope	**4 795**	**33.8**	**19**	**23.75**
Tragelaphus scriptus	1 880	13.2	10	12.50
Tragelaphus angasii	480	3.4	1	1.25
Redunca fulvorufula	840	5.9	2	2.50
Sylvicapra grimmia	125	0.9	2	2.50
Philantomba monticola	750	5.3	1	1.25
Pelea capreolus	410	2.9	1	1.25
unidentified	310	2.2	2	2.50
Livestock	**2 723**	**19.2**	**13**	**16.25**
Hyrax *Procavia capensis*	**3 005**	**21.2**	**13**	**16.25**
Rodents	**840**	**5.9**	**5**	**6.25**
Pedetes capensis	670	4.7	3	3.75
Rhabdomys pumilio	20	trace	1	1.25
Aethomys namaquensis	150	1.1	1	1.25
Lagomorphs	**1 540**	**10.8**	**7**	**8.72**
Carnivora	**380**	**2.7**	**2**	2.50
Ictonyx striatus	360	2.5	1	1.25
Vulpes chama	20	trace	1	1.25
Aves	**45**	**trace**	**2**	**2.50**
Primate	**110**	**0.8**	**1**	**1.25**
Carrion	**280**	**2.0**	**1**	**1.25**
Plants	**152**	**1.1**	**9**	**11.25**
Unidentified	326	**2.3**	**8**	**10.00**
TOTAL	14 196	100.0	80	100.00

The wild artiodactyl component of the caracal diet comprised six species, with bushbuck (*Tragelaphus scriptus*), being the most abundant, both in terms of PTV and PTO (Table 3.1). The next most abundant ungulate in the diet of caracal was mountain reedbuck (*Redunca fulvorufula*), followed by blue duiker (*Philantomba monticola*), nyala (*Tragelaphus angasii*), grey rhebuck (*Pelea capreolus*) and grey duiker (*Sylvicapra grimmia*).

Rock hyrax (*Procavia capensis*) was found to be the most abundant medium-sized mammal in the diet of caracal (21.2% PTV; 16.3% PTO), followed by lagomorphs (10.8% PTV; 8.7% PTO).

Of the five rodent occurrences the majority were springhare (*Pedetes capensis*) with only two occurrences of small rodents recorded, one *Aethomys namaquensis* and one *Rhabdomys pumilio*.

Carnivore remains occurred in two stomachs, and consisted of striped polecat (*Ictonyx striatus*) and Cape fox (*Vulpes chama*). Although caracal hairs were found in a number of stomachs, the small amount of hairs present and the absence of muscle tissue or bone fragments, led to the conclusion that this phenomenon was due to grooming and not cannibalism, as reported by Stuart (1982).

Avian remains, namely feathers, were discovered in two stomachs and were identified by Professor Adrian Craig of Rhodes University, as belonging to wild species. Due to the absence of further evidence however, these remains could not be identified beyond this level.

Carrion was found in only one stomach and consisted of well digested muscle tissue and fly larvae. The colour and length of hairs present in this sample identified the carrion as originating from a wild ungulate. The species was not identified.

Plant material, although occurring in 11.3% of all samples, constituted very little by way of PTV (Table 3.1) and consisted primarily of grass and leaves.

3.3.2. Stomach fullness

There was no significant difference between the number of male and female caracal which had stomachs 80 - 100% full ($\chi^2 = 0.72$; df = 1; $p > 0.05$), 50 - 79% full ($\chi^2 = 0.01$; df = 1; $p > 0.05$), or 0 - 49% full ($\chi^2 = 1.28$; df = 1; $p > 0.05$).

The majority (56%), of stomachs examined were between 80 - 100% full, while thirty-five percent of stomachs examined, including ten empty stomachs, were less than 50% full. The remaining stomachs were between 50% and 80% full.

3.3.3. Data sheet responses

A total of 57 data sheets were returned and the responses received from the various hunt club owners are summarized in Table 3.2 below.

Table 3.2. The summarized responses of hunt club members to the question, "was the animal killed a known stock-killer?" (n = 57).

	Correct	Incorrect	Empty	Total
Answer "YES"	6	12	4	22
Answer "NO"	28	3	4	35
Total	34	15	8	57

Six farmers were correct in identifying stock killers, while twelve were incorrect. On the other hand, 28 farmers were correct in identifying non stock-killers and 3 were proven incorrect. In total, 34 correct identifications were made, 15 caracal were incorrectly identified and eight stomachs for which there were data sheets were empty.

3.3.4. Seasonal changes in caracal diet

A total of 22 summer samples (Table 3.3) and 47 winter samples (Table 3.4) were examined. The ten empty stomachs comprised three summer samples and seven winter samples.

Table 3.3. Prey species of *Felis caracal* for summer, as determined by stomach content analysis (n = 22; 12 males, 10 females).

PTV = Percentage Total Volume
PTO = Occurrence of an item as a percentage of the total occurrence of all food items

PREY	VOLUME(ml) [PTV]			OCCURRENCE [PTO]		
	Male	Female	Total	Male	Female	Total
Antelope	630 [18.9]	120 [9.3]	750 [16.2]	5 [27.9]	1 [11.2]	6 [22.2]
Hyrax	995 [29.8]	950 [73.8]	1 945 [42.0]	4 [22.2]	3 [33.2]	7 [25.9]
Rodents	210 [6.3]	-	210 [4.5]	2 [11.1]	-	2 [7.4]
Livestock	840 [25.1]	83 [6.4]	923 [19.9]	3 [16.7]	2 [22.2]	5 [18.6]
Lagomorph	640 [19.2]	120 [9.3]	760 [16.4]	2 [11.1]	1 [11.2]	3 [11.1]
Carnivora	20 [0.6]	-	20 [trace]	1 [5.5]	-	1 [3.7]
Aves	-	-	-	-	-	-
Primate	-	-	-	-	-	-
Carrion	-	-	-	-	-	-
Plant	5 [trace]	15 [1.2]	20 [trace]	1 [5.5]	2 [22.2]	3 [11.1]
Unidentified	-	-	-	-	-	-
Total	3 340	1 288	4 628	18	9	27

Rock hyraxes comprised the most abundant food item in the combined diets of both sexes in summer, both in terms of PTV (42.0%) and PTO (25.9%) (Table 3.3). Wild ungulates and domestic livestock were the next most abundant prey items, with ungulates occurring in more samples than livestock, although livestock comprised a larger proportion of the summer diet in terms of PTV (Table 3.3).

The combined winter diet (Table 3.4) of both sexes exhibits a marked change in prey composition from that of the combined summer diet, with wild ungulates forming a significantly greater proportion of the caracal winter diet, in terms of PTV ($\chi^2 = 11.58$; df = 1; $p < 0.01$), although there was no significant difference in the PTO of ungulate in winter and summer ($\chi^2 = 0.07$; df = 1; $p > 0.05$).

Table 3.4. Prey species of *Felis caracal* for winter, as determined by stomach content analysis (n = 47; 22 males, 25 females).

PTV = Percentage Total Volume
PTO = Occurrence of an item as a percentage of the total occurrence of all food items

PREY	VOLUME(ml) [PTV]			OCCURRENCE [PTO]		
	Male	Female	Total	Male	Female	Total
Antelope	3 060 [51.6]	985 [26.9]	4 045 [42.2]	8 [28.6]	5 [17.8]	13 [23.2]
Hyrax	210 [3.5]	850 [23.2]	1 060 [11.1]	2 [7.1]	4 [14.3]	6 [10.7]
Rodents	200 [3.4]	430 [11.8]	630 [6.6]	1 [3.6]	2 [7.1]	3 [5.4]
Livestock	1 630 [27.5]	170 [4.6]	1 800 [18.8]	5 [17.8]	3 [10.7]	8 [14.3]
Lagomorph	350 [5.9]	430 [11.8]	780 [8.1]	2 [7.1]	2 [7.1]	4 [7.1]
Carnivora	-	360 [9.8]	360 [3.8]	-	1 [3.6]	1 [1.8]
Aves	45 [0.8]	-	45 [trace]	1 [3.6]	-	1 [1.8]
Primate	-	110 [3.0]	110 [1.1]	-	1 [3.6]	1 [1.8]
Carrion	280 [4.7]	-	280 [2.9]	1 [3.6]	-	1 [1.8]
Plant	115 [1.9]	17 [trace]	132 [1.4]	4 [14.3]	4 [14.3]	8 [14.3]
Unidentified	31 [0.5]	295 [8.1]	326 [3.4]	4 [14.3]	6 [21.5]	10 [17.8]
Total	5 921	3 647	9 568	28	28	56

The proportion of livestock in the winter diet of caracal, was not found to be significantly less than that in the summer diet, either in terms of PTV ($\chi^2 = 0.04$;df = 1; $p > 0.05$), or PTO ($\chi^2 = 0.40$; df = 1; $p > 0.05$).

The proportion of hyrax in the winter diet of caracal, is significantly less than that in the summer diet, both in terms of PTV ($\chi^2 = 21.84$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 5.7$; df = 1; $p < 0.05$).

3.3.5. Caracal diet in relation to sex

A total of 40 male and 39 female caracal were examined, including the ten empty stomachs, which comprised four female and six male samples.

Wild artiodactyls formed the major dietary component in male caracal (PTV = 39.8%; PTO = 28.3%), with a significantly greater proportion of this food item being consumed during winter in terms of PTV ($\chi^2 = 15.1$; df = 1; $p < 0.01$), but not in terms of PTO ($\chi^2 = 0.01$; df = 1; $p > 0.05$).

Male caracal also consumed a significantly greater proportion of wild artiodactyls in winter than female caracal in terms of PTV ($\chi^2 = 7.7$; df=1; $p < 0.01$), but not in terms of PTO ($\chi^2 = 2.5$; df = 1; $p > 0.05$).

Male caracal consumed a greater proportion of domestic livestock than female caracal, in terms of PTV, in summer ($\chi^2 = 11.2$; df = 1; $p < 0.01$) and winter ($\chi^2 = 16.3$; df = 1; $p < 0.01$).

Rock hyraxes constituted the major prey item in the diet of female caracal (PTV = 36.5% ; PTO = 18.9%) (Table 3.3 & 3.4). The proportion of hyrax in the diet of female animals, in terms of PTV, is significantly greater in summer than in winter ($\chi^2 = 26.6$; df = 1; $p < 0.01$) and is also significantly greater than that in the diet of male animals, in winter ($\chi^2 = 14.5$; df = 1; $p < 0.01$) and summer ($\chi^2 = 18.6$; df = 1; $p < 0.01$).

There was no significant difference in the proportion of wild artiodactyls in the combined seasonal diets of male and female caracal, both in terms of PTV ($\chi^2 = 4.46$; df = 1; $p > 0.05$) and PTO ($\chi^2 = 2.4$; df = 1; $p > 0.05$). Neither was there any significant difference in the proportion of lagomorph consumed between male and female caracal, both in terms of PTV ($\chi^2 = 0.02$; df = 1; $p > 0.05$) and PTO ($\chi^2 = 0.4$; df = 1; $p > 0.05$).

Comparative analyses between the sexes within a given season, between the sexes in different seasons, or within a sex between the two seasons, were limited due to the relatively small sample sizes.

The stomachs of four female caracal in various stages of pregnancy or lactation, were examined. One of these females had an empty stomach, while the other three had 10ml plant material, 180ml bushbuck and 170ml lagomorph in their stomachs respectively.

3.3.6. The influence of age on caracal diet

A total of 16 young, 35 adult, 13 old and 5 caracal of unknown age, were examined.

Adult caracal preyed predominantly on wild artiodactyls and rock hyraxes, while old caracal were found to prey predominantly on domestic livestock (Table 3.5). The proportion of livestock in the diets of the three age groups was found to differ significantly in terms of PTV ($\chi^2 = 42.50$; df = 2; $p < 0.01$). Adult caracal were found to consume very little domestic livestock (PTV = 6.6% ; PTO = 10%), while accounting for almost all (97.4% by volume) the wild artiodactyl remains examined (Table 3.5).

In terms of volume hyrax and lagomorphs (PTV = 24.4% for both) were the most abundant prey item in the diet of young caracal. No wild artiodactyl remains were found in the samples of young caracal.

Livestock was found to be the predominant (PTV = 55.8% ; PTO = 33.3%) food item of old caracal. Old animals were not found to consume rodents.

Due to the very low numbers of young and old caracal killed during summer months, no seasonal comparison amongst the age classes was possible.

Table 3.5. Prey species of young, adult and old *Felis caracal*, as determined by stomach content analysis (n = 69; 16 young, 35 adults, 13 old, 5 not aged).

PREY	VOLUME (ml)					OCCURRENCE [% of age group]				
	Young	Adult	Old	Not Aged	Total	Young	Adult	Old	Not Aged	Total
Antelope	-	4 670	125	-	4 795	-	17 [42.5]	2 [13.3]	-	19
Hyrax	330	1 935	60	680	3 005	3 [15.0]	6 [15.0]	1 [6.6]	3 [60.0]	13
Rodent	150	690	-	-	840	2 [10.0]	2 [5.0]	-	1 [20.0]	5
Livestock	315	598	1 660	150	2 723	3 [15.0]	4 [10.0]	5 [33.3]	1 [20.0]	13
Lagomorph	330	740	470	-	1 540	2 [10.0]	3 [7.5]	2 [13.3]	-	7
Carnivore	-	10	370	-	380	-	1 [2.5]	1 [6.7]	-	2
Aves	43	2	-	-	45	1 [5.0]	1 [2.5]	-	-	2
Primate	110	-	-	-	110	1 [5.0]	-	-	-	1
Carrion	-	-	280	-	280	-	-	1 [6.7]	-	1
Plant	16	125	11	-	152	3 [15.0]	3 [7.5]	3 [20.0]	-	9
Unidentified	60	266	-	-	326	5 [25.0]	3 [7.5]	-	-	8
Total	1 354	9 036	2 976	830	14 196	20	40	15	5	80

3.4. DISCUSSION

It is evident from the data presented in this study, that four prey categories constitute the bulk of the diet of the 79 caracal examined. More than 85% of this diet by volume and 65% of the diet by occurrence in the stomachs examined, comprises wild artiodactyl, rock hyrax, domestic livestock and lagomorphs.

These results are supported by those of Stuart (1982), Palmer and Fairall (1988) and Stuart and Hickman (1991), who reported wild artiodactyls to occur the most frequently in the stomach contents and scats of caracal. Grobler (1981), reported rock hyraxes as the most frequently encountered prey item in caracal scats, with wild artiodactyls being the second-most frequent prey item.

The livestock-killing habits of caracal are reported by Pringle and Pringle (1979), Stuart (1982) and Stuart and Hickman (1991), who recorded the relative percentage occurrence of livestock in the diet of caracal, as 72%, 33% and 28% respectively. The absence of livestock in the diets recorded by Grobler (1981) and Palmer and Fairall (1988), is easily explained by the fact that these studies were conducted within game reserves, as opposed to livestock farming areas.

The data presented in this study therefore, supports that of previous authors. Caracal are predominantly opportunistic hunters of small to medium-sized mammals, with wild artiodactyls and hyraxes predominating in the diets of males and females respectively. This phenomenon suggests that wild artiodactyls are preyed upon by the larger, stronger animals, which in this instance appear to be predominantly male caracal, a suggestion that is supported by the data of Skinner and Smithers (1990), Stuart (1982) and Stuart and Stuart (1992). Rock hyraxes, on the other hand, which exhibit peak births during summer months (Skinner and Smithers 1990, Estes 1993), form the bulk of female caracal diet, suggesting that, possibly due to energetic requirements and a lesser physical ability than male caracal, females are forced to utilize this food resource to a greater degree than male animals.

Both male and female caracal will, at times, take livestock and smaller carnivores (Tables 3.3 and 3.4), although the latter is certainly not a common dietary phenomenon. Carrion is consumed, albeit very infrequently and then seemingly by the old individuals (Table 3.5). Due to the very low occurrence of carrion in the caracal samples, no deductions could be made regarding a preference for carrion between the sexes.

Apart from these observations regarding the general diet of caracal, a number of interesting points emerge from this study. The first, regards the relatively low percentage of livestock (16.3% PTO) in the diet of these predators. It must be remembered, that 40 to 50% of the animals killed in the course of this study, were suspected livestock killers. As such, they could be expected to have exhibited a far greater proportion of livestock in their diet, similar in fact, to the average 55% total occurrence reported by Pringle and Pringle (1979).

A feasible explanation of course, is that the landowners or hunt club owners, were incorrect in their identification of problem animals and killed non-stock killers instead. This possibility is indeed supported by the fact that only 27% of those caracal which were thought to be livestock killers, were found to have livestock remains in their stomachs. Furthermore, the fact that non stock-killers were correctly identified (80% accuracy), but still hunted, raises the possibility that the term 'problem animal' has been broadened in recent times to include those animals which prey on commercially valuable ungulate species. These individuals, through their habit of preying on species such as bushbuck (*Tragelaphus scriptus*) (Table 3.1), would certainly come into conflict with game farmers and trophy hunters. When deciding whether to hunt an area with a hound pack therefore, many landowners may well feel justified in this approach, if they feel predators are removing valuable game species. Although these individuals would therefore not be labelled as 'livestock killers', they would nevertheless be actively hunted.

A further explanation for the high number of hound pack owners who incorrectly identified stock killers, could lie in the possibility that incorrect information was passed on between the farmer and the hound pack owner. Problem animal control operations often require a hound pack to operate far from its 'home base' and a breakdown in communication can therefore often lead to the 'wrong area' being hunted and non stock-killers being captured (Allan Stevenson, Algoa Regional Services Council, *pers. comm.*). The experience of the individual hound packs which were used in this study, was not quantified in any way and a lack of experience on the part of the hounds and/or the huntsman, may have contributed to the high proportion of non stock-killers captured.

Additional factors that may influence which prey items are recorded in the stomachs examined include, gut passage time, detectability of prey items, the non-consumption of killed prey and the regurgitation of food by the predator.

It is quite conceivable that certain prey items, such as masses of wool or fur, will be less-digestible than others and as such, will possibly remain in the stomach of a given predator for a longer period of time than a prey item which is quickly digested. Furthermore, prey items such as rodents and insectivores, due to their small size, may not have been detected in stomach samples (Rowe-Rowe 1983a). This possibility is supported by the findings of Weaver and Hoffman (1979), who reported a 100% detectability of rodents with a mass over 100g, but only a 34% detectability when prey mass was 25g.

The possibility also exists that some stock-killers are captured long after having eaten and as such, have empty stomachs, or have subsequently eaten non-livestock prey.

If the problem animal in question is in the habit of mass-killing livestock, but not consuming anything, such behaviour would obviously not be apparent from the examination of stomach contents. This phenomenon, was in fact, mentioned by a number of landowners (John Potter, Peter Wood, *pers. comm.*).

Lastly, a behavioural trait which was also mentioned by a number of farmers, but is as yet unconfirmed, is the regurgitation of food by a predator when being pursued by hounds. The apparent explanation for this behaviour is twofold namely, to lighten the predator and to possibly delay or mislead the hounds upon discovering the regurgitated stomach contents (John Potter, *pers. comm.*).

The second point of interest is the lack of a seasonal peak in the occurrence of livestock in the diet of caracal (Tables 3.3 and 3.4), supporting the results of Stuart and Hickman (1991). Although male caracal consume a significantly greater proportion of livestock than female caracal, no significant difference in the seasonal proportion of livestock, for either sex, was recorded. This phenomenon would seem to dispel the notion that female caracal, at certain times of the year, due to increased energetic requirements related to reproduction, are more prone to taking livestock than male caracal.

This statement is further supported by the absence of livestock in the stomachs of the four pregnant or lactating females examined. The relatively few female caracal captured which were either pregnant or lactating, may also be interpreted as indicating that these females are not a problem in terms of killing livestock and are therefore not hunted as often as male caracal. Alternatively, pregnant or lactating caracal may simply be more evasive.

The third and possibly most striking point regarding caracal in this study, relates to the effect of age on the diet of these predators. The data in Table 3.5, clearly show old animals to be the predominant killers of livestock, followed by young, immature animals. Adult animals were seen to consume very little livestock. The reasons for this phenomenon possibly exist as a combination of related physical and social factors.

When compared to adult animals, old caracal are those most likely to be passed their physical prime, while young individuals, on the other hand, are not yet at their physical peak. It is conceivable therefore, that these two categories of caracal, would also be least likely to have permanent homeranges and the associated regular food supply, leading young and old caracal, out of necessity at times, to prey on domestic livestock.

Adult caracal, either through choice, or due to non-overlapping territories with livestock farmers, appear to prey on domestic livestock only occasionally, with only a 10% occurrence being recorded (Table 3.5).

This phenomenon offers a potential management tool for the control of problem caracal, if livestock farming is the primary agricultural pursuit.

As adult caracal are known to defend largely non-overlapping territories (Estes 1993), such territorial animals, if known to occur within an area and also known not to prey on livestock, should not be hunted. These animals are most likely to exclude younger or older non-territorial individuals and therefore exclude 'high risk' caracal from an area. Game farming activities however, as illustrated by numerous dietary studies (Pringle and Pringle 1979, Grobler 1981, Palmer and Fairall 1988) and the results of this study, will most likely lead to direct conflict between landowners and adult, territorial caracal.

The presence on local game farms, of predators in general and caracal and black-backed jackal in particular, will be further discussed in the final chapter of this study.

Summary

In terms of the variables investigated in this study therefore, it would appear that individual age, possibly because of the repercussions it may have in terms of physical condition and territoriality, and not sex or season, is the primary factor which causes caracal to prey on livestock. Factors such as natural prey abundance and interspecific competition, although falling beyond the scope of the present study, may well however, also contribute to stock losses in one way or another. The fact that none of the 200 caracal scats analyzed by Grobler (1981), or the 100 caracal scats analyzed by Palmer and Fairall (1988), originating in the Mountain Zebra National Park and Karoo National Park respectively, contained any traces of livestock, further illustrates the importance of natural prey species for caracal. In the immediate absence of livestock (although present on surrounding farms) and the relative abundance of natural prey, caracal are shown in these two studies, to prey solely on natural prey, making no effort to select livestock from surrounding farms.

Furthermore, the data presented in this study, suggests that stock losses can be minimized by encouraging the presence of territorial caracal and maintaining a natural food supply for these resident animals.

The alternative to this approach, which appears to find favour with many landowners at present, is to regularly exterminate, or attempt to exterminate, all caracal in a given area. It is felt that the results presented in this chapter and those in chapter five on caracal homerange movements, support the suggestion that this practise results in these 'exterminated areas' being re-colonized by non-territorial stock-killers.

CHAPTER FOUR
BLACK-BACKED JACKAL DIET

4.1. INTRODUCTION

The black-backed jackal (*Canis mesomelas*) is considered by many farmers in the Eastern Cape to be nothing more than a scavenging pest, to be exterminated at every opportunity and as such, this species is usually the predominant target of predator control operations (*pers. obs.*).

Dietary studies conducted on black-backed jackal, within farming areas, have reported the frequency of livestock in their diet, to range from 32% by volume in KwaZulu-Natal (Rowe-Rowe 1976), to 25% in the Transvaal (Bothma 1971a,b) and 18.5% in samples collected countrywide (Grafton 1965).

As is the case with caracal, the primary means of black-backed jackal control in the Eastern Cape, is the use of hound packs, while coyote getters, poison drop baits and toxic collars find favour with some landowners. Although local livestock depredations may vary greatly, within the present study area, the black-backed jackal is considered to constitute the bulk of problem animal 'kills' by landowners and hunt clubs, comprising an estimated 300 to 400 animals annually (*pers. obs.*).

The reasons for undertaking a study of the diet of the black-backed jackal population in the Eastern Cape, were very similar to those forwarded in support of studying the diet of caracal. The lack of dietary information regarding the species locally and the lack of any information regarding possible livestock-killing within the species as a whole, were identified as major motivating aspects for the inclusion of the black-backed jackal in this study.

In addition to farmland, data were also collected within a nature reserve, thus providing the first comparative dietary analysis in the Eastern Cape, between animals occurring in a 'natural', as opposed to a 'human-controlled' environment.

As with caracal, it was felt that certain biological factors, such as heightened energetic requirements due to reproductive demands and various social interactions, would influence the diets of certain sections of the black-backed jackal population. Such discernible traits would, in turn, better enable the authorities to make recommendations pertaining to the control of this species within farmland and nature reserves. It was particularly regarding the diet of black-backed jackal within the Double Drift Game Reserve, that conservation authorities were eager to gain further information. At the inception of this reserve, it was felt that black-backed jackal, through predation, were abnormally depressing antelope populations, thus adversely affecting the tourism potential of the new reserve. The study of black-backed jackal diet within the reserve, it was hoped, would either verify this theory, or would suggest alternative areas of research.

4.2. MATERIALS AND METHODS

The procedures followed in the examination, identification and statistical analyses of black-backed jackal samples, were the same as those employed for caracal. Compared to the caracal samples, slight differences in technique occurred in the collection and ageing of black-backed jackal samples.

In addition to using hound packs in farmland, black-backed jackal samples were also collected in Double Drift Game Reserve (hereafter DDGR) (Fig. 4.1), with the use of coyote getters.

Due to the absence of whole carcasses and skull damage, individual animals were aged using tooth wear and tooth eruption patterns (Lombard 1971).

Total skull length and zygomatic width were used exclusively in ageing animals younger than six months, as the cranial measurement of older animals exhibit a large degree of overlap, thus making accurate age assessment extremely difficult (Lombard 1971). Animals older than

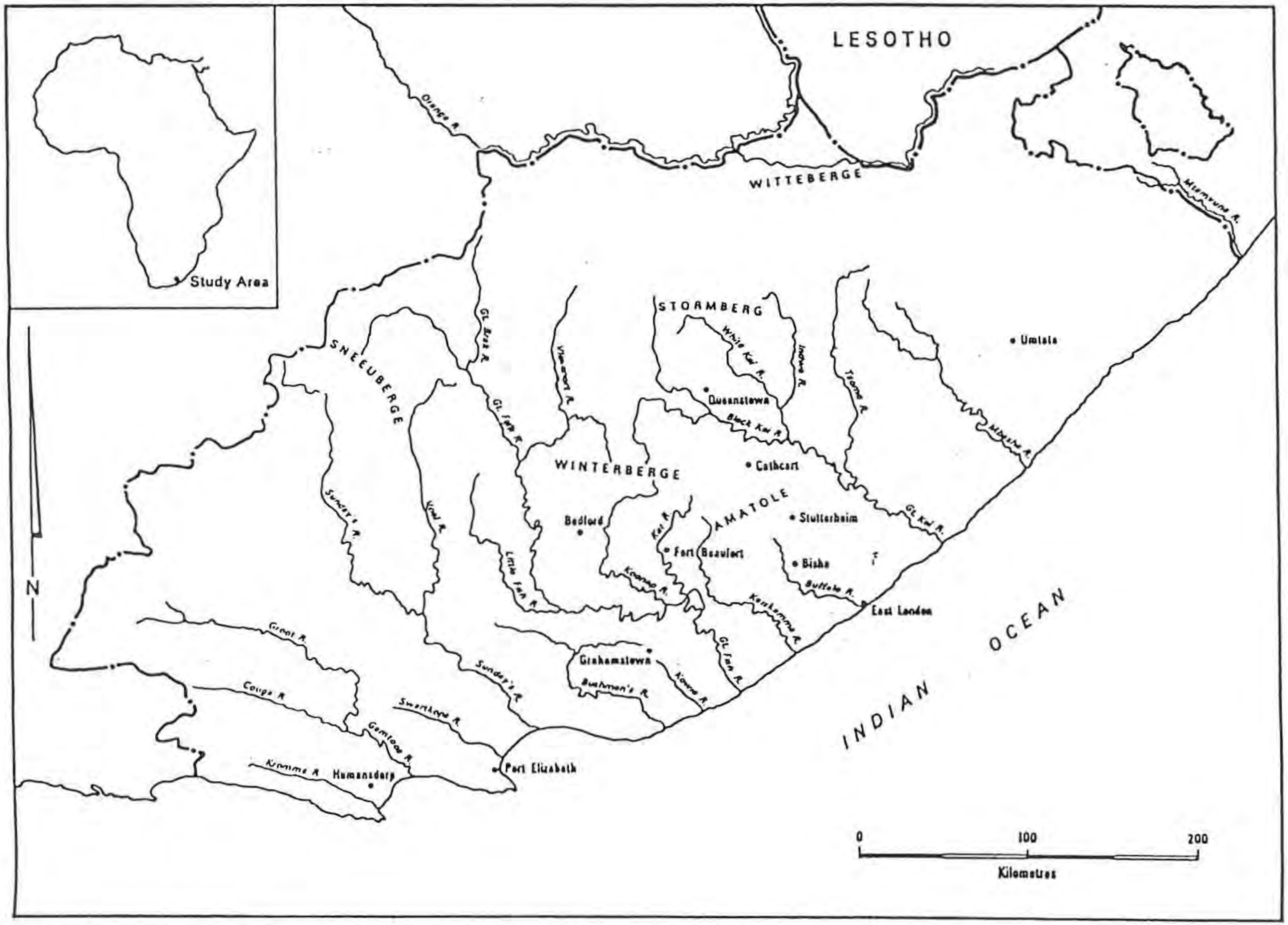

Figure 4.1. The Eastern Cape, illustrating the position of the Double Drift Game Reserve □ in the study area.

six months were aged by examining the tooth wear on the cusps and fissures of the upper median incisors (Lombard 1971).

Individual animals were assigned to one of three age classes, ranging from birth to eight months of age (hereafter referred to as young black-backed jackal), from eight months to four years (hereafter referred to as adult black-backed jackal) and from four years and older (hereafter referred to as old black-backed jackal).

Animals killed in farmland were classified as 'farm animals', while those killed in the DDGR, were classified as 'reserve animals'.

4.3. RESULTS

Sixty-eight stomach samples were obtained from black-backed jackal killed by hound packs in farmland and a further 32 were obtained by means of coyote getters in the Double Drift Game Reserve, yielding a total sample of 100 black-backed jackal stomachs.

A total of 50 male and 36 female samples were examined, while 14 samples were unsexed. The farmland sample consisted of 33 males, 22 females and 13 unsexed animals, while the reserve sample consisted of 17 males, 14 females and a single unsexed animal.

Only two stomachs were found to be empty, representing 2.0% of the total sample.

In terms of age classes, the black-backed jackal sample consisted of 24 young, 63 adult, 10 old and three unaged animals. The farmland sample consisted of 20 young, 40 adult, five old and three unaged animals, while the DDGR sample comprised four young, 23 adult and five old animals.

The two empty stomachs belonged to an adult male animal and an old female, both originating from farmland.

4.3.1. General diet

A total of 15 044ml of stomach contents were examined from 98 stomachs (Table 4.1). The major dietary components, for the combined farmland and reserve samples, in terms of percentage of total volume (PTV), were livestock (36.1% PTV), wild artiodactyls (35.0% PTV), invertebrates (9.2% PTV) and carrion (8.1% PTV). In terms of percentage of total occurrence (PTO), the major dietary items for the combined farmland and reserve samples, were found to be plant material (33.2% PTO), wild artiodactyls (18.3% PTO), livestock (17.3% PTO) and invertebrates (15.4% PTO).

The remaining dietary items for the combined farmland and reserve samples, consisted of rodents (2.3% PTV; 4.1% PTO), lagomorphs (3.1% PTV; 1.5% PTO), traces of wild birds and reptiles and various unidentified items (Table 4.1).

4.3.1.1. Farmland

As shown in Table 4.2 the major dietary items found in the stomach samples from farming areas, in terms of PTV and PTO, were livestock (52.1% PTV; 29.6% PTO), wild artiodactyls (35.3% PTV; 20.8% PTO) and lagomorphs (4.5% PTV; 2.6% PTO).

The wild artiodactyl component comprised five species, totalling 3 685ml, including 250ml which were not identified to species level. The most abundant ungulate species was found to be bushbuck (*Tragelaphus scriptus*) (54.4% PTV; 41.0% PTO), followed by common duiker (*Sylvicapra grimmia*) (12.6% PTV; 16.7% PTO), nyala (*Tragelaphus angasii*) (10.3% PTV; 12.5% PTO), grey rhebok (*Pelea capreolus*) (8.7% PTV; 8.3% PTO) and mountain reedbuck (*Redunca fulvorufula*) (7.2% PTV; 4.2% PTO).

Plant material, although occurring in 33.0% of farmland samples, constituted very little by way of PTV (2.2% PTV; Table 4.2) and consisted primarily of grass and leaves.

Carrion was found in four samples from farmland and consisted primarily of wild artiodactyl remains. One sample contained livestock carrion.

Table 4.1. Prey species of *Canis mesomelas* as determined by stomach content analysis of animals killed in both farmland and the Double Drift Game Reserve (n = 98).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME (ml)	PTV	OCCURRENCE	PTO
Antelope	**5 270**	**35.0**	**36**	**18.3**
Tragelaphus scriptus	2 475	16.5	13	6.7
Tragelaphus angasii	595	3.9	5	2.5
Tragelaphus strepsiceros	225	1.5	2	1.0
Redunca fulvorufula	265	1.8	1	0.5
Sylvicapra grimmia	575	3.8	5	2.5
Aepyceros melampus	15	trace	1	0.5
Pelea capreolus	320	2.1	2	1.0
unidentified	800	5.3	7	3.6
Livestock	**5 435**	**36.1**	**34**	**17.3**
Rodents	**353**	**2.3**	**8**	**4.1**
Lagomorphs	**470**	**3.1**	**3**	**1.5**
Invertebrates	**1 384**	**9.2**	**30**	**15.4**
Aves	**18**	**trace**	**6**	**3.1**
Carrion	**1 221**	**8.1**	**10**	**5.1**
Reptiles	**11**	**trace**	**2**	**1.0**
Plants	**867**	**5.8**	**65**	**33.2**
Unidentified	**15**	**trace**	**2**	**1.0**
TOTAL	**15 044**	**100.0**	**196**	**100.0**

Table 4.2. Prey species of *Canis mesomelas* as determined by stomach content analysis of animals killed in farmland (n = 66).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME (ml)	PTV	OCCURRENCE	PTO
Antelope	**3 685**	**35.3**	**24**	**20.8**
Tragelaphus scriptus	2 005	19.2	10	8.7
Tragelaphus angasii	380	3.6	3	2.6
Tragelaphus strepsiceros	-	-	-	-
Redunca fulvorufula	265	2.5	1	0.8
Sylvicapra grimmia	465	4.5	4	3.5
Aepyceros melampus	-	-	-	-
Pelea capreolus	320	3.1	2	1.7
unidentified	250	2.4	4	3.5
Livestock	**5 435**	**52.1**	**34**	**29.6**
Rodents	**178**	**1.7**	**3**	**2.6**
Lagomorphs	**470**	**4.5**	**3**	**2.6**
Invertebrates	**63**	**0.6**	**5**	**4.4**
Aves	**6**	**trace**	**2**	**1.7**
Carrion	**350**	**3.3**	**4**	**3.5**
Reptiles	**-**	**-**	**-**	**-**
Plants	**233**	**2.2**	**38**	**33.0**
Unidentified	**15**	**trace**	**2**	**1.7**
TOTAL	**10 435**	**100.0**	**115**	**100.0**

4.3.1.2. Reserve

Table 4.3 shows that the major dietary items found in the stomach samples from DDGR, in terms of PTV and PTV, were wild artiodactyls (34.4% PTV; 14.8% PTO), invertebrates (28.6% PTV; 30.9% PTO) and carrion (18.9% PTV; 7.4% PTO).

The wild artiodactyl component comprised five species, totalling 1 035ml, with a further 550ml of ungulate remains not being identified to species level. The most abundant ungulate species was found to be bushbuck (29.6% PTV; 25.0% PTO), followed by kudu (*Tragelaphus strepsiceros*) (14.2% PTV; 16.7% PTO), nyala (13.6% PTV; 16.7% PTO), common duiker (6.9% PTV; 8.3% PTO) and traces of impala (*Aepyceros melampus*).

Carrion was found in six reserve samples and consisted only of wild artiodactyl remains. The colour and length of the hairs present in these samples identified the carrion as originating from wild ungulates.

Plant material, although only constituting 13.7% by way of PTV, occurred in 33.3% of all reserve samples. As opposed to farmland samples, this material consisted primarily of partially digested prickly pear (*Opuntia vulgaris*).

The remaining dietary items for the reserve samples comprised rodents (3.8% PTV; 6.2% PTO), traces of wild birds and reptiles. No livestock remains were found in any of the reserve samples.

Carnivore remains were not found in either farmland, or reserve, samples. Although black-backed jackal hairs were found in a number of stomachs, the small amount of hairs present and the absence of bone fragments and/or muscle tissue, led to the conclusion that, as with the caracal samples, this phenomenon was due to grooming and not cannibalism.

Table 4.3. Prey species of *Canis mesomelas* as determined by stomach content analysis of animals killed in the Double Drift Game Reserve (n = 32).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME (ml)	PTV	OCCURRENCE	PTO
Antelope	**1 585**	**34.4**	**12**	**14.8**
Tragelaphus scriptus	470	10.2	3	3.7
Tragelaphus angasii	215	4.7	2	2.5
Tragelaphus strepsiceros	225	4.9	2	2.5
Redunca fulvorufula	-	-	-	-
Sylvicapra grimmia	110	2.4	1	1.2
Aepyceros melampus	15	trace	1	1.2
Pelea capreolus	-	-	-	-
unidentified	550	11.9	3	3.7
Livestock	-	-	-	-
Rodents	**175**	**3.8**	**5**	**6.2**
Lagomorphs	-	-	-	-
Invertebrates	**1 321**	**28.7**	**25**	**30.9**
Aves	**12**	**trace**	**4**	**4.9**
Carrion	**871**	**18.9**	**6**	**7.4**
Reptiles	**11**	**trace**	**2**	**2.5**
Plants	**634**	**13.7**	**27**	**33.3**
Unidentified	-	-	-	-
TOTAL	**4 609**	**100.0**	**81**	**100.0**

4.3.1.3. Comparison of farmland and reserve data

A number of points emerge from the above-mentioned data.

Firstly, the proportion of wild artiodactyl in the diets of both farmland and reserve jackals was not significantly different, either in terms of PTV (χ^2 = 0.0001; df = 1; p > 0.05), or PTO (χ^2 =0.01; df = 1; p > 0.05).

There was however, a significantly greater proportion of invertebrates in the diet of reserve jackals as opposed to farmland jackals, both in terms of PTV (χ^2 = 26.94; df = 1; p < 0.01) and PTO (χ^2 = 19.89; df = 1; p < 0.01).

Carrion was also found to occur in significantly greater proportions in the diet of reserve jackals, than in the diet of farmland animals, in terms of PTV (χ^2 = 10.96; df = 1; p < 0.01), but not PTO (χ^2 = 1.39; df = 1; p > 0.05).

4.3.2. Seasonality of black-backed jackal diet

4.3.2.1. Farmland

A total of 36 summer samples, including one empty stomach, and 27 winter samples were examined. Five stomachs did not have any seasonal data (Table 4.4).

4.3.2.1.a. Summer

Livestock comprised the single largest food item in the combined diets of both sexes of black-backed jackal in summer, both in terms of PTV (64.8%) and PTO (33.9%) (Table 4.4). In terms of PTV, antelope (22.3%) and rodents (3.8%), were the next most abundant prey items, although plant material occurred in a greater number of samples than either of these prey items (Table 4.4).

Table 4.4. Seasonal diet of *Canis mesomelas*, as determined by stomach content analysis for animals killed in farmland (n=68; 36 summer, 27 winter and five samples not seasoned).

PREY	VOLUME (ml) [% of season volume]				OCCURRENCE [% of age group]			
	Summer	Winter	Not seasoned	Total	Summer	Winter	Not seasoned	Total
Antelope	990 [22.3]	2 605 [47.3]	90 [18.5]	3 685 [35.3]	9 [15.3]	13 [26.5]	2 [23.6]	24 [20.9]
Livestock	2 880 [64.8]	2 185 [39.7]	370 [76.1]	5 435 [52.1]	20 [33.9]	12 [24.5]	2 [28.6]	34 [29.6]
Rodents	168 [3.8]	10 [trace]	-	178 [1.7]	2 [3.4]	1 [2.0]	-	3 [2.6]
Lagomorphs	100 [2.2]	370 [6.7]	-	470 [2.6]	1 [1.7]	2 [4.1]	-	3 [2.6]
Invertebrates	23 [0.5]	40 [0.7]	-	63 [0.6]	4 [6.8]	1 [2.0]	-	5 [4.3]
Carrion	115 [2.6]	235 [4.3]	-	350 [3.3]	2 [3.4]	2 [4.1]	-	4 [3.5]
Aves	-	6 [trace]	-	6 [trace]	-	2 [4.1]	-	2 [1.7]
Plant	156 [3.5]	51 [0.9]	26 [5.3]	233 [2.2]	19 [33.2]	16 [32.7]	3 [42.9]	38 [33.0]
Unidentified	15 [trace]	-	-	15 [trace]	2 [3.4]	-	-	2 [1.7]
Total	4 447	5 502	486	10 435	59	49	7	115

4.3.2.1.b. Winter

Antelope comprised the largest food item in the combined diets of both sexes in winter, in terms of PTV (47.3%), although plant material was found to occur in more samples than antelope remains and, as such, was the most abundant prey item in terms of PTO (32.6%) (Table 4.4). Livestock (39.7%) and lagomorphs (12.7%) were the next most abundant prey items in terms of PTV, while after plant material, antelope (26.5%) and livestock (24.5%) were the next most abundant prey items in terms of PTO (Table 4.4)

4.3.2.1.c. Comparison of summer and winter diets

The summer and winter diets for the combined stomach contents of male and female animals, killed in farmland, differs in a number of areas. In terms of PTV, wild artiodactyls are significantly more abundant in winter than in summer ($\chi^2 = 9.04$; df = 1; $P < 0.01$), although there is no significant difference in terms of PTO ($\chi^2 = 3.00$; df = 1; $p > 0.05$). The abundance of livestock in the combined diets of male and female animals is also seen to change seasonally, with significantly greater proportions of livestock occurring in summer, than in winter, in terms of PTV ($\chi^2 = 6.03$; df = 1; $p < 0.01$), but not PTO ($\chi^2 = 1.51$; df = 1; $p > 0.05$).

4.3.2.2. Reserve

A total of 32 summer samples were examined. The lack of black-backed jackal samples from the DDGR during winter months, precluded any dietary comparison between seasons within a reserve environment. The summer dietary analysis therefore, is the same as described in the 'general diet' section above.

4.3.2.3. Comparison of farmland and reserve data

The dietary composition of reserve and farmland summer samples, show a number of differences.

In terms of PTV and PTO, the reserve samples show a significantly greater proportion of invertebrates ($\chi^2 = 27.23$; df = 1; $p < 0.01$: $\chi^2 = 15.41$; df = 1; $p < 0.01$). In terms of only PTV, the reserve samples show a significantly greater proportion of carrion ($\chi^2 = 12.36$;

df = 1; $p < 0.01$) and plant material ($\chi^2 = 6.05$; df = 1; $p < 0.01$), than is found in the farmland samples.

There is no significant difference in the PTV of wild artiodactyls in the reserve samples, as opposed to the farmland summer samples ($\chi^2 = 2.58$; df = 1; $p > 0.05$).

4.3.3. Black-backed jackal diet in relation to sex

A total of 50 male and 36 female stomachs were examined. Fourteen stomachs originated from individuals which were not sexed. The two empty stomachs which were examined came from a single male and a single female.

4.3.3.1. Farmland

The farmland sample comprised 33 male, 22 female and 13 unsexed samples (Tables 4.5 and 4.6).

Table 4.5. The summer diet of *Canis mesomelas*, as determined by stomach content analysis for 14 male and 16 female animals killed on farmland (n = 30).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME(ml) [PTV]			OCCURRENCE [PTO]		
	Male	Female	Total	Male	Female	Total
Antelope	460 [33.6]	530 [22.4]	990 [26.4]	4 [18.2]	5 [20.8]	9 [19.6]
Livestock	740 [53.9]	1 565 [66.0]	2 305 [61.6]	7 [31.8]	8 [33.3]	15 [32.6]
Rodents	140 [10.3]	-	140 [3.7]	1 [4.5]	-	1 [2.2]
Lagomorphs	-	100 [4.2]	100 [2.7]	-	1 [4.2]	1 [2.2]
Invertebrates	8 [0.5]	15 [0.6]	23 [0.6]	3 [13.6]	1 [4.2]	4 [8.7]
Carrion	10 [0.7]	105 [4.4]	115 [3.1]	1 [4.5]	1 [4.2]	2 [4.3]
Aves	-	-	-	-	-	-
Plant	14 [1.0]	56 [2.4]	70 [1.9]	6 [27.4]	8 [33.3]	14 [30.4]
Unidentified	-	-	-	-	-	-
Total	1 372	2 371	3 743	22	24	46

Table 4.6. The winter diet of *Canis mesomelas*, as determined by stomach content analysis for 19 male and 6 female animals killed on farmland (n = 25).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME(ml) [PTV]			OCCURRENCE [PTO]		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
Antelope	2 325 [58.5]	-	2 325 [45.3]	11 [34.4]	-	11 [24.5]
Livestock	1 340 [33.7]	795 [68.6]	2 135 [41.6]	5 [15.6]	6 [46.2]	11 [24.5]
Rodents	10 [trace]	-	10 [trace]	1 [3.1]	-	1 [2.2]
Lagomorphs	-	350 [30.2]	350 [6.8]	-	1 [7.6]	1 [2.2]
Invertebrates	40 [1.0]	-	40 [0.8]	1 [3.1]	-	1 [2.2]
Carrion	235 [5.9]	-	235 [4.6]	2 [6.3]	-	2 [4.4]
Aves	-	6 [0.5]	6 [trace]	-	2 [15.4]	2 [4.4]
Plant	23 [0.5]	8 [0.7]	31 [0.6]	12 [37.5]	4 [30.3]	16 [35.6]
Unidentified	-	-	-	-	-	-
Total	3 973	1 159	5 132	32	13	45

In terms of PTV, wild artiodactyls formed the major dietary component in male black-backed jackal (52.1%), followed by livestock (38.9%) and carrion (4.6%). In terms of PTO, plant material was found to be the most abundant food item (33.3%), followed by wild artiodactyls (27.8%) and livestock (22.2%).

The most abundant food item, in terms of PTV, in the diet of female black-backed jackal, was livestock (66.8%), followed by wild artiodactyls (15.0%) and lagomorphs (12.7%). Livestock was also found to be the most abundant food item in terms of PTO (37.8%), followed by plant material (32.4%) and wild artiodactyls (13.5%).

The combined seasonal data for male and female black-backed jackal killed in farmland, indicate a number of differences between the diets of the sexes. Male black-backed jackal were found to consume significantly greater proportions of wild artiodactyls than females, both in terms of PTV ($\chi^2 = 19.80$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 4.95$; df = 1; $p < 0.01$).

Female black-backed jackal however, consumed significantly greater proportions of livestock, than male animals, both in terms of PTV ($\chi^2 = 7.48$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 4.06$; df = 1; $p < 0.01$).

A seasonal analysis of the diets of male and female black-backed jackal, yields further interesting comparisons within and between the sexes. Males are seen to consume significantly greater proportions of livestock in summer than in winter, both in terms of PTV ($\chi^2 = 4.66$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 5.54$; df = 1; $p < 0.01$). Wild artiodactyls on the other hand, constitute a significantly greater proportion of males' winter diet, than their summer diet, both in terms of PTV ($\chi^2 = 9.26$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 4.98$; df = 1; $p < 0.01$).

Female black-backed jackal consumed no wild artiodactyls in winter and very similar proportions of livestock in summer and winter (Tables 4.5 and 4.6).

There is no significant difference in the proportion of livestock consumed between male and female animals in summer, either in terms of PTV ($\chi^2 = 0.61$; df = 1; $p > 0.05$), or PTO ($\chi^2 = 0.03$; df = 1; $p > 0.05$), although female animals are seen to consume a significantly greater proportion of livestock in winter than males, both in terms of PTV ($\chi^2 = 11.94$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 15.15$; df = 1; $p < 0.01$).

There is also no difference in the proportion of wild artiodactyl consumed between the sexes in summer, both in terms of PTV ($\chi^2 = 2.24$; df = 1; $p > 0.05$) and PTO ($\chi^2 = 0.17$; df = 1; $p > 0.05$).

4.3.3.2. Reserve

The reserve sample comprised 17 male, 14 female and one unsexed sample (Table 4.7).

The major dietary component in terms of PTV, in the black-backed jackal males originating in the DDGR, was wild artiodactyl (32.0%), followed by invertebrates (25.4%) and plant material (13.4%). In terms of PTO, plant material (34.0%) and invertebrates (29.8%) were the most often encountered food items.

Table 4.7. The summer diet of *Canis mesomelas*, as determined by stomach content analysis for 17 male and 14 female animals killed in the Double Drift Game Reserve (n = 31).

PTV = Percentage Total Volume
PTO = Percentage Total Occurrence

PREY	VOLUME(ml) [PTV]			OCCURRENCE [PTO]		
	Male	Female	Total	Male	Female	Total
Antelope	890 [32.0]	355 [23.8]	1 245 [29.2]	7 [14.8]	4 [12.9]	11 [14.1]
Livestock	-	-	-	-	-	-
Rodents	70 [2.5]	105 [7.1]	175 [4.1]	2 [4.2]	3 [9.7]	5 [6.4]
Lagomorphs	-	-	-	-	-	-
Invertebrates	706 [25.4]	615 [41.3]	1 321 [30.9]	14 [29.8]	11 [35.5]	25 [32.1]
Carrion	721 [25.9]	150 [10.1]	871 [20.4]	5 [10.6]	1 [3.2]	6 [7.7]
Aves	11 [0.4]	1 [trace]	12 [trace]	3 [6.4]	1 [3.2]	4 [5.1]
Plant	372 [13.4]	262 [17.6]	634 [14.9]	16 [34.0]	11 [35.5]	27 [34.6]
Unidentified	-	-	-	-	-	-
Total	2 781	1 488	4 269	47	31	78

Female black-backed jackal were found to consume mostly invertebrates (41.6% PTV; 35.5% PTO), wild artiodactyls (24.0% PTV; 12.9% PTO) and plant material (17.7% PTV; 35.5% PTO).

The proportion of wild artiodactyls in the diet of male animals, was not significantly greater than that in female animals, both in terms of PTV ($\chi^2 = 1.21$; df = 1; $p > 0.05$) and PTO ($\chi^2 = 0.14$; df = 1; $p > 0.05$). There was also no significant difference between the sexes, in terms of PTV, in the proportion of invertebrates consumed ($\chi^2 = 3.79$; df = 1; $p > 0.05$).

Male animals consumed a significantly greater proportion of carrion than female animals, in terms of PTV ($\chi^2 = 6.9$; df = 1; $p < 0.01$).

4.3.4. Black-backed jackal diet in relation to age

A total of 24 young, 63 adult, 10 old and three unaged black-backed jackal samples were examined. The two empty stomachs both came from adult animals.

4.3.4.1. Farmland

The farmland sample comprised 20 young, 32 adult, five old and two unaged samples (Table 4.8).

The major components in the diet of young black-backed jackal were livestock (74.9% PTV; 40.5% PTO), wild artiodactyls (6.5% PTV; 5.4% PTO) and plant material (6.1% PTV; 40.5% PTO).

Livestock and wild artiodactyls constituted the major food items in the diets of both adult (47.7% PTV; 22.9% PTO: 39.3% PTV; 27.8% PTO) and old (59.2% PTV; 38.5% PTO: 38.7% PTV; 23.1% PTO) black-backed jackal respectively (Table 4.8).

Young black-backed jackal consumed significantly greater proportions of livestock than adult animals, both in terms of PTV ($\chi^2 = 6.01$; df = 1; $p < 0.01$) and PTO ($\chi^2 = 6.45$; df = 1; $p < 0.01$). There was no significant difference in the proportion of livestock consumed between young and old animals, either in terms of PTV ($\chi^2 = 1.84$; df = 1; $p > 0.05$), or PTO ($\chi^2 = 0.16$; df = 1; $p > 0.01$). Adult and old animals showed no significant difference in the proportion of livestock consumed in terms of PTV ($\chi^2 = 1.23$; df = 1; $p > 0.05$), although there was a significant difference in terms of PTO ($\chi^2 = 4.62$; df = 1; $p < 0.01$).

Young animals consumed significantly smaller proportions of artiodactyls, both in terms of PTV and PTO respectively, than either adult animals ($\chi^2 = 11.75$; df = 1; $p > 0.05$: $\chi^2 = 15.74$; df = 1; $p > 0.05$), or old animals ($\chi^2 = 22.93$; df = 1; $p > 0.05$: $\chi^2 = 5.55$; df = 1; $p > 0.05$).

In terms of PTV, lagomorphs (7.3%) and carrion (3.8%) were the next most abundant food items in the diet of adult black-backed jackal, while plant material constituted the major dietary item in terms of PTO, in both adult (28.3%) and old (38.5%) animals.

Table 4.8. Prey species of 20 young, 40 adult and five old *Canis mesomelas*, as determined by stomach content analysis of animals killed in farmland.

PREY	VOLUME (ml)					OCCURRENCE [% of age group]				
	Young	Adult	Old	Not Aged	Total	Young	Adult	Old	Not Aged	Total
Antelope	140	2 520	500	525	3 685	2 [5.3]	17 [28.3]	3 [23.0]	2 [50.0]	24
Livestock	1 610	3 060	765	-	5 435	16 [42.1]	13 [21.8]	5 [38.5]	-	34
Rodents	140	38	-	-	178	1 [2.6]	2 [3.3]	-	-	3
Lagomorphs	-	470	-	-	470	-	3 [5.0]	-	-	3
Invertebrates	17	6	-	40	63	2 [5.3]	2 [3.3]	-	1 [25.0]	5
Carrion	105	245	-	-	350	1 [2.6]	3 [5.0]	-	-	4
Aves	-	6	-	-	6	-	2 [3.3]	-	-	2
Plants	130	56	27	20	233	15 [39.5]	17 [28.3]	5 [38.5]	1 [25.0]	38
Unidentified	5	10	-	-	15	1 [2.6]	1 [1.7]	-	-	2
Total	2 147	6 411	1 292	585	10 435	38	60	13	4	115

4.3.4.2. Reserve

The reserve sample comprised four young, 23 adult and five old animals (Table 4.9).

Table 4.9. Prey species of four young, 23 adult and five old *Canis mesomelas*, as determined by stomach content analysis of animals killed in the Double Drift Game Reserve.

PREY	VOLUME (ml)				OCCURRENCE [% of age group]			
	Young	Adult	Old	Total	Young	Adult	Old	Total
Antelope	325	1 050	210	1 585	3 [23.1]	7 [13.2]	2 [13.3]	12 [14.8]
Livestock	-	-	-	-	-	-	-	-
Rodents	5	170	-	175	1 [7.7]	4 [7.5]	-	5 [6.2]
Lagomorphs	-	-	-	-	-	-	-	-
Invertebrates	128	486	707	1 321	4 [30.7]	16 [30.2]	5 [33.3]	25 [30.9]
Carrion	150	701	20	871	1 [7.7]	4 [7.5]	1 [6.7]	6 [7.4]
Aves	1	5	6	12	1 [7.7]	1 [1.9]	2 [13.3]	4 [4.9]
Plants	162	394	78	634	3 [23.1]	19 [35.9]	5 [33.3]	27 [33.3]
Unidentified	-	-	-	-	-	-	-	-
Total	771	2 817	1 021	4 609	13	53	15	81

The major items in the diet of young animals, were wild artiodactyls (42.2% PTV; 23.1% PTO), plant material (21.0% PTV; 23.1% PTO), carrion (19.5% PTV;7.7% PTO) and invertebrates (16.6% PTV; 30.8% PTO).

Adult animals were found to eat predominantly wild artiodactyls (37.3% PTV; 13.2% PTO), carrion (24.9% PTV; 7.5% PTO), invertebrates (17.3% PTV; 30.2% PTO) and plant material (14.0% PTV; 35.8% PTO).

Old animals were found to eat predominantly invertebrates (69.2% PTV; 33.3% PTO), wild artiodactyls (20.6% PTV; 13.3% PTO) and plant material (7.6% PTV; 33.3% PTO).

In terms of PTV, old animals ate significantly smaller proportions of artiodactyls than either young ($\chi^2 = 9.5$; df = 1; $p < 0.01$), or adult animals ($\chi^2 = 4.82$; df = 1; $p < 0.01$).

Old animals were also seen to consume significantly greater proportions of invertebrates, in terms of PTV, than either young ($\chi^2 = 32.25$; df = 1; $p < 0.01$), or adult ($\chi^2 = 31.14$; df = 1; $p < 0.01$) animals. In terms of PTO, there was no significant difference in the proportion of invertebrates consumed between old and young animals ($\chi^2 = 2.64$; df = 1; $p > 0.05$), between old and adult animals ($\chi^2 = 0.001$; df = 1; $p > 0.05$), or between young and adult animals ($\chi^2 = 2.7$; df = 1; $p > 0.05$).

4.3.4.3. Comparison of farmland and reserve age data

When comparing the data between farmland and DDGR for the various age classes, a number of interesting points emerge.

Firstly, young animals in farmland, consume large quantities of livestock, whereas reserve animals did not consume any livestock at all. In light of this phenomenon, in terms of PTV, the proportions of artiodactyl ($\chi^2 = 25.98$; df = 1; $p < 0.01$), invertebrates ($\chi^2 = 14.35$; df = 1; $p < 0.01$) and plant material ($\chi^2 = 8.19$; df = 1; $p < 0.01$), in young reserve samples, are all significantly greater than for young farmland samples.

Adult reserve animals are seen to consume significantly greater proportions, in terms of PTV, of invertebrates ($\chi^2 = 14.23$; df = 1; $p < 0.01$:) and plant material ($\chi^2 = 11.77$; df = 1; $p < 0.01$), than farmland animals. There is no significant difference in the proportions of artiodactyls consumed by reserve and farmland animals, in terms of PTV ($\chi^2 = 0.05$; df = 1; $p > 0.05$), although the proportions are significantly different in terms of PTO ($\chi^2 = 5.94$; df = 1; $p < 0.01$).

The major difference between the diets of old farmland and reserve animals is the large proportion of invertebrates consumed by reserve animals, as opposed to farmland animals, which ate no invertebrates.

4.3.5. Data sheet responses

A total of 47 data sheets were returned from farmland and the responses are summarized in Table 4.10.

Table 4.10. The summarized responses of hunt club members to the question, "was the animal killed a known stock-killer?" (n = 35).

	Correct	Incorrect	Total
Answer "YES"	11	4	15
Answer "NO"	15	5	20
Total	26	9	35

Twelve of the data sheets returned commented on black-backed jackal pups, which were allegedly too young to kill livestock themselves. When analysing the accuracy of farmers in identifying livestock killers therefore, these twelve data sheets were ignored.

Eleven responses were correct in identifying stock killers, while four were incorrect. A further fifteen responses were correct in identifying non-stock killers, with five responses being incorrect in identifying non-stock killers.

A total of 26 responses were therefore correct, while nine were incorrect.

4.3.6. Stomach fullness

There was no significant difference between the number of male and female black-backed jackal which had stomachs 80-100% full ($\chi^2 = 0.02$; df = 1; $p > 0.05$). A significant number of female jackal had stomachs 50-79% full ($\chi^2 = 4.19$; df = 1; $p < 0.01$), while significantly more males had stomachs 0-49% full than females ($\chi^2 = 4.93$; df = 1; $p < 0.01$).

The majority (72%) of stomachs were 80-100% full, while 16% of stomachs examined were 50-79% full and 12% were 0-49% full.

Seventeen samples consisted of only stomach contents and were thus not classified in terms of stomach fullness.

4.4. DISCUSSION

4.4.1. General diet

The data presented in this study clearly illustrate that livestock, wild artiodactyls, invertebrates and carrion constitute the major dietary items, in terms of volume, of the 98 black-backed jackals examined. In terms of occurrence, these items remain the major dietary components, with the addition of plant material, which is encountered most often, although constituting very little by way of volume.

Remaining dietary items comprise rodents, lagomorphs, wild birds and reptile remains.

The major difference between the data from farmland and that from DDGR, is the amount of livestock, and to a lesser extent invertebrates and carrion, found in the diets of these two populations.

Whereas the black-backed jackal from farmland can be seen to prey on livestock, this prey item is, as expected, conspicuously absent from the DDGR samples. The livestock-killing habits of black-backed jackal in farmland have been well documented in numerous studies (Grafton 1965, Bothma 1971a,b, Rowe-Rowe 1974, 1975, 1976, 1991, Roberts 1986, Lawson 1989) and the fact that livestock is prominent in the farmland samples in this study, is therefore in itself, not surprising. It is interesting to note however, that the proportion of livestock in terms of volume, in the present study, is approximately 20-34% greater than in the studies mentioned above. This phenomenon suggests that the animals killed in the present study, were either more effectively selected as livestock killers by the hound packs than in the previous studies, or that previously livestock constituted a smaller percentage of their diet due to the scarceness of this food supply. The fact that a significant number of animals in this study were correctly identified by hunt clubs as stock-killers, further supports the notion that the clubs presently involved are relatively more efficient at eliminating problem animals than those in the previous studies.

A further point of interest in this regard, is the fact that many non-stock killers were correctly identified as such, suggesting that, as for caracal, the term 'problem animal' has today been broadened to include killers of commercially valuable game species. The relatively large proportion of livestock reported in the diets of farmland black-backed jackal in this study therefore, is both misleading, but at the same time encouraging. It is potentially misleading, as it creates the impression that these animals prey predominantly on livestock and farmers are therefore justified in calling for their total extermination, but also encouraging, as it shows that the animals which are killed, are by and large, responsible for eating livestock. Whether or not these animals are responsible for the actual killing of livestock, will be discussed later.

Of further significance, are the data obtained randomly from DDGR, by means of coyote getters. These data clearly indicate that in the immediate absence of livestock, although this food item is available on surrounding pastoral lands, black-backed jackal do not, as is widely believed by many farmers, solely select livestock, or consciously forage for this prey item. Instead, these animals utilize alternative sources of food, namely invertebrates, carrion and plant material. These findings are largely supported by those of Rowe-Rowe (1976), who studied the diets of black-backed jackal in sheep farming areas and nature reserves of Natal. The author reported livestock remains to constitute 32% of black-backed jackal diet by volume in farming areas, but only 4% by volume for animals killed within reserve areas, with wild artiodactyl remains, both fresh and carrion, constituting the bulk of reserve diets. This phenomenon suggests therefore, that as for caracal, if the primary agricultural pursuit is livestock farming, stock losses can be reduced by encouraging a supply of natural prey items, thus providing the black-backed jackal with an alternative source of food.

It is also interesting to note that the carrion component in the present study (8.1% PTV), constitutes much less of the diet by way of volume, than that reported by Grafton (1965) - 28.7% , or Rowe-Rowe (1976) - 53.0%, suggesting that this food item and not livestock, was more available to black-backed jackal in the previous studies. This suggestion is supported by the fact that these studies were conducted at relatively higher altitudes than the present study (Rowe-Rowe 1976, above 1 600m; Grafton 1965, Transvaal highveld), which in turn suggests colder winters and an accompanying supply of livestock carrion. The fact that the DDGR samples were also only collected during summer months, would further reduce the chances of carrion being discovered, as this food item is most abundant towards the end of winter (Rowe-Rowe 1976).

In terms of the proportion of antelope in the diet of black-backed jackal from DDGR, it is apparent that this dietary component is the most abundant in terms of PTV, but not PTO. It is not felt however, that the data presented indicate an unacceptably high degree of predation by black-backed jackal on wild artiodactyls. In terms of monetary value and aesthetic ecotourism priorities, it is important to note that the bulk of wild artiodactyls consumed, consisted of bushbuck (Table 4.3), which is a relatively abundant species within the region (Lubke *et al.* 1988a) and by nature, a secretive animal and is thus not often sighted (Estes 1993). As the most valuable hunted species within DDGR include the larger antelope such as kudu and nyala, it is felt that predation by black-backed jackal within DDGR on wild artiodactyls, is not causing an unacceptably high degree of lost revenue, as the target species appear to be both abundant and relatively inexpensive when compared to other species.

Ultimately however, the question of what constitutes 'acceptable' levels of antelope predation within DDGR, lies with the management of the reserve and as such, the data presented in this study, can merely serve as a useful guideline.

The results presented in this study and those of previous authors, clearly show therefore, that the black-backed jackal is an opportunistic omnivore, eating whatever is readily available and obtainable. This statement is probably best illustrated by the plant material component found in the diet of animals killed in the DDGR, which consisted solely of prickly pear remains during February, the time of year when this fruit ripens and drops to the ground (*pers. obs.*).

4.4.2. The effect of season and sex on black-backed jackal diet

The results pertaining to the seasonal and sexual trends in the diets of black-backed jackal, are presented in Tables 4.4-4.7.

Of primary interest regarding black-backed jackal diet in farmland, is the apparent seasonal trend in the proportion of livestock, which is seen to exhibit a definite summer peak, both in terms of PTV and PTO (Table 4.4). These results are supported by the findings of Rowe-Rowe (1975), who reported sheep kills in Natal farmland to increase shortly after major lambing months, with a distinct peak usually occurring in early summer.

Upon closer analysis, it is evident that the summer peak reported in this study, is due largely to the increased proportion of livestock found in the diet of male animals, not female animals, as was originally thought to be more likely. The proportion of livestock in the female diet, in terms of PTV, is actually seen to remain almost constant between the seasons, with a slight increase in terms of PTO in summer as opposed to winter (Tables 4.5 and 4.6).

It is thought that a possible explanation for this phenomenon lies in the social system prevalent amongst black-backed jackals. It is a well-documented fact that male black-backed jackal and animals from previous litters function as 'helpers', assisting with pup rearing by regurgitating food and protecting the young animals, thus ultimately increasing pup survival (Skinner and Smithers 1990; Estes 1993). As black-backed jackal births in the Cape Province are known to peak during July/August (Bernard and Stuart 1992), with subsequent peak energetic demands occurring during spring and early summer, it is quite feasible, that due to these increased energetic needs of young pups and possibly also the lactating female, male black-backed jackal take to livestock killing as an alternative and relatively abundant source of protein.

The absence of any discernible dietary trait regarding livestock amongst female animals, is somewhat more perplexing, although the reason for this could possibly lie in the relatively small sample collected from farmland during winter (Table 4.6), accompanied by possible data bias. The small female sample obtained in winter is in itself, an interesting phenomenon.

A possible explanation for this skewed sex ratio amongst animals killed during winter lies in the reproductive behaviour of black-backed jackal. Bernard and Stuart (1992), reported a peak in male black-backed jackal reproductive activity during May - July. It seems quite feasible therefore, that during this time of heightened sexual activity, male animals would also exhibit an increased aggressiveness, possibly linked to territoriality and mate protection. This behaviour would, in turn, be more likely to cause male black-backed jackal, as opposed to female animals, to confront hound packs.

The summer samples from both farmland and DDGR indicate a more even sex ratio than amongst winter kills, which in turn suggests that summer is in fact a much more favourable period for black-backed jackal control. As reported for caracal, for any control measure to be effective, it needs to target the breeding nucleus within a given population. If mostly adult male animals are killed during winter months, the breeding potential of the black-backed jackal population, which rests predominantly with the adult female animals, is not being effectively diminished.

The type of control measure employed is also of potential interest. Although no seasonal data were obtained on the coyote getter during this study, a closer look at the data obtained with the use of hounds and getters, nevertheless yields some interesting information. The use of hound packs in farmland yielded a total of 20 young animals, representing a total of 31% of all aged animals which were killed. By comparison, the use of coyote getters yielded only four young animals, representing 12% of all animals killed. The fact that the sex ratio for the coyote getter kills was near parity, further increases the effectiveness of this control measure. It would appear that when using hound packs, a relatively large proportion of young animals are killed. This may well be as a result of the hounds following a scent to a den and then concentrating their efforts on the pups, while the adult animals are allowed to escape. It was in fact, felt by some farmers, that when chased by hounds, adult animals would purposely lead the hound pack to the den, thus facilitating their own escape (Potter, *pers. comm.*). Although this theory remains untested, the larger proportion of adult animals killed with the use of coyote getters, as opposed to hound packs, means that the adult black-backed jackal breeding nucleus in hound pack operations, is relatively less affected than when coyote getters are used.

In contrast to the livestock component in the diet of black-backed jackal, other mammalian remains, primarily antelope and lagomorphs, appear to increase in the drier winter months, while plant remains are more prominent during the wetter summer months, although this phenomenon is largely obscured by the relatively small volumes of plant remains discovered in general. These trends are supported by Wyman (1967), Stuart (1976), Lamprecht (1978) and Rowe-Rowe (1983a), all of whom reported increased mammalian food intake during months of low rainfall, with an increased plant intake during months of higher rainfall.

Bernard and Stuart (1992), have suggested that the increased proportion of antelope and carrion remains in the winter diet of black-backed jackal (Table 4.4), is facilitated by the relatively large carnassial teeth of the species, as opposed to other Southern African canids, and the presence of helpers from previous litters. A combination of these factors allow black-backed jackal to utilize a food resource (carcasses and weak antelope), which is relatively plentiful during winter months and which subsequently allows first births to occur in winter.

4.4.3. The effect of age on black-backed jackal diet

The data describing the diets of the various black-backed jackal age classes, highlight a number of interesting facts.

Firstly, it is apparent that antelope and livestock constitute the bulk of all the age classes, in terms of PTV, with plants constituting a large proportion of the diet of all age classes in terms of PTO (Table 4.8 and 4.9). Lagomorphs, carrion and invertebrates can also be seen to constitute important dietary components in terms of PTV (Table 4.8 and 4.9). Antelope appear to be consumed largely by adult animals, possibly suggesting that this prey item is taken predominantly by the stronger animals within the black-backed jackal population.

Although young and old black-backed jackal can be seen to consume larger proportions of livestock than adult animals, both in terms of PTV and PTO (Table 4.8), these data, especially in terms of the young animals, may be potentially misleading and should be interpreted with due caution. Although not mentioned specifically in the data sheet responses, a number of the young animals killed by the hound packs were indeed too young to hunt and kill livestock for themselves (Potter *pers. comm.*), instead relying on their parents and/or helpers to supply them with food. Although the young animals therefore appear to be targeting livestock, it is actually the adult animals responsible for killing livestock, in order to provide the young with food. This phenomenon would therefore appear to severely limit the usefulness of age-related data, particularly that relating to the diet of very young animals.

The data collected from DDGR illustrate a further point of interest, namely that old animals would also appear to make greater use of 'alternative' sources of food, as is evidenced by the relatively large percentage of invertebrates in their diets, than the younger animals.

Also, although not quantified, old animals were found to be the sole consumers of items such as plastic bags and material, suggesting a somewhat less-selective approach to obtaining food.

Summary

In conclusion therefore, it is felt that a number of interesting points emerge from the data presented.

Firstly, and probably most importantly in terms of black-backed jackal management policies, it is evident that the type of control technique employed by the landowner(s), will to a large extent, influence the overall effectiveness of black-backed jackal control in a given area. Coyote getters appear to kill mostly adult animals, as is evidenced by the data from DDGR, thereby reducing the overall reproductive capacity of a population. Hound packs on the other hand, appear to remove a larger proportion of young animals than coyote getters, thus being less effective in terms of reducing overall black-backed jackal reproductive potential. Hound packs were however, seen to be relatively efficient in terms of removing specific 'problem animals' and although no comparison between the two techniques, regarding 'problem animal' selectivity, was conducted, the relative selectivity of hound packs, combined with the seemingly accurate identification of 'problem animals' by landowners, would suggest that hound packs are indeed an effective control measure against livestock-killing black-backed jackal within the present study area. This statement however, can only hold true, if a number of potentially misleading phenomena are thoroughly investigated by landowners.

An area of possible confusion, remains the following of scent trails by hounds, from carcasses found in the veld. As black-backed jackal are known to scavenge from dead carcasses (Skinner and Smithers 1990), it is to be expected that these animals would investigate livestock carcasses discovered within their territory and nearby surrounds. A black-backed jackal scent thus followed from a carcase, would not necessarily result in a stock killer being caught. Furthermore, the killing of livestock by stray dogs has been documented by Lawson (1989), in the Natal Drakensberg and is known to occur locally (Stevenson, *pers. comm.*), although no quantitative data exists to this end. Only by examining the carcase and measuring the distance between the punctures caused by the upper canines, can a landowner positively determine the identity of the livestock killer, as the distance between the upper canines of black-backed jackal is less than that of even the smallest domestic dog (Rowe-Rowe 1991, Bussiahn 1995). This information, combined with the characteristic killing and feeding techniques of black-backed jackal described by Rowe-Rowe (1983b), and the presence of bruising surrounding the bitten areas, indicating the predated animal was alive when killed and not a scavenged carcase, all present the landowner with a near-foolproof method of predator identification.

Furthermore, the correct identification of animals as either livestock killers or non-livestock killers, is only of any value if the identification was made before the animal was killed by the hounds. Any examination of the stomach, or intestinal contents, would obviously lend considerable bias to any identification made by the landowner. Although it is unclear whether this phenomenon occurred in the present study, this possibility should not be totally discounted.

The second point of importance, is the fact that it would appear as though the social structure and parental care prevalent amongst black-backed jackal, causes adult male animals to exhibit a seasonal livestock-killing tendency, whereas female animals show no such seasonal peak in livestock killing.

Thirdly, although it can be seen that old black-backed jackal prey largely on livestock, it is felt that the presence of this prey item in the diet of young animals, is somewhat misleading, as this phenomenon is most probably due to the regurgitation of livestock remains by adult animals. Apart from the old animals therefore, it would seem that energetic demands due to reproduction and parental care, and not age, are the primary driving force in determining the extent of livestock killing amongst black-backed jackal in farmland.

In conclusion therefore, the results of the present study, as well as those of numerous other authors, illustrate that the black-backed jackal as a species, is a very adaptable animal, being able to survive as an active hunter of small game (Ferguson 1980), a scavenger of carcasses (Rowe-Rowe 1976, Smithers 1983, Nel and Loutit 1986, Hiscocks and Perrin 1987), or as a livestock killer (Rowe-Rowe 1975). Only by examining livestock carcasses, can a landowner positively determine whether a black-backed jackal has indeed, been responsible for killing livestock. Although the results of this study suggest a responsible use of hound packs amongst farmers for the control of black-backed jackal, the extermination of these animals without the prior investigation of livestock carcasses, should be strongly discouraged.

CHAPTER FIVE
CARACAL HOMERANGE

5.1. INTRODUCTION

Prior to the present study, only Moolman (1986), had undertaken any radio telemetric research on the movement patterns and home range sizes of caracal in the Eastern Cape. This study however, was primarily conducted within the Mountain Zebra National Park and the only information available about the movement patterns and homerange sizes of caracal in farming areas, was collected by Norton and Lawson (1985) and Stuart (1982), in the Western Cape. These authors found male caracal homeranges to be larger than those of females, while homerange sizes were reported to be primarily a function of overall prey abundance, habitat suitability and conspecific density.

The present study therefore, attempts to obtain information about the movement patterns of caracal in farming areas along the well-watered and wooded coastal plain of the Lower Albany district, in order to assess the relative local densities of these animals and to see whether their movements differed in any way from prior studies.

5.2. MATERIAL AND METHODS

Two caracals, a young male and an adult female, were captured by private landowners, using walk-in cage traps, as part of ongoing predator control operations. The two animals were each separately transported from the point of capture, to Kariega Park Private Game Reserve (Fig. 5.1), where they were immobilized with ketamine (Rowe-Rowe and Lowry 1982, Stuart 1982) and weighed. Prior to release, after a two to three week observation period, the animals were again immobilized, using an intra-muscular ketamine injection and fitted with a 280g leather collar, radio transmitter and battery pack, with an estimated 13 month transmission life.

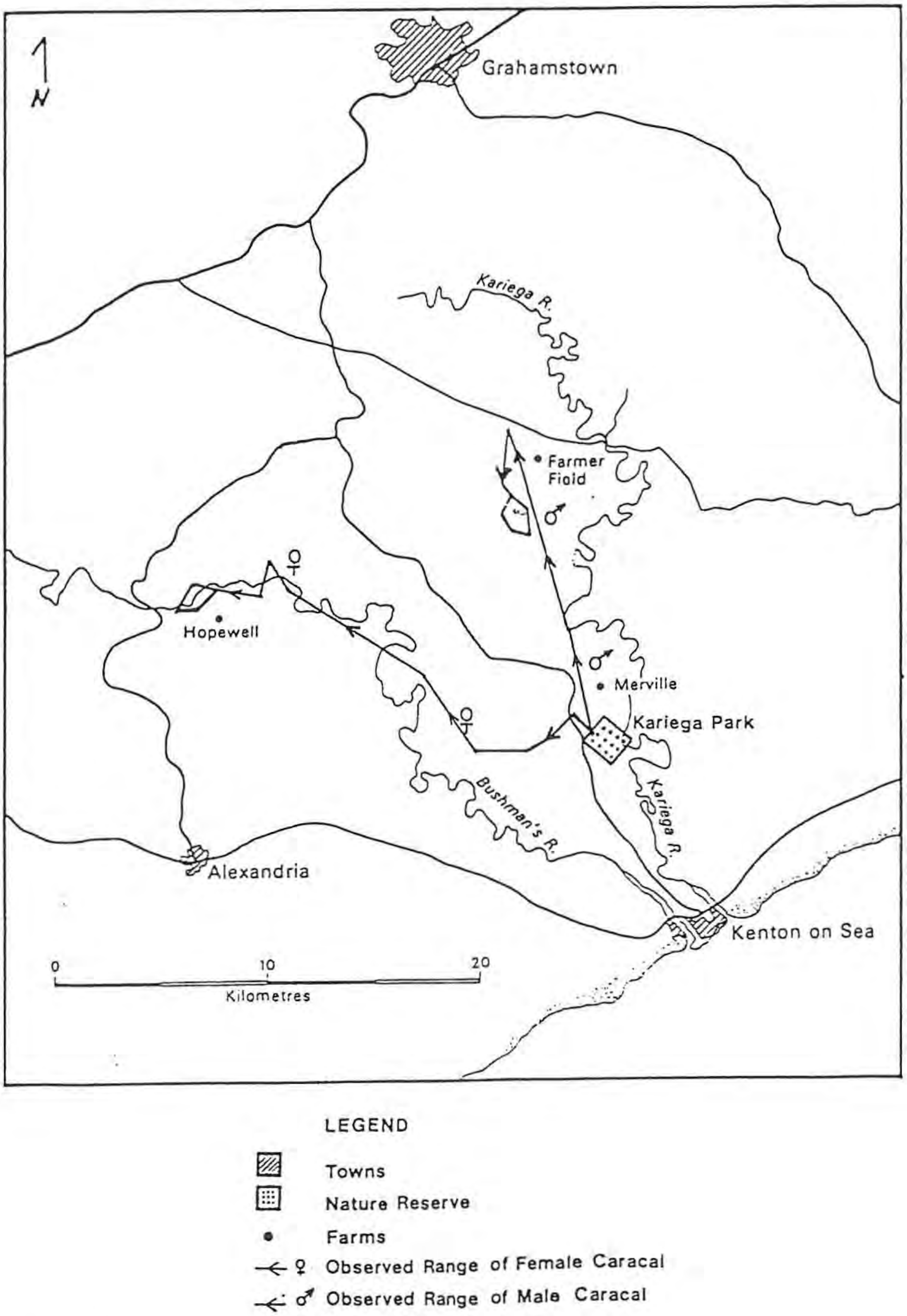

Figure 5.1. Observed range of male and female caracal.

□ = Male homerange

□ = Female homerange

The Falcon receiver was purchased from Custom Electronics, Urbana, U.S.A. and was operated on 216 mHz frequency. A three dipole, collapsible Yagi antennae was used when tracking an animal on foot, or from a vehicle.

Animals were routinely tracked weekly or bi-weekly over a twelve month period from July 1993 to September 1994. As far as was practical, tracking was conducted in either the early morning or late afternoon, so as to approximate the activity patterns of the species (Skinner and Smithers 1990).

Each location was obtained and certified by triangulation, based on two or more bearings. Locations were initially detailed and recorded in the field and later plotted on 1:50 000 maps and 1:10 000 orthophotos.

Homerange sizes were calculated using the minimum area method (Mohr 1947, Jenrich and Turner 1969, Norton and Lawson 1985), which calculates the area of a polygon, formed by connecting the outermost radio-tracking locations. Observed ranges were calculated on 1:50 000 maps, while homeranges were calculated on 1:10 000 orthophotos. No allowances were made for the increased areas of deep ravines and kloofs (Norton and Lawson 1985). In addition to this, any plotted locations which were considered to be affected by re-orientation after release, drugging, or the activities of hound packs, were excluded from the calculation of homerange size (Hamilton 1976). These 'outer points', were however, used in the calculation of the observed range of both individuals (Norton and Lawson 1985).

Due to the relatively low number of plots obtained for both animals and the short tracking periods involved, no seasonal centres of activity were calculated (Norton and Lawson 1985).

Observation-area curves (Odum and Kuenzler 1955), were plotted to examine the effect of the number of radio tracking plots on the size of the calculated homeranges, by calculating the areas of the homerange polygons with successive groups of five plots.

Due to the relatively few locations plotted and the consistency of locations in terms of vegetation, no description of preference between habitats, for either animal, was possible.

During the radio tracking period, landowners on whose property the collared animal was known to be, were requested to report any stock or game losses in the area. It was hoped that the confirmation of such stock losses, or lack thereof, would further strengthen any information gathered on the diet of the caracal occurring on farmland in the Eastern Cape.

At one stage during the study, it became necessary to re-capture the adult female caracal, accused of killing commercially valuable game species. This task was accomplished by 'treeing' the collared animal with the use of hounds and tranquillizing it, using a Telinject dart gun. The dart itself contained 3ml of water, mixed with 120mg of Ketamine and 12mg of Xylazene. Once captured, the animal was re-released on Kariega Park Game Reserve.

5.3. RESULTS

Both caracal were successfully radio tracked, each over a six month period (Table 5.1). The young male caracal died of natural causes (Stevenson, *pers. comm.*), while the female animal was killed after being caught in a gin trap.

Table 5.1. Data from two caracal trapped and radio tracked in the Albany District of the Eastern Cape.

Capture Date	Sex	Mass (kg)	Period (months)	Plots	Remarks
20/7/93	Male	10.2	6	18	Died of natural causes
8/3/94	Female	11.8	6	28	Killed in a trap

5.3.1. Homerange

The observed areas (Norton and Lawson 1985), covered by the two caracal are shown in Figure 5.1, while the homeranges are illustrated in more detail in Figures 5.2 and 5.3.

The male caracal had an observed range of 9.56km^2 (Table 5.2), while the observed range of the female animal measured 68.17km^2 (Table 5.2). Homerange sizes were much smaller, with the male and female establishing homeranges of 2.05km^2 (Fig. 5.2) and 1.31km^2 (Fig. 5.3), respectively.

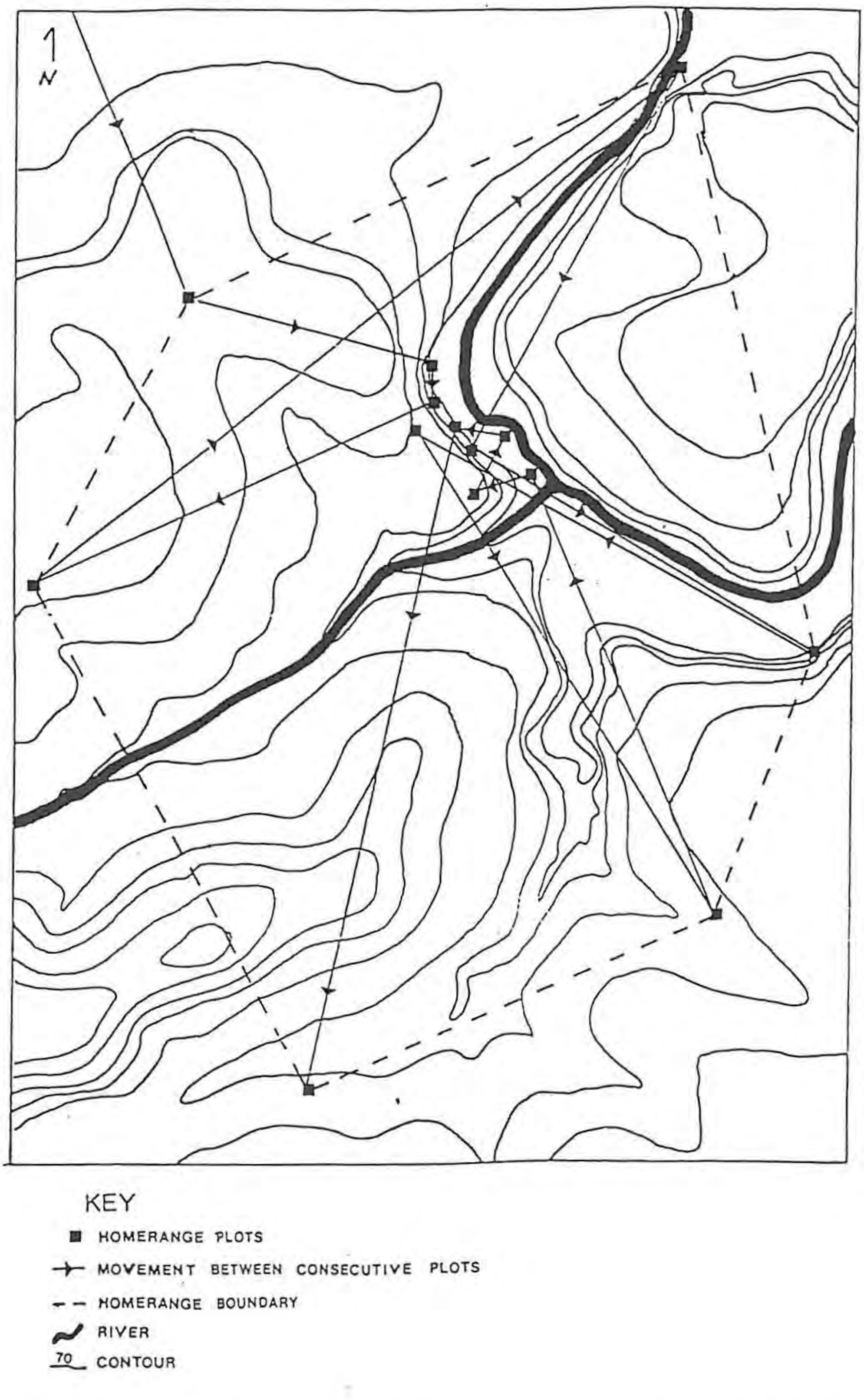

Figure 5.2. Homerange of the male caracal illustrating the core area and outer boundary as determined by points plotted over a six month period.

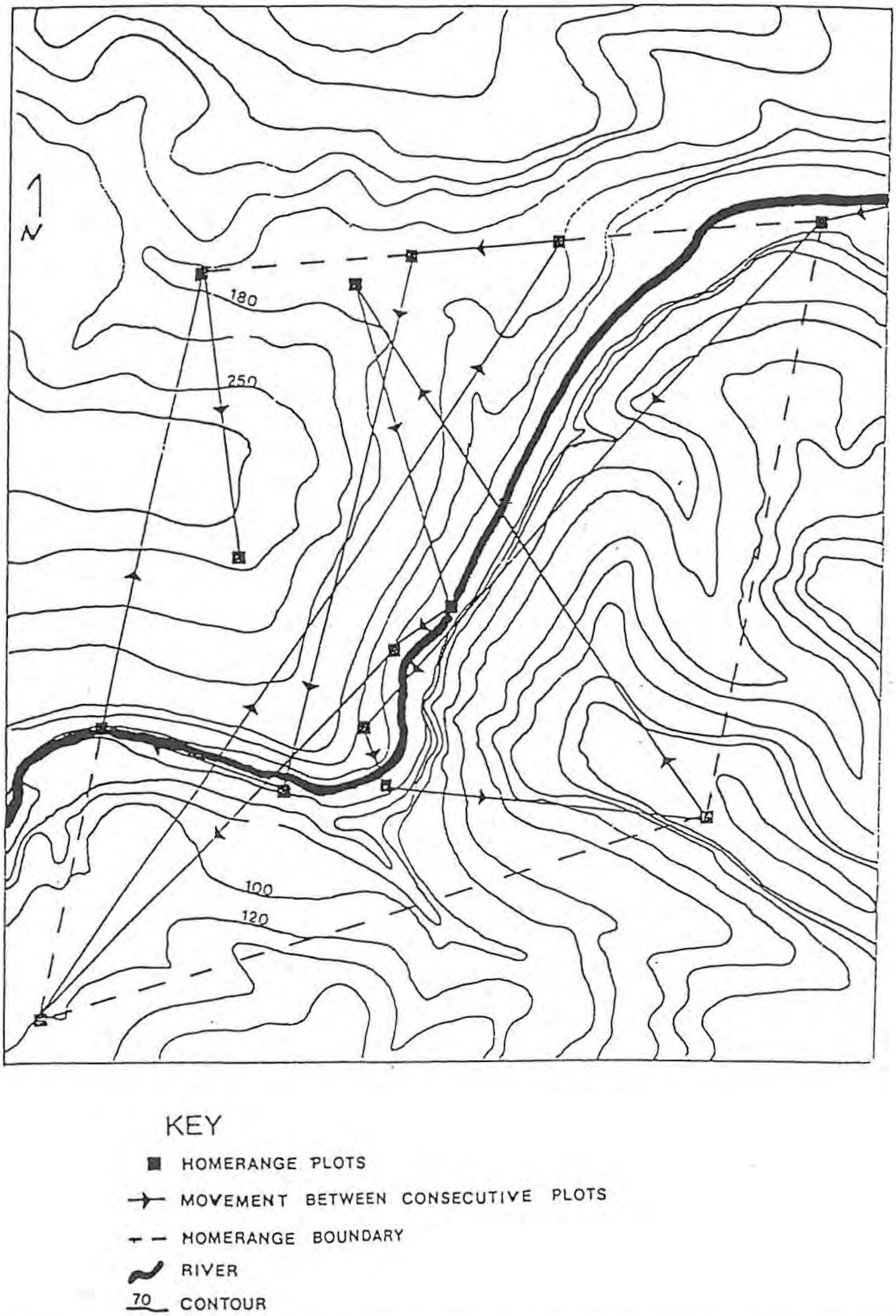

Figure 5.3. Homerange of the female caracal illustrating the core area and outer boundary as determined by points plotted over a six month period.

Table 5.2. Homeranges of caracal, as found in this study and as reported in other studies in South Africa.

Source	Locality	Sex	Sample size	Plots	Observed range	Homerange
Moolman (1986)	Mountain Zebra National Park	Male	7	$\bar{x}$=36	-	5.1-30.6km^2
		Female	4	$\bar{x}$=36	-	3.9-6.5km^2
Norton & Lawson (1985)	Western Cape	Male	1	25	895km^2	65.0km^2
Stuart (1982)	Karoo	Male	1	62	697km^2	48.0km^2
		Female	3	$\bar{x}$=24	-	11.8-26.7km^2
Present (1993/1994)	Albany	Male	1	18	9.6km^2	2.1km^2
		Female	1	28	68.2km^2	1.3km^2

The first four plots recorded for the male caracal and the first 13 plots recorded for the female animal, were not considered in the calculation of homerange sizes, as they indicated rapid movement away from the site of release (Fig. 5.1) and were therefore attributed to translocation (Norton and Lawson 1985). These plots were however, used in the calculation of the observed ranges of both animals (Norton and Lawson 1985).

Within nine days of being released, the male caracal had moved approximately 11km from Kariega Park, in a northwesterly direction along the Kariega River (Fig. 5.1). This animal then reversed direction, moving approximately 3km back in the direction of Kariega Park, eventually settling in a small area in the vicinity of Farmerfield (Fig. 5.1). This small homerange included livestock grazing areas, thickly wooded kloofs with adjoining cliffs and dense riverine bush (Fig. 5.2). The majority of locations were recorded at the foot of a large cliff, with the animal also making regular excursions along small, densely vegetated river courses (Fig. 5.2). Although the homerange of this animal included livestock grazing areas, no stock losses were reported by the landowner throughout the study period. This animal was found dead on the 27 January 1994, approximately six months after being released.

The female caracal exhibited a greater dispersal than the male animal, moving in a westerly direction from Kariega Park, approximately 15km along the Bushmans River (Fig. 5.1). The female eventually settled within a small area along a steep, densely wooded kloof (Fig. 5.3).

Due to reported losses of bushbuck and blue duiker, this animal was re-captured and re-released on Kariega Park. Within 14 days of being re-released, the female had moved back to her original homerange, where she remained until being killed by huntsmen on the 6 September 1994, approximately six months after her original release. With the exception of the final location, all the locations for the female caracal were recorded at the foot of steep cliffs, along water courses, or amongst dense vegetation (Fig. 5.3).

Due to the deaths of both animals, within six months of being released, no data were obtained on the possible seasonal changes in homerange sizes.

The observation area curves for both animals did not appear to level off before ten plots (Figs 5.4 and 5.5), although a subtle levelling off effect was observed between 10 and 15 plots, with this phenomenon being more apparent for the homerange of the female caracal (Fig. 5.5).

5.4. DISCUSSION

It is apparent from the data presented in Table 5.2, that the homerange sizes recorded in the present study are certainly the smallest reported for caracal to date. Prior to this study, the smallest recorded homerange was 3.9km^2 (Moolman 1986), for a female caracal in the Mountain Zebra National Park. The mean homerange sizes for male and female caracal, recorded from the Western Cape (Norton and Lawson 1985, Stuart 1982) and Karoo (Moolman 1986), are 25.7 and 11.8km^2 respectively.

There are a number of factors, both human and biological, which may be useful in explaining the relatively small homerange sizes recorded in the present study. As the calculation of homerange size, using the minimum area method of Mohr (1947), is inherently biased depending on the number of plots recorded (Norton and Lawson 1985), the relatively few plots recorded for the two study animals (18 for the male and 28 for the female), may well have had a bearing on the calculated homerange size. This idea is further supported by Jenrich and Turner (1969), who claim that this bias is substantial when the number of recorded plots is less than 25. Previous studies conducted on caracal however, seem to suggest otherwise. Norton and Lawson (1985), reported a levelling off of homerange size for a male caracal,

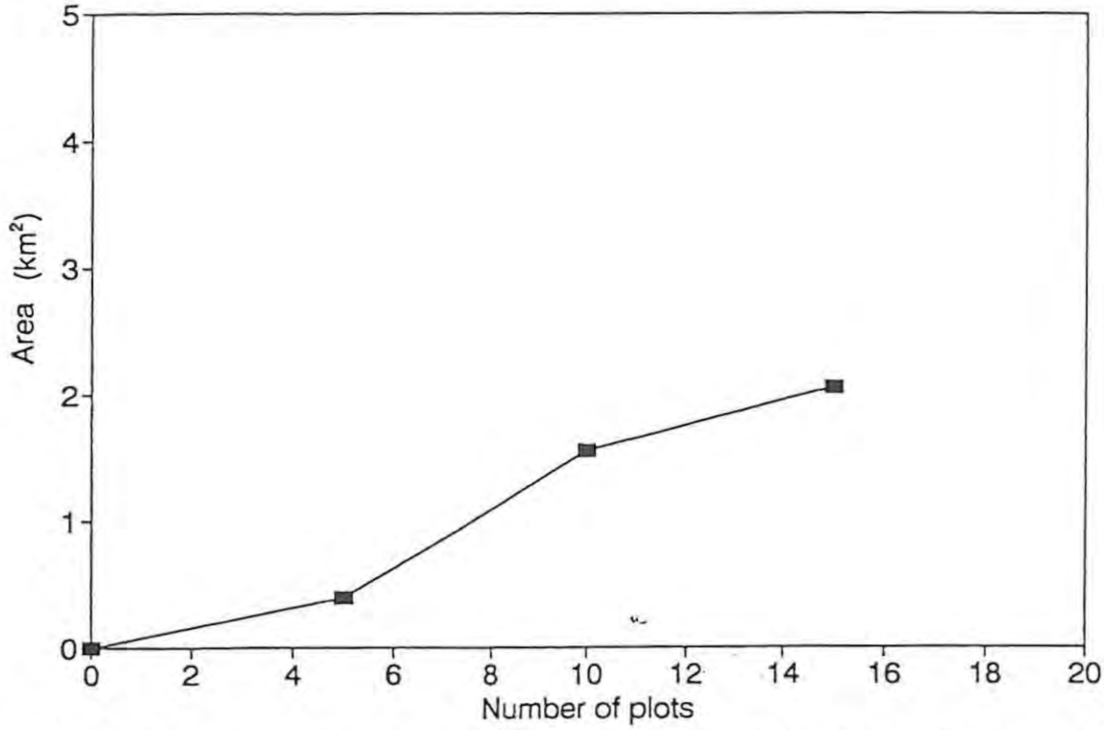

Figure 5.4. The observation area curve for the male caracal showing the leveling-off effect that results after sufficient points have been plotted.

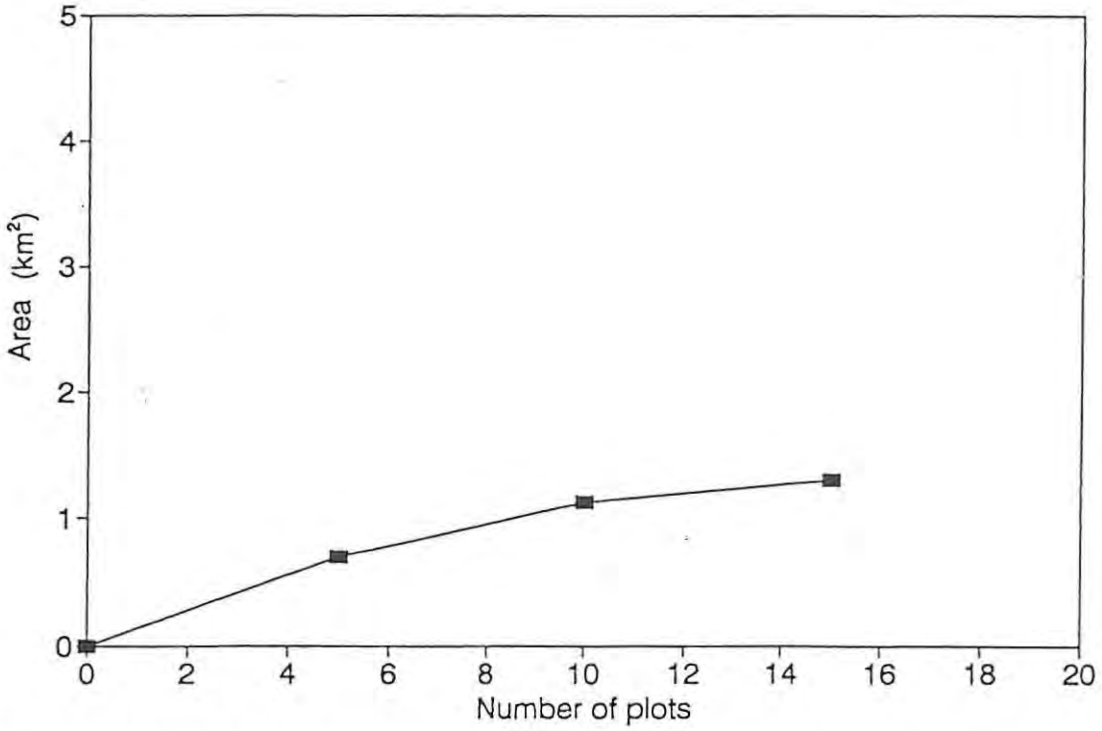

Figure 5.5. The observation area curve for the female caracal showing the leveling-off effect that results after sufficient points have been plotted.

after only 15 plots had been recorded. Furthermore, Moolman (1986) and Stuart (1982), recorded larger homerange sizes than the present study, although recording similar numbers of plots (Table 5.2). This seems to suggest that the actual number of plots recorded in these studies, was not as crucial as may have been the case elsewhere.

Furthermore, the male and female animals reached their recorded homerange areas within nine and 44 days respectively, remaining in these areas until death. When compared to the actual time spent radio tracking these caracal therefore, the two study animals remained in their respective homerange areas for relatively extended periods, possibly suggesting that these areas were stable over the study period (Norton and Lawson, 1985). It is therefore felt that an increase in the number of plots alone, would not have led to a significant increase in the size of either the recorded homeranges.

A factor which may well have influenced the size of the homeranges, is the time at which radio tracking was conducted. It is interesting to note that most of the locations which comprise the outer boundaries of the homerange polygons, were plotted during the late afternoon or early morning. Most of the locations plotted near the centres of the homerange polygons however, were recorded around midday. This phenomenon suggests that during the evenings, or early mornings, these animals would set out, or return, from hunting, or patrol their respective territories, returning to their favoured resting places during the heat of the day. As caracal are known to be predominantly nocturnal in areas where they are persecuted (Stuart 1982), it is not surprising that different locations were plotted at different times of the day. Unfortunately, radio tracking was not conducted often enough to enable the calculation of 'daily movement distances' (Hamilton 1976, Moolman 1986).

Having discussed the possible influence of various human factors on the size of the calculated homeranges, it is also important to consider the other possible reasons for the observed homerange sizes.

Firstly, the relatively small recorded homerange size of the male caracal can primarily be explained by this animals' young age. According to the data presented by Stuart (1982), a male caracal of 10.2kg, would be approximately eight months of age, not yet having undergone puberty (Bernard and Stuart 1987). According to Moolman (1986), caracal show four distinct stages in the establishment of a permanent homerange. The first stage extends from birth until the animal is weaned. The second stage is a short period, during which time the animal moves around at 'random', with no discernible homerange.

During the third stage, young animals establish relatively small homeranges, prior to the fourth stage, which is the establishment of larger, permanent homeranges. This phenomenon was also mentioned by Norton and Lawson (1985), who reported that a young, male caracal of approximately seven months of age, established a temporary homerange of less than $6km^2$, prior to establishing a permanent homerange of approximately $65km^2$.

Stuart (1982), recorded a similar 'temporary refuge' of $9.25km^2$, while tracking a young male caracal, who eventually established a permanent homerange of $48.0km^2$.

It would appear therefore, that the movement patterns and small homerange size exhibited by the young male caracal in this study, correspond with the third stage described by Moolman (1986) and the ' small, temporary refuge' described by Norton and Lawson (1985) and Stuart (1982). Unfortunately however, none of the above-mentioned authors offered any explanations as to the reasons such temporary homeranges should exist. It is therefore postulated that young animals, while undergoing puberty, avoid contact, as far as possible, with adult conspecifics. This 'avoidance' period may well result in these young animals confining themselves to small areas of safety, which are void of adult animals and contain an adequate prey base (Stevenson, *pers. comm.*).

Although speculative, it seems likely therefore that had this young male not died, it would eventually have moved out of the small core area initially recorded in, to establish a larger, permanent homerange.

As opposed to the male caracal which was a juvenile animal, the female caracal was estimated to be approximately 14 months old, the age of a young adult. It is doubtful therefore, whether the homerange of this female was merely a 'temporary refuge', as is thought to be the case for the male animal. In fact, a number of relatively small homeranges, similar in size to the $1.3km^2$ recorded for this animal, were recorded for female caracal by Moolman (1986), in the Mountain Zebra National Park. These homeranges varied in size from 3.9 to $5.9km^2$. Although homerange sizes were larger than the homerange recorded for the female caracal in the present study, a similar phenomenon was reported by Stuart (1982), who recorded mean female caracal homeranges of $18.2km^2$, as opposed to a homerange size of $48.0km^2$ for a male caracal. This difference in homerange size, Stuart (1982), argued, was partly due to the fact that pregnant and lactating female caracal, need to make use of much smaller areas when hunting than males do, as it is both energetically expensive and unsafe for the kittens, if the female animal wanders over extensive areas. Although no signs of lactation were visible when the female was re-captured, it is quite likely that this animal was pregnant, as she had been accompanied by an adult male caracal prior to capture (*pers. obs.*).

Homerange size is furthermore dependent on prey abundance, conspecific density and habitat suitability (Stuart 1982; Norton and Lawson 1985). The small homerange size recorded for the adult female therefore, suggests a relatively high prey abundance, combined with a high conspecific density and suitable habitat. The homerange of the female caracal occurred within the boundaries of a game-rich farm (*pers. obs.*, Stevenson *pers. comm.*), which included thickly wooded kloofs and ravines. Together, these facts may partly explain the small homerange of the female caracal. Unfortunately, as no census of caracal was undertaken, conspecific densities within the region of the females homerange, cannot be discussed in detail. The area however, is known to be rich in caracal, often yielding large numbers of caracal during control operations (Stevenson *pers. comm.*).

A further point which warrants mention, relates to the 'vacuum effect' created by the routine extermination of territorial adult animals, by hound packs and other forms of predator control. Both areas inhabited by the male and female caracal, are regularly hunted and cleared of predators (*pers. obs.*, Stevenson *pers. comm.*). This, in part, may explain the relatively short time taken for both animals to find a suitable homerange after being released. The fact that the female caracal was able to settle in such "prime caracal habitat" (Stevenson *pers. comm.*), without any visible confrontation, further supports the possibility that the previous resident caracal, had been removed from the area, most probably through predator control activities.

No hound packs were permitted in the area during the study period, thus allowing the female caracal to settle and establish a permanent homerange.

Two points arise from the previous statement. Firstly, the use of hound packs may well prove to be an effective method of temporarily excluding predators from any given area. Secondly however, it is also apparent that such measures need to be implemented continuously, in order to be effective, as suspending such operations, simply creates vacuum areas, void of territorial animals. These vacuum areas are therefore open to re-colonization by young, dispersing animals (Moolman 1986), which may well prove to be 'problem' animals, whereas the previous, territorial animals may have been innocent of killing livestock.

Furthermore, the fact that no stock losses were reported in either of the two areas the male and female caracal were resident in, illustrates the fact that not all caracal will kill livestock, even when it is available. These 'non-stock killers', if they are territorial adults, will therefore assist in excluding potential stock killers from any given area.

Summary

In conclusion therefore, it is felt that the data obtained for the male caracal, due to his young age, represents a temporary stage in that animals establishment of a homerange and should therefore be treated with caution.

The data obtained from the female caracal however, is felt to be a true reflection of the spatial requirements of female caracal, within the lower Albany district. It suggests the region is ideally suited for caracal, being relatively rich in natural prey and containing suitable habitat. Although no caracal census was undertaken, it is further suggested that the combination of prey abundance and habitat suitability, has led to relatively high caracal numbers compared to previous study areas (Moehlman 1978, Stuart 1982), which are temporarily reduced locally, from time to time, through various predator control measures.

Possibly the most important factor relating to the size of homeranges in this study however, is the sample size. The fact that only one animal of either sex was tracked, precluded any measure of variation in homerange size. Moolman (1986), recorded differences in homerange sizes of up to 40% amongst four female caracals and of up to 83% amongst seven male caracals. This phenomenon undoubtedly illustrates the importance of tracking a number of individual animals, in order to obtain some measure of variability under local conditions, when undertaking caracal homerange studies. The small sample size which is reported in the present study and the conclusions which have been drawn therefrom, should be treated with due caution and with the understanding that they are necessarily limited.

CHAPTER SIX
PREDATOR CONTROL IN THE EASTERN CAPE

6.1. INTRODUCTION

Predator control, or, as many researchers prefer it to be called, 'problem animal control', as a management tool in livestock farming, probably dates back to the start of livestock farming itself. In South Africa, from the latter part of the nineteenth century, until recently, the Government subsidised predator control measures through a widely-used bounty system (Kingwill 1993). By 1982 however, the bounty system was rarely used (Stuart 1982).

The onus today, is on the landowner to undertake control measures, as problem animal control is seen as being "primarily the responsibility of the landowner, as it forms an integral part of his/her production process" (Anon. Cape Nature Conservation Training Manual 1992).

The preferred *modus operandi* of the Government with regard to problem animal control at present, is outlined in the Problem Animal Control Ordinance no. 26 of 1957. This ordinance makes provision for groups of six or more landowners to form a hunt club for the purpose of hunting proclaimed problem animals. Members are required to pay an annual fee, which is usually determined by the size of their property (John Potter, *pers. comm.*). It is necessary for such hunt clubs to be registered by a Regional Services Council, with the Provincial governing body being the controlling body of all clubs. A Government subsidy may then be made available, in order to pay for the hunter's salary and the maintenance of a pack of hounds. Legally, such hunt clubs may enter and hunt proclaimed problem animals on any land without the landowner's permission, excluding Tribal Trust Land and proclaimed nature reserves.

In the Eastern Cape, this subsidised hunt club system is by far the most common form of problem animal control (*pers. obs.*, Pringle and Pringle 1979, Stuart 1982) and is also common in KwaZulu-Natal (Bigalke and Rowe-Rowe 1969, Lawson 1989). A hound pack usually comprises eight to 12 dogs, consisting of one or two greyhounds, used for their speed, one or two Jack Russels/Fox Terriers, which enter the burrows of cornered animals and the Foxhounds which give chase to the problem animal. The Foxhounds must exhibit characteristics such as hard feet, stamina, an excellent sense of smell and a strong baying voice, all of which are selected to ensure they do not lose the quarry in the harsh terrain and conditions often encountered. When on the trail of a problem animal, the hounds primarily make use of their sense of smell. The warm, dry conditions in the Eastern Cape however, usually lead to the rapid dissipation of such scent trails, often necessitating the deployment of the hounds before sunrise (*pers. obs.*).

In addition to using hound packs, numerous alternative control measures are available to landowners. In the Eastern Cape, these include coyote getters (Janse van Rensburg 1965, Brand 1993) and cage traps (Strydom 1993), for the control of black-backed jackal and caracal respectively, while steel-jawed traps (Rowe-Rowe and Green 1981), toxic collars (Loubser 1993), or poison drop baits (Laws 1993), may be used against either species.

'Deterrent techniques' which are employed, include the use of predator proof and electric fencing (Heard and Stevenson 1987, Heard 1993), or the use of guard dogs at night. Management options, which are widely in use, include the timing of the lambing season, or the kraaling of livestock at night and/or at certain times of the year (Potter, Stevenson *pers. comm.*).

The choice of control measure is dependant on a variety of physical and human factors, which include climate, vegetation, topography and experience. The choice ultimately however, of which control measure to use, is often based on past experience, personal preference and cost.

6.2. MATERIALS AND METHODS

The hunt returns of a representative hunt club were analysed, in order to record any observed trends in predator control in the Eastern Cape and to assess the general efficiency of local hunt clubs, when compared to similar organisations in KwaZulu-Natal (Bigalke and Rowe-Rowe 1969).

Data recorded for black-backed jackal and caracal killed by the 'Potter Hound Pack', which is one of three hound packs comprising the Henderson Hunt Club, were analysed over a seven year period, from 1982-1989. Insufficient records were available for 1985.

All data were recorded by the owner of the hound pack, Mr John Potter, on official forms supplied by the Provincial Nature Conservation Authorities.

The hound pack in question is used intensively in predator control operations, primarily on farmland and occasionally on government forestry land, in the Great Kei River valley. The selection of the 'Potter Pack', as a representative hound pack, was based on the facts that:

1) detailed records had been kept for an extended period
2) the hounds hunted continuously, thus ensuring a constant hunting ability at all times
3) the fact that the same huntsman had been in control of the hounds for the entire period, thereby ensuring a relatively uniform human effort (Stevenson *pers. comm.*)

6.2.1. Definitions

The huntsman in charge of the hound pack, Mr Z. Fana, made a distinction between two age categories, namely 'young' and 'adult'. For this reason therefore, 'young' is taken to mean juvenile animals killed in the vicinity of their natal den, prior to dispersal, whereas 'adult' is taken to mean any animal which has dispersed from its natal den.

The unit of hunting effort is the 'pack day', which is defined as one pack of dogs, comprising between 10 and 14 animals, hunting on one day (Bigalke and Rowe-Rowe 1969). No allowance was made for possible differences in the amount of time spent hunting on different days.

6.3. RESULTS

A total of 118 black-backed jackal, 52 caracal and 19 non-target animals, comprising five species, were killed by the Potter Hound Pack over a seven year period (Table 6.1). Annual rainfall and temperature data for the Eastern Cape are presented in Figure 6.1.

The non-target species killed comprised seven African wild cats (*Felis lybica*), six Cape foxes (*Vulpes chama*), three bushpigs (*Potamochoerus porcus*), two African civets (*Civettictis civetta*) and one white-tailed mongoose (*Ichneumia albicauda*). A total of 1 804 pack days were recorded, with a mean of 21.5 pack days per month (Table 6.1).

6.3.1. Seasonality of kills

The total numbers of all animals killed, on a monthly basis, during predator control operations, can be seen in Figure 6.2, while mean monthly data are presented in Table 6.1 and Figures 6.3-6.6.

Total black-backed jackal kills peaked during September (19) and October (18), while total caracal kills peaked during January (8), February (7) and March (10), (Fig. 6.2). The least number of black-backed jackal were killed during December (4), January (5) and May (5), while caracal kills were at their lowest during June, July, September and October, with a total of only one animal being killed in each month (Fig. 6.2).

The ratio of total black-backed jackal:caracal killed was greatest during September (18:1) and October (19:1). January was the most productive month for killing caracal, in terms of caracal:black-backed jackal ratio, with a ratio of 1.6 caracal killed for every black-backed jackal. March was the most productive month in terms of pack days per kill, with the Potter Hound Pack recording a mean pack day per caracal kill of 15.9 (Table 6.1).

6.3.2 Hunting efficiency

The efficiency of the Potter Hound Pack, in terms of pack days per kill (PD/k), on a monthly and annual basis, is shown in Tables 6.1 and 6.2. The overall hunting efficiency for all species, is 9.5 PD/k, while that for black-backed jackal (15.2 PD/K), is significantly different from that of caracal ($\chi^2 = 10.41$; df = 1; $p < 0.01$).

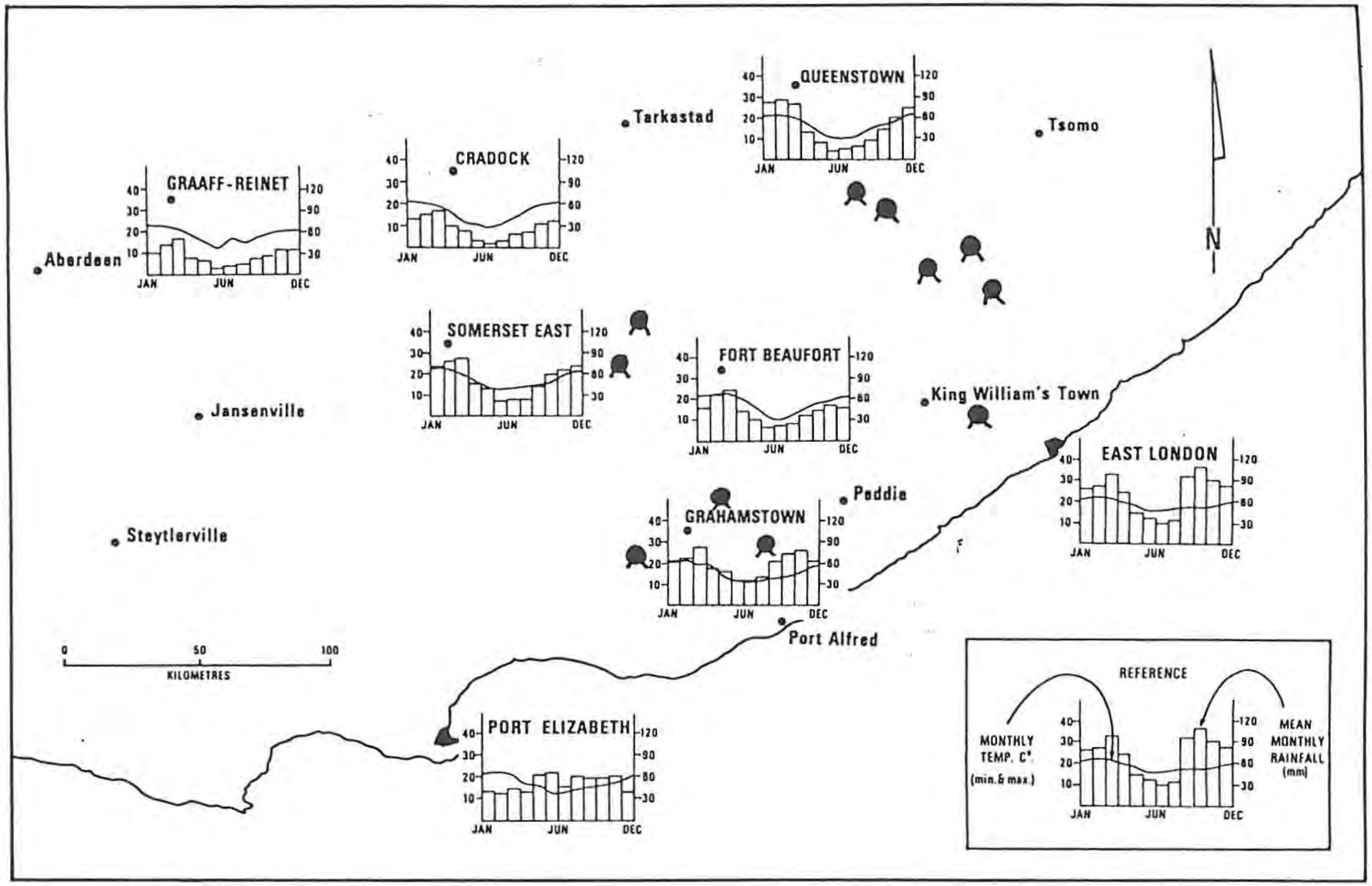

Figure 6.1. The Eastern Cape, with the hunt clubs marked (●) and temperature and rainfall data for selected localities.

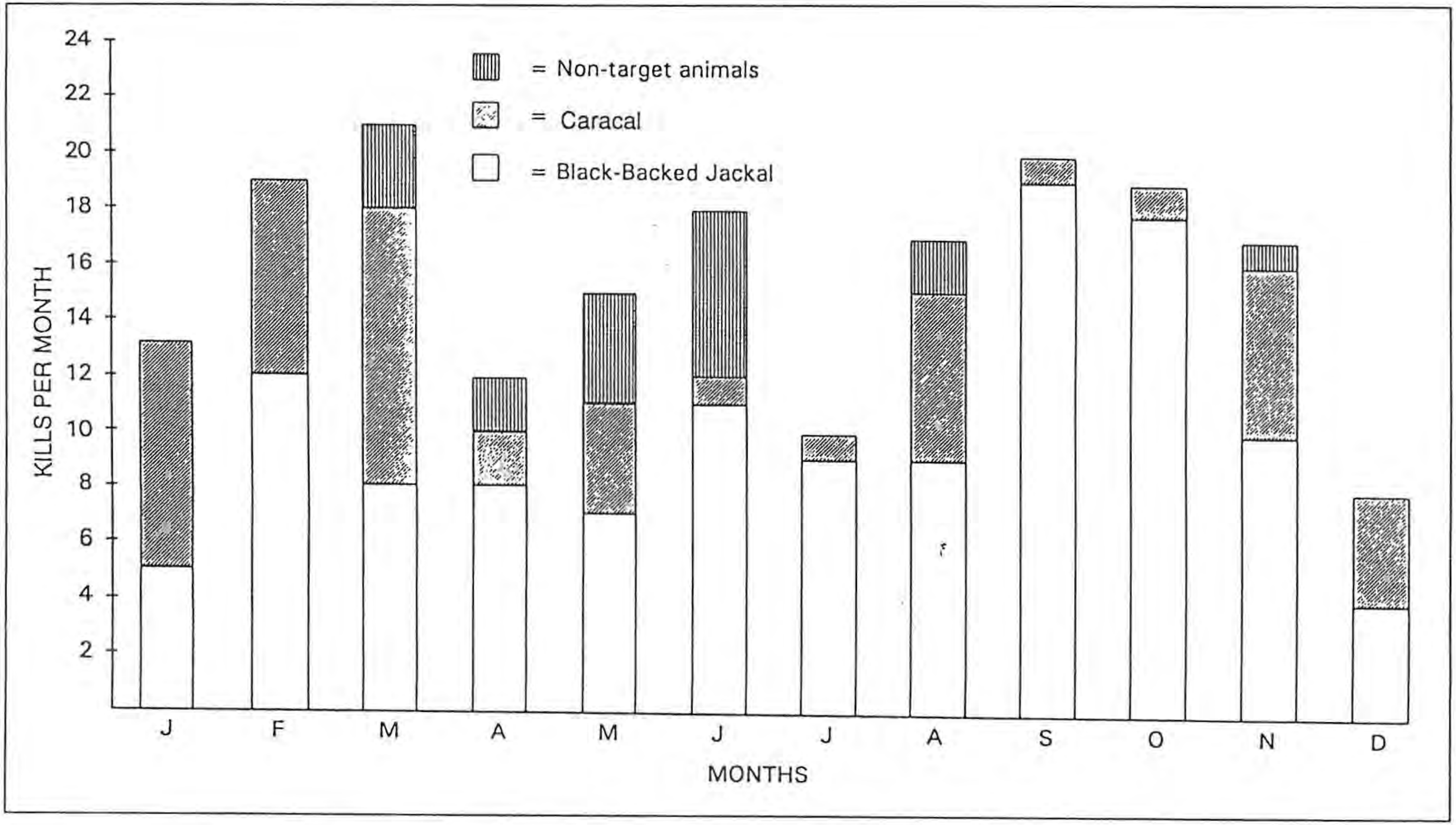

Figure 6.2. The total number of monthly kills (including young), killed by the Potter Hound Pack, from 1982-1989.

Table 6.1. Summary of the data for the Potter Hound Pack, over a seven year period (1982-1989).

PD = Total number of Pack days
$\bar{x}$ = Average number of pack days/month
Mean±SD = Mean number of Black-backed Jackal/Caracal killed per month ± Standard Deviation
PD/Kill = Number of Pack Days/Kill

Month	PD	$\bar{X}$	Black-backed Jackal	Mean±SD	PD/Kill	Caracal	Mean±SD	PD/Kill	Non-target animals	PD/Kill	Total PD/Kill
January	141	20.1	5	0.71±0.95	28.2	8	1.14±1.66	17.6	-	-	10.8
February	142	20.3	12	1.71±1.49	11.8	7	1.00±1.53	20.3	-	-	7.4
March	159	22.7	8	1.14±0.81	19.9	10	1.43±1.25	15.9	3	53.0	7.5
April	164	23.4	8	1.14±0.81	20.5	2	0.29±0.48	82.0	2	82.0	13.6
May	157	22.4	5	0.71±1.11	31.4	5	0.71±1.11	31.4	5	31.4	10.5
June	157	22.4	11	1.57±2.15	14.3	1	0.14±0.38	157.0	6	26.2	8.7
July	145	20.7	9	1.29±2.56	16.1	1	0.14±0.38	145.0	-	-	14.5
August	137	19.6	9	1.29±1.79	15.2	6	0.86±1.07	22.8	2	68.5	8.1
September	160	22.9	19	2.71±3.49	8.4	1	0.14±0.38	160.0	-	-	8.0
October	157	22.4	18	2.57±1.90	8.7	1	0.14±0.38	157.0	-	-	8.2
November	159	22.7	10	1.43±1.27	15.9	6	0.86±0.89	26.5	1	159.0	9.4
December	126	18.0	4	0.57±0.79	31.5	4	0.57±0.78	31.5	-	-	15.8
Total	1 804	21.5	118		15.2	52		34.7	19	94.9	9.5

Overall, the most efficient months for hunting were February (7.5 PD/k), March (7.6 PD/k) and September (8.0 PD/k), while the least efficient months were April (13.6 PD/k), July (14.5 PD/k) and December (15.8 PD/k). This difference in monthly hunting efficiency is not significantly different ($\chi^2 = 2.09$; df = 1; $p > 0.05$).

The hunting efficiency of the Potter Hound Pack and the annual number of problem animals killed from 1982-1989, can be seen in Table 6.2. The greatest number of black-backed jackal were killed during 1986 (24) and 1989 (25), while the least number were recorded in 1983 (6). The greatest number of caracal were killed in 1983 (16), while the least were killed in 1988 (1). The most efficient years, in terms of pack days/kill, were 1982 (8.6) and 1989 (7.9), while the least efficient year was 1984 (16.5). These differences are, however, not significantly different ($\chi^2 = 2.76$; df = 1; $p > 0.05$).

Table 6.2. The annual number of predators killed, and the effort required to kill them, by the Potter Hound Pack, over a seven year period (1982-1989).

PD/Total Kill = Pack Days per Total number of Kills, including non-target animals

PD/Kill = Pack Days per Black-backed Jackal and Caracal Kills (excluding non-target animals).

Year	Pack Days	Black-backed Jackal	Caracal	Non-target animals	Total	PD/ Total Kill	PD/ Kill
1982	258	21	9	4	34	7.6	8.6
1983	268	6	16	5	27	9.9	12.2
1984	281	9	8	9	27	10.4	16.5
1986	254	24	5	0	29	8.8	8.8
1987	246	14	6	1	21	11.7	12.3
1988	245	19	1	0	20	12.3	12.3
1989	252	25	7	0	32	7.9	7.9
Total	1 804	118	52	19	189	9.5	10.6

6.3.3. Sex ratios

The total annual and mean monthly ratios of male:female black-backed jackal and caracal killed by the Potter Hound Pack, are illustrated in Table 6.1 and Figures 6.3 and 6.4. Seventy two (61%), of all black-backed jackal killed were males, while 32 caracal (60%), were found to be males. No data were recorded regarding the sex of non-target animals.

An overall ratio of 1.6:1 males to females was recorded for black-backed jackal. The greatest ratio of adult male:female black-backed jackal killed, was recorded during January (5:0), May (4:1) and August (3.5:1) (Fig. 6.3).

An overall ratio of 1.5:1 males to females was recorded for caracal. The largest ratio of adult male:female caracal, was recorded during August (5:1) and November (2:1). During the months of April, July, September and October, no females were killed at all. No male animals were killed during June (Fig. 6.4).

6.3.4. Age group incidence

A total of 16 black-backed jackal pups (13.5%) and four caracal kittens (7.6%), were killed (Figs 6.5 and 6.6).

Black-backed jackal pups were only killed during August, September and November (Fig. 6.5), while caracal kittens were only killed during January and March (Fig. 6.6).

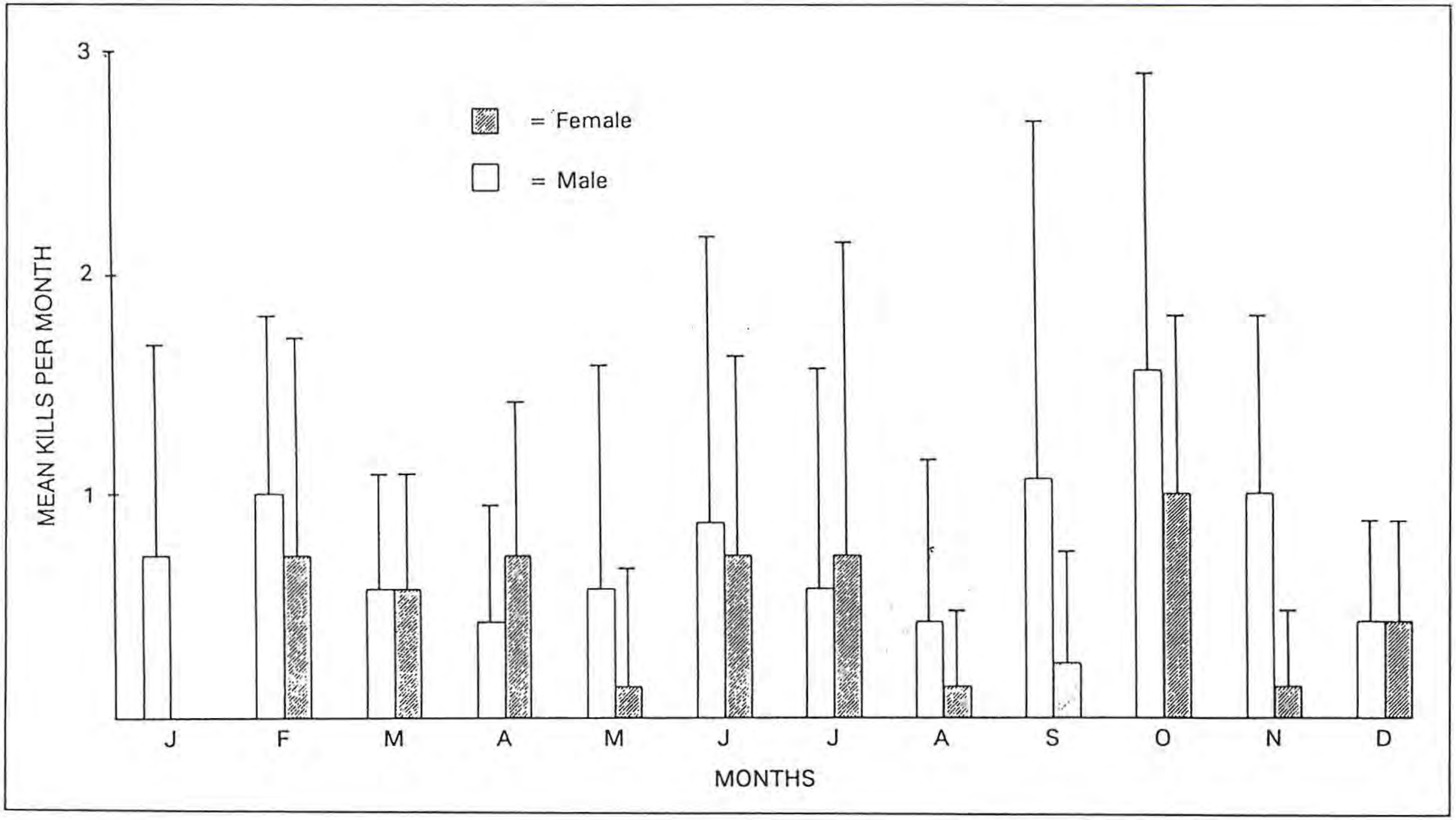

Figure 6.3. The mean monthly incidence of adult male and femal black-backed jackal killed by the Potter Hound Pack, from 1982-1989 (vertical lines represent standard deviation).

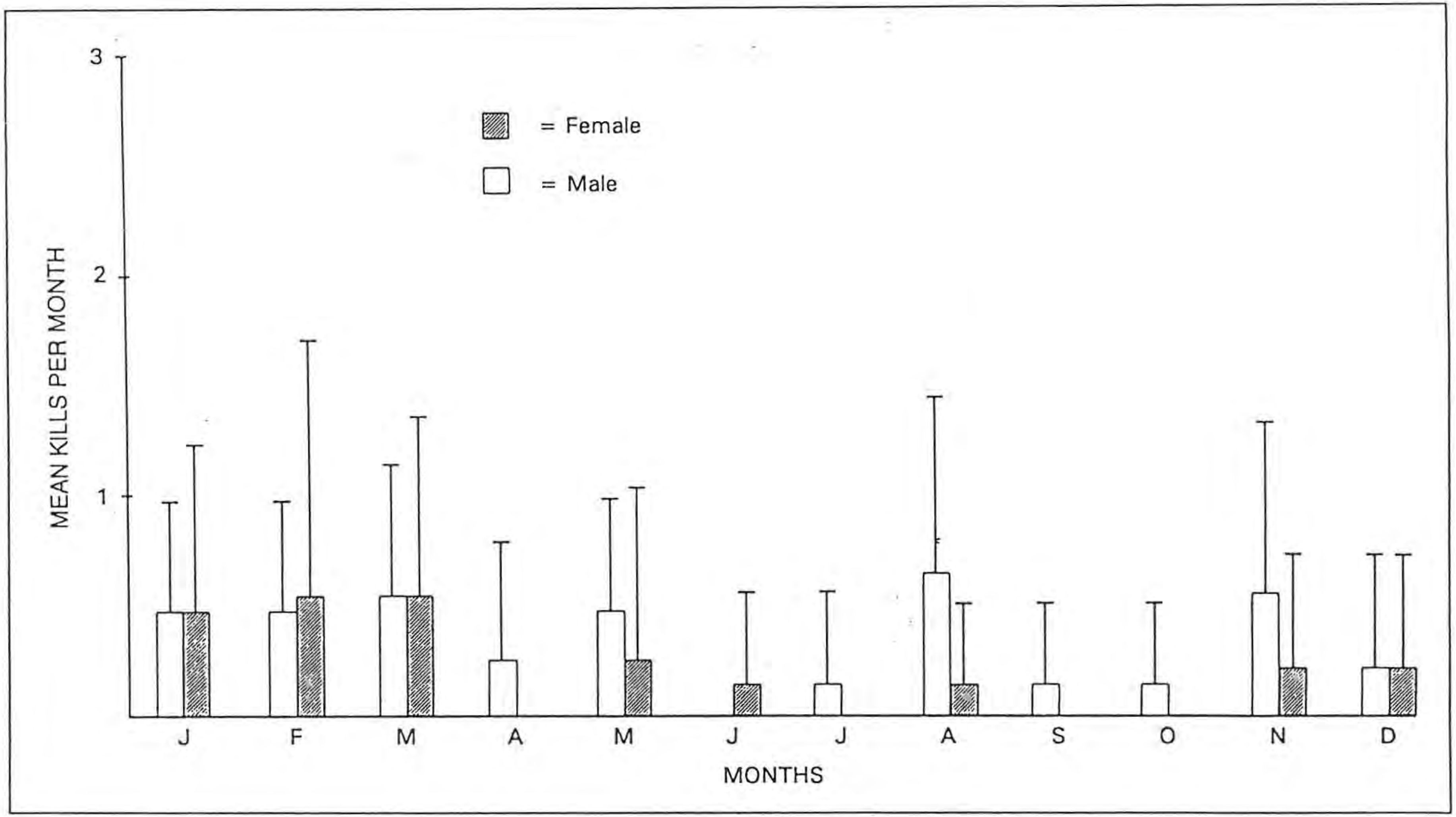

Figure 6.4. The mean monthly incidence of adult male and female caracal killed by the Potter Hound Pack, from 1982-1989 (vertical lines represent standard deviation).

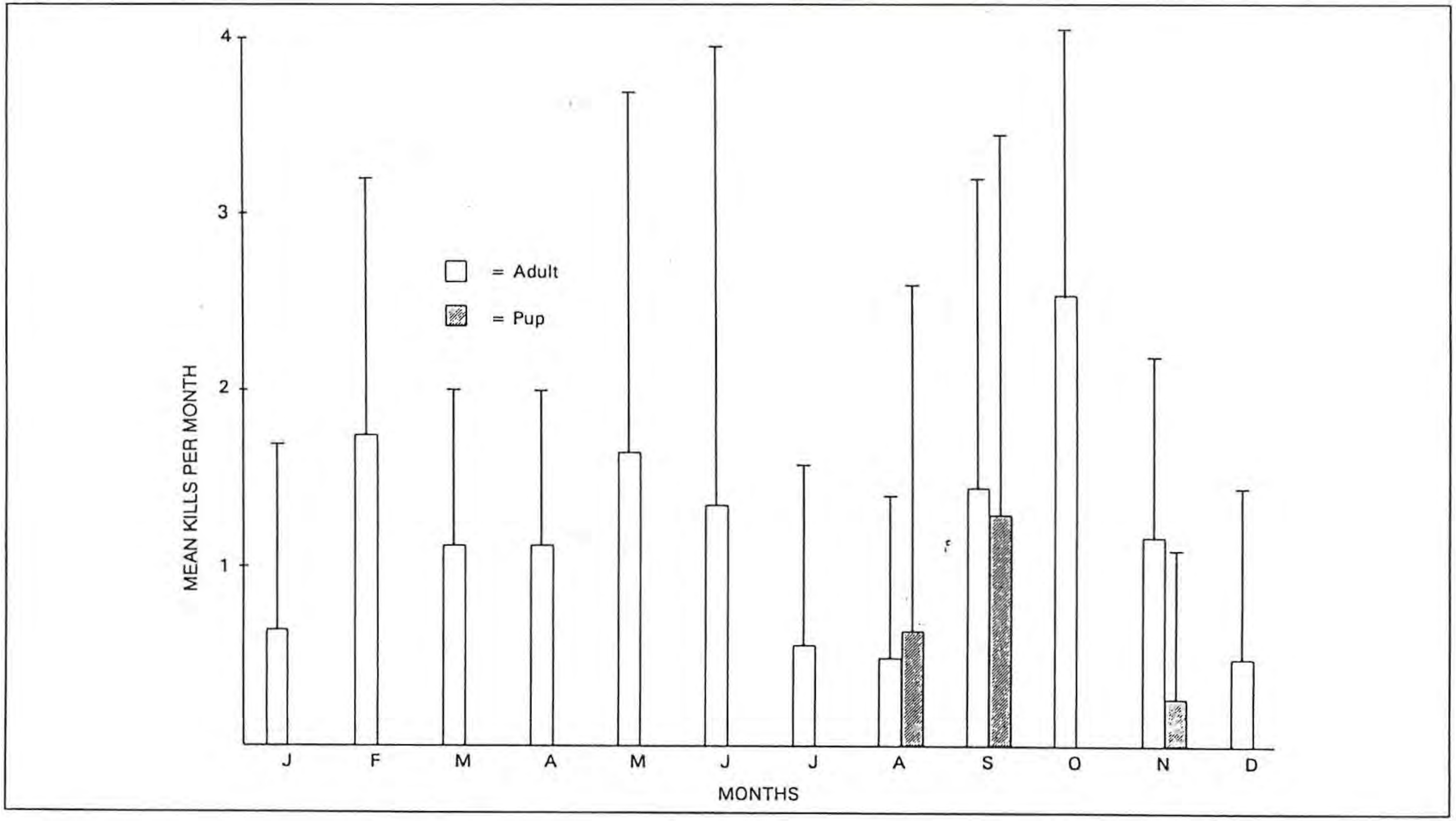

Figure 6.5. The mean monthly incidence of black-backed jackal adults and pups killed by the Potter Hound Pack, from 1982-1989 (vertical lines represent standard deviation).

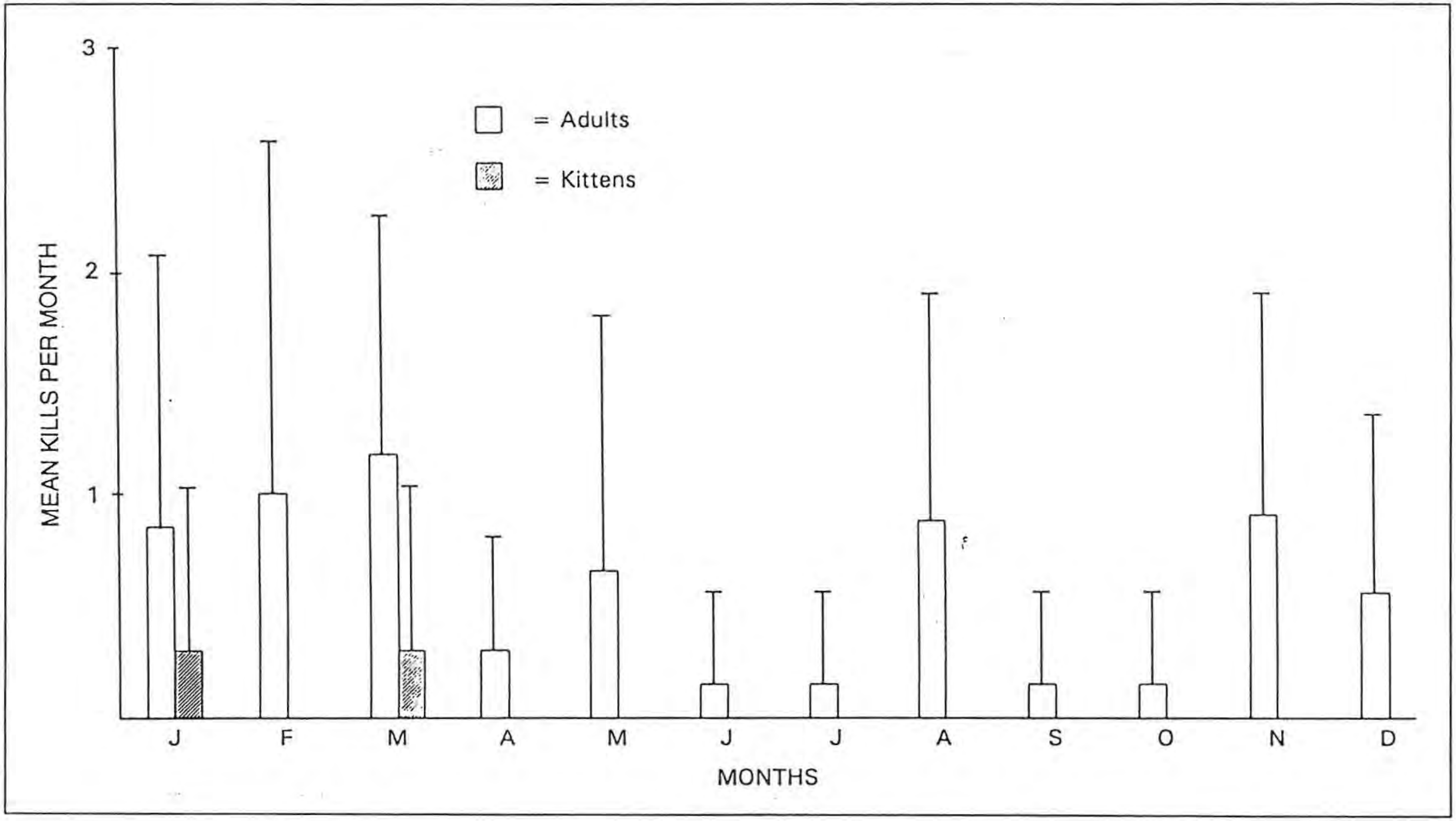

Figure 6.6. The mean monthly incidence of caracal adults and kittens killed by the Potter Hound Pack, from 1982-1989 (vertical lines represent standard deviation).

6.4. DISCUSSION

The composition and seasonality of the kills recorded by the Potter Hound Pack and the hunting efficiency of the pack, can be explained by considering a number of human, climatic and species-specific biological factors.

6.4.1. Seasonality of predator kills

The climatic conditions in any area which is hunted, strongly influence the seasonal distribution of kills (Bigalke and Rowe-Rowe 1969, Pringle 1986).

As previously mentioned, the hounds used for predator control operations, rely predominantly on their keen sense of smell to track problem animals. Whereas warm, moist conditions assist the hounds in picking up a scent, cold, dry and windy conditions make this task more difficult (Bigalke and Rowe-Rowe 1969, Pringle 1986). The region in which the Potter Hound Pack operates, records minimum temperatures and rainfall during the months May-July (Stone 1988). It can therefore safely be assumed, that these months represent the least favourable period for hunting with hound packs and are therefore responsible for the relatively low numbers of black-backed jackal and caracal killed during April-July (Fig. 6.2) and the high total number of Pack Days/Kill (Table 6.1).

These climatic factors, it is argued, further lead to the higher number of non-target animals caught in May/June, as scent trails possibly become increasingly difficult to distinguish. The fact that the hounds in question, are trained to specifically follow only black-backed jackal and caracal scent and the fact that non-target kills peak during May/June, suggest that the incidence of these kills is merely a 'mistake' on the part of the hound pack, rather than due to a decline in predator numbers over this period.

The relatively low number of predator kills recorded during December (15.8 PD/kill), compared to October/November, is directly related to human influence. In the latter half of December, the huntsman responsible for the hound pack, receives his annual leave, during which time the hounds are not hunted. The greater number of kills recorded during December in Natal (Bigalke and Rowe-Rowe 1969), as opposed to the Potter Hound Pack, can be explained by the fact that the hunting in Natal was carried out by officers of the Natal Parks

Board, who hunted throughout the year, or were replaced when on leave, thus ensuring a continuous hunting effort.

6.4.2. Annual incidence of kills

It appears from the data that the number of caracal killed generally declines whenever the number of black-backed jackal killed increases and *vice versa* (Table 6.2). This would seem to suggest a strong interspecific relationship between black-backed jackal and caracal in any given area. Similar observations have been reported by Pringle (1986) and Pringle and Pringle (1979), who claimed that a decrease in black-backed jackal numbers in any given area, ultimately leads to an increase in the number of caracal. The authors further postulated that this phenomenon is due to the fact that although caracal are physically stronger than black-backed jackal, the latter species out-competes the caracal as it is able, through its keen sense of smell, to locate and devour caracal litters. The removal of this check will in all probability result in an increase in caracal numbers (Pringle and Pringle 1979). Food availability, disease epidemics and habitat change due to farming practices however, may all contribute to the relative abundance of any given predator (van Rensburg 1993). It is therefore speculative to assume interspecific aggression to be the sole cause of annual species composition of hound pack kills, although the findings of this study would suggest that such aggression does indeed occur. A further factor which may contribute to the composition of hound pack kills, lies in the possibility that the hound packs preferentially hunt black-backed jackal, switching to caracal when black-backed jackal numbers are low, thereby resulting in greater caracal kills at the time.

Furthermore, the data presented in this study, in no way indicates a decline in predator numbers in the area hunted, due to control measures. In fact, hunting proved to be as successful in 1989 (7.9 PD/kill), as in 1982 (7.6 PD/kill), (Table 6.2). These findings are supported by Bigalke and Rowe-Rowe (1969) and Pringle (1986), who felt that hound packs were in no way capable of totally eliminating either black-backed jackal or caracal from an area. The use of hound packs therefore, if correctly trained, results primarily in the selective removal of specific problem animals and/or the removal of 'excess' predators from a given region.

6.4.3. The incidence of age classes

The greatest number of black-backed jackal are killed during September/October (Fig. 6.2 and Table 6.1), with the kill in these months consisting primarily of adult males (Fig. 6.3), while pups were only recorded in August, September and November (Fig.6.5). These findings are supported by Bigalke and Rowe-Rowe (1969), who reported black-backed jackal kills in Natal, to peak from October to February, with pups only being recorded from October to December.

In contrast, caracal kills peak from November to March (Fig. 6.2), with kittens only being recorded in January and March (Fig. 6.6).

The composition of these kills, it can be seen, follows the natural reproductive patterns of black-backed jackal and caracal. The fact that black-backed jackal births peak during the dry season (Fairall 1968, Rowe-Rowe 1978, Stuart 1981, Estes 1993), explains the predominance of pups during August and September, which constitute the tail end of the dry season in the Eastern Cape (Stone 1988).

The seasonal occurrence of caracal kittens is supported by Pringle (1986) and Bernard and Stuart (1987), who reported caracal births in the Eastern Cape to peak from October to February. As no prior research has been conducted on the seasonality of caracal kills, the data in this study could not be compared to any prior findings.

As black-backed jackal litters usually consist of 3-4 pups (Estes 1993), with up to seven pups being recorded (Roberts 1951), and caracal litters usually containing 2-3 kittens (Stuart 1982), young animals can be expected to form a major component of their respective populations during months of peak births. It is perhaps strange therefore, that in the present study and those of Bigalke and Rowe-Rowe (1969), black-backed jackal pups merely comprise 13.5% and 5.5% of their populations respectively. The figures for caracal are very similar, with the present study recording only 7.5% kittens out of the total number of animals killed, while Pringle (1986), reported kittens to comprise 9% of the caracal population in the Bedford district.

It is highly unlikely though, that the low numbers of pups and kittens killed, reflects the incidence of these age groups in the respective populations. The young animals remain hidden or seek refuge in dens (Skinner and Smithers 1990) and are therefore most probably under-represented in the kills recorded by the Potter Hound Pack. One can conclude therefore, that the method of hunting these predators with hounds, is biased in favour of adult animals at all times of the year, even during the months when young animals would be considered to be the most prominent age group in the composition of kills. If the stated objective of the landowner is the total removal of all black-backed jackal and caracal, the use of hounds would appear to be a helpful means, as predominantly adult, sexually mature animals are killed, thus reducing the reproductive capacity of the respective populations. On the other hand however, the use of hounds could possibly contribute to creating undefended 'vacuum' areas with regard to adult animals, which may then well attract young, immature animals. Compared to the older animals, these young animals, possibly due to less experience in taking natural prey items, may be more prone to killing livestock (Pringle 1986) and may thus ultimately cause more damage.

6.4.4. Sex ratios

The sex ratios of killed predators, indicates an overall tendency for the hounds to kill more male, than female animals, for both species.

The sex ratios recorded for black-backed jackal by the Potter Hound Pack, are strongly supported by the findings of Bigalke and Rowe-Rowe (1969), who also reported a greater male:female ratio in kills, during summer months. This phenomenon is thought to be due to the fact that during the months of parturition and lactation, females with pups would tend to be more wary, whereas males in general are thought to be more aggressive and would thus be more prone to defending a territory and/or mate (Bigalke and Rowe-Rowe 1969).

The sex ratios recorded for caracal, as opposed to black-backed jackal however, show a definite increase in the number of females killed from November to March, when caracal births are known to peak in the Eastern Cape (Bernard and Stuart 1987). These contrasting sex ratios recorded between the two species during months of peak births and lactation, can partly be explained by the different social structures exhibited by these predators. Whereas black-backed jackal form long-term pair bonds (Estes 1993), with the male helping to defend the young, female caracal are left to care for and defend the young on their own (Skinner and Smithers 1990). Whereas female and young black-backed jackal may therefore have the protection of a male if confronted by a hound pack, female caracal have no such benefit. The greater energetic demands placed on the female animals during lactation, may further explain the reported sex ratios of these species. As female caracal do not have the benefit of helpers when rearing young, they would naturally be expected to hunt prey themselves. During these times of energetic stress, it is foreseeable therefore, that relatively easy prey, such as livestock would feature prominently in the diet of the animals. This pattern, in turn, would increase the chance of these females coming into contact with the hound packs, thus featuring more often during 'lactation months', in the kills recorded by such packs. Black-backed jackal females however, although experiencing similar energetic demands, have the advantage of helpers from previous litters (Estes 1993) and a male mate. As these helpers are known to hunt and subsequently regurgitate food for the young pups (Skinner and Smithers 1990, Estes 1993), the risk of exposure to the hound packs by the female, is greatly reduced, thus possibly explaining the fewer number of black-backed jackal females killed during the months of lactation, as opposed to female caracal.

The results obtained by Pringle (1986) and Pringle and Pringle (1979), both indicate a near-equal ratio of male:female caracal killed over a number of years. The difference between these results and the results of this study (sex ratio of 1.5 males for every female), may be explained by looking at the different hunting techniques used by the two hound packs. Whereas the Potter Hound Pack hunted only specific problem animals, the Pringle Hound Pack hunted caracal on an indiscriminate basis from 1972 until 1974 (Pringle and Pringle 1979). After 1974 however, the Pringle Hound Pack selectively hunted only stock killers. Although no year-by-year data were available to verify the hypothesis, it is thought that while hunting indiscriminately, a greater number of females were killed. When selecting only stock killers however, it is thought that mostly male animals were killed, yielding an overall even sex ratio. The results obtained by the Potter Hound Pack however, include only problem animals and do not therefore, indicate the sex ratio of adult males to females in the population. The results obtained by the Potter Hound Pack therefore, suggest a preference amongst male caracal for livestock, a theory supported by the dietary data reported in this study (Tables 3.3 and 3.4).

The overall predominance of males as opposed to females, in both species however, may also be due to the fact that males are known to wander over much larger areas than females (Ferguson *et al.* 1983, Moolman 1986), thus increasing the chance of coming into contact with hound packs (Pringle 1986).

As effective control requires breeding females to be taken in at least the ratio they occur in the population (Bigalke and Rowe-Rowe 1969), the results obtained in this study and that of Bigalke and Rowe-Rowe (1969), suggest that hunting with hounds may be less effective in controlling black-backed jackal, than measures such as coyote getters or poison collars. The results recorded by the hound pack for caracal however, suggest that this form of control is more effective when applied to caracal, than to black-backed jackal. Although more male caracal were killed overall, a greater number of females were killed during the season of peak births than during the rest of the year, thus suggesting a reduced local breeding capacity for the species.

6.4.5. Hunting efficiency

6.4.5.1. Inter-species

The significant difference in pack days/kill between black-backed jackal and caracal, recorded by the Potter Hound Pack (Table 6.1), may be explained by a combination of factors, including predator densities, habitat selection and dietary preference within a given area.

Firstly, if one assumes the area hunted by the Potter Hound Pack to be equally suitable for both species, it is further reasonable to assume that 'top predators' such as caracal, due to their more specific dietary requirements, would be less abundant than those predators lower down the proverbial food chain, such as black-backed jackal, who would utilize a broader resource base (van Rensburg 1993). Although no census of either species was undertaken in the area concerned, it is felt that black-backed jackal densities were indeed greater than those of caracal, thus leading to greater contact with the hound pack, resulting in more kills and therefore a more efficient pack day/kill ratio.

Secondly, it is possible that the areas inhabited by caracal within this region, are less favourable for livestock than those inhabited by black-backed jackal, which would again reduce contact between problem caracal and the Potter Hound Pack.

A third possible explanation for the difference in pack days/kill between the two species, lies in the behavioural and dietary traits of these two predators. As black-backed jackal are known to readily consume carrion (Skinner and Smithers 1990), livestock carcasses found by this species would in all probability be examined and partly eaten, thus creating the impression of active predation by the 'culprit'. A scent followed from such a carcass, may well result in a black-backed jackal being killed, but not necessarily in a stock killer being caught. Due to their dietary aversion to carrion (*pers. obs.*), caracal would therefore be less likely to consume such finds, thus further reducing the possibility of contact with hound packs.

The data obtained in this study therefore, should not be interpreted as indicating that the Potter Hound Pack is more efficient at catching black-backed jackal than caracal, but rather that the difference in pack days/kill ratios recorded for the two species, are a reflection of the abundance of these species and also as a result of respective contact levels between these species and the hound pack in question. The predominance of caracal in the kills recorded Pringle and Pringle (1979), suggests therefore that the terrain hunted by the Pringle hound pack constituted a more favourable habitat for caracal than for black-backed jackal, resulting in lower numbers of the latter species and an accompanying lower level of contact between the hound pack and black-backed jackal.

6.4.5.2. Inter-region

It is apparent from the data presented in this study (Table 6.3), that the hunting efficiency of hound packs, in terms of black-backed jackal, in Eastern Cape farmland, is less than that recorded for hound packs operating in Natal farmland. The hunting efficiency of hound packs in farmland, in both areas however, is seen to be much less than for hound packs operating in Natal reserves (Table 6.3). There are a number of factors which may be useful in explaining these differences. Terrain, hunting technique, hound pack experience and predator numbers and wariness, are all factors which may potentially affect the pack day/kill ratio. Hunting conditions on farmland are often more difficult than on reserves, due to the presence of internal fences and gates. Furthermore, it is generally accepted that black-backed jackal and caracal which live in close proximity to humans and are continuously persecuted, tend to be more wary and evasive than those which live in protected areas (Estes 1993). It is conceivable therefore, that black-backed jackal hunted in farmland, would be more difficult to capture, than those hunted in reserves. The efficiency recorded in Natal reserves is further misleading, as the authors themselves claim to have "skimmed off the cream from jackal-rich areas", in order to maximise the training received by the hounds.

Table 6.3. The effort required, in terms of the number of pack days per kill, to kill predators in KwaZulu-Natal reserves and farmland (1962-1966) (Bigalke and Rowe-Rowe 1969) and Eastern Cape farmland (1983-1989).

Area	Pack Days [PD/month]	Black-backed Jackal [PD/Kill]	Caracal [PD/Kill]	Non-target animals [PD/Kill]	Total Kills	PD/Kill
Eastern Cape Farmland	1 804 [21.5]	118 [15.2]	52 [34.7]	19 [94.9]	189	9.5
KwaZulu-Natal Farmland	441 [7.4]	47 [9.4]	-	-	47	9.4
KwaZulu-Natal Reserve	291 [4.9]	95 [3.1]	-	-	95	3.1

The difference between the pack days/black-backed jackal kill ratios recorded for the Eastern Cape and Natal farmland (Table 6.3), is possibly due to a combination of factors. Firstly, due to higher rainfall and humidity in Natal (Davies and Day 1986), it is assumed that hunting conditions in this region are more favourable than in the relatively dry, windy Eastern Cape (Davies and Day 1986, Stone 1988).

Secondly, the different pack days/kill ratios may simply be an anomaly caused by the thirty-odd years separating the two studies and predator numbers could obviously vary greatly over such an extended time period.

Thirdly, the results presented for Natal, were recorded from a number of hound packs (Bigalke and Rowe-Rowe 1969), whereas the data from the Eastern Cape, were recorded from only one hound pack. The variation, although not recorded, amongst these hound packs, may well therefore explain the slight difference in efficiency between the two regions. Lastly, the different hunting techniques employed by the hound packs, are also thought to be partly responsible for the slight difference in observed hunting efficiency. Whereas the Potter Hound Pack was always accompanied by a huntsman on foot, the hound packs in Natal were usually accompanied by a mounted horseman, thereby ensuring a greater manoeuvrability and a larger hunting area.

Notwithstanding these factors, the hunting efficiency of hound packs in the Eastern Cape, as illustrated by the Potter Hound Pack, appears to be on a par with that recorded for hound packs in Natal, during the late nineteen sixties.

As no prior studies have described the difference in hound pack hunting efficiency for other predators, no comparative analyses were possible for the caracal.

Summary

It is concluded therefore, that local weather conditions favour the use of hound packs during the warm, wet months of September-February, while climatic conditions are least favourable during the relatively cold, dry months of March - August. In order to maximize the efficiency of hound packs in terms of predators killed (PD/Kill) and to minimize the financial costs involved in hiring such a service therefore, local control operations should be concentrated during the months of highest rainfall and humidity and scaled down (although not suspended, in order to keep the hounds fit), during the coldest and driest months within a given area.

Furthermore, although the hound pack used in the present study was found to be as efficient in terms of PD/Kill for both predator species (9.5 PD/Kill), as hound packs in KwaZulu-Natal reserves were for black-backed jackal (9.4 PD/Kill), it is quite conceivable that not all local hound packs are as efficient. If one assumes that the PD/Kill ratios obtained in the present study are indeed a reliable measure of hound pack efficiency and that favourable climatic conditions exist for hound pack operation, poorly trained hound packs could then be expected to exhibit much greater PD/kill ratios than those reported for the Potter Hound pack and the hound packs used described by Bigalke and Rowe-Rowe (1969) and would also be expected to kill a relatively large proportion of non target animals. Ultimately therefore, such poorly trained hound packs would result in both unecessary damage to the environment and increased costs to the landowner.

It is wise for landowners therefore, to investigate the results of hound packs operating on their property in order to assess the efficiency of such packs. By ensuring a high level of competence in any hound pack, a landowner thus ensures the efficient removal of problem animals and a minimal impact on the environment in terms of non-targeted animal kills. Such an approach therefore, ultimately favours both landowners and conservation authorities.

CHAPTER SEVEN
SUMMARY

Predator control, or more specifically, black-backed jackal and caracal control, is often an emotional and tension-filled topic amongst most livestock farmers in the Eastern Cape, with the general consensus favouring the local extermination of both species.
Conservation authorities, although supporting the right of landowners to protect their livelihood in instances of livestock depredation, favour a more cautious approach to this area of conflict.

Here follows a summary of the key findings of this study, accompanied by a number of recommendations regarding predator control and future areas of problem animal research in the Eastern Cape.

1) Although only suspected problem animals were examined, not all individual black-backed jackal or caracal were seen to prey on livestock.

2) Adult male black-backed jackal exhibited a summer peak in livestock killing, thought to be to meet the energetic demands that their role in parental care places on them.

3) Caracal did not exhibit a marked seasonal peak in livestock killing. The extent of livestock depredation amongst caracal is considered to be primarily related to individual age, which in turn, affects the likelihood of an animal having a permanent territory and therefore a reliable food source.

4) The results of the present study suggest that in farmland, the black-backed jackal (52.1% PTV; 29.6% PTO), is more prone to taking livestock than caracal (19.2% PTV; 16.3 PTO).

5) In terms of depredations on wild artiodactyls in farmland, both black-backed jackal (35.3% PTV; 20.8% PTO) and caracal (33.8% PTV; 23.8% PTO), exhibited similar levels of predation, with bushbuck constituting the major antelope component in the diet of both species.

6) In terms of overall diet, the black-backed jackal was found to be extremely adaptable, consuming a wider variety of dietary items than caracal.

7) The use of hound packs resulted in a greater proportion of adult female caracal being killed than black-backed jackal, suggesting, that if the objective of a given problem animal control programme is the overall reduction in the population levels of either species, that this form of control is more effective for caracal than black-backed jackal.

8) The data obtained for black-backed jackal killed by means of coyote getters, indicate a greater proportion of adult animals are killed by this technique (71.8%) than are killed by hound packs (58.8%). These findings suggest therefore, that coyote getters, although being less selective, are more effective in lowering the reproductive potential of a given black-backed jackal population than hound packs.

9) In terms of identifying 'problem animals', landowners were seen to be more accurate in their identification of problem black-backed jackal (74.2%), than problem caracal (61.4%).

10) The data obtained on the homerange size of caracal, although limited due to the small sample size and the age of the male caracal, suggest ideal local conditions for caracal and a relatively high density of caracal within Lower Albany, when compared to previous study areas in the Western and Eastern Cape.

11) The movement patterns of both the male and female caracal strongly support the theory that areas which are regularly cleared of caracal, become 'vacuums' which are

soon re-inhabited, necessitating constant control operations if predators are to be completely excluded from a given area.

The results presented in the present study clearly indicate that a certain amount of uncertainty exists amongst landowners regarding the identification of 'problem animals'. The fact that only 29.6% of black-backed jackal and 16.3% of caracal killed in this study had consumed livestock, suggests two interesting possibilities.

The first, and possibly the most obvious, is that landowners are presently still employing the 'blanket approach' to predator control (Stuart 1982), simply identifying an animal as a livestock or non livestock killer after the individual had been killed. As this approach tends to be relatively unselective in terms of distinguishing between stock killers and non stock killers, it is potentially costly in terms of time, money and environmental impact.

The second point, is that although the proportion of confirmed livestock killers in the samples of both species might not be as high as may have been expected, many non stock killers were correctly identified as such, but still hunted, due to their perceived depredations on commercially valuable game species.

The growth of the local game industry over the past number of years and the accompanying increase in the value of many species, therefore appears to have changed the meaning of the term 'problem animal', to include killers of game.

This phenomenon therefore appears to have increased the potential of conflict arising between landowners, black-backed jackal and caracal.

It is obvious from the data presented in this study and that of previous studies, that in terms of dietary requirements, both the caracal the black-backed jackal are adaptable predators and that no single method of predator control therefore, will solve all management problems between these species and landowners. In terms of efficient and environmentally sound predator control, "the most success will generally be achieved by localised, selective control of the animal causing the damage" (Stuart 1982).

In order to achieve this objective, the landowner needs to adhere to a relatively simple, although essential, procedure.

Firstly, before deciding upon a programme of predator control, actual stock losses need to be verified. A carcass which is discovered does not necessarily constitute a predator kill, as the animal may well have died from natural causes. Additional information such as signs of a struggle and/or bruising around the areas bitten, is therefore essential in identifying an actual 'kill'.

Secondly, once livestock losses have been verified, the landowner, should, before commencing with a programme of predator control, as far as possible determine the identity of the culprit. Stray dogs were shown by Lawson (1989), to be responsible for a large proportion of stock losses reported in KwaZulu-Natal, although many landowners were unaware of this fact. The characteristic killing and feeding techniques exhibited by stray dogs, black-backed jackals and caracal have been documented by various authors (Grobler 1986, Rowe-Rowe 1991, Bussiahn 1995). Although this information is readily available to farmers in KwaZulu-Natal, it would appear that farmers in the Eastern Cape are relatively unaware of many of these facts (*pers. obs.*). It is felt therefore, that urgent attention needs to be given to this aspect of predator control by the various conservation bodies within the Eastern Cape.

As different control techniques (such as hound packs, coyote getters, cage traps and toxic collars), exhibit different levels of effectiveness against different species (Stuart 1982), the correct identification of species responsible for livestock losses would facilitate the use of the most effective control measure. Such an approach to predator control would ultimately therefore, favour both landowners and conservation authorities alike.

It is also important for landowners to realise that problem animal control, on its own, is not the most effective method of combatting livestock depredation. Rather, a combination of sound management practises and problem animal control measures can deliver the best results. Minimizing the risk of predation through various measures, such as the timing of lambing, the herding of livestock and the protection of flocks with guard dogs and herdsmen, can therefore be as effective in combatting livestock losses as actual predator control measures.

Thirdly, once a programme of predator control has been decided upon, it is important for the landowner to continuously assess the success and efficiency of such measures, as the usefulness of any control measure is dependant upon its cost effectiveness. Simply exterminating all predators in a given area as a precautionary step, may well prove both financially costly and unwise in terms of management objectives, as such areas may well be re-colonized by livestock-killing individuals.

The conflict between black-backed jackal, caracal and game farmers is somewhat more complex. Numerous studies have shown that wild antelope are regularly preyed upon by both these species (Rowe-Rowe 1976, Stuart 1982). Although these predators may not always prey upon livestock, they will almost certainly, prey on various antelope species occurring within a given area. The challenge for the landowner in this situation therefore, is to determine the level of predation and to decide whether such levels are acceptable or not, both in terms of financial implications and management objectives. In making such a decision, it is important for the game farmer to remember that in any ecosystem, predators function as a form of natural selection, generally removing old and weak individuals from within a population. By removing this natural check through predator extermination, the farmer may unwittingly be decreasing the overall fitness and condition of a given antelope population, as individuals which may not have survived otherwise, are less likely to be predated and may even breed successfully, perpetuating their weak genetic characteristics.

In this situation therefore, management objectives are of the utmost importance. For example, the rapid decrease in the numbers of a given antelope species may well justify the short term extermination of predators if excessive predation has been identified. Conversely, the long term goal of producing animals of trophy quality, may well require some level of natural predation, in order to remove the weaker individuals from a given population.

Apart from fulfilling a role of natural selection, predators (especially caracal), may well have an inherent value as ecotourism attractions and potential hunting trophies (*pers. obs.*). Game farmers therefore need to identify management objectives and assess the potential advantages and disadvantages, before commencing with any such predator control programme.

In terms of future research, it is felt that two areas in particular, regarding the interaction between predators and landowners, need to be more thoroughly investigated.

Most importantly, it is considered that the extent of stock loss within the study area, needs to be quantified, in order to assess the cost effectiveness of current control measures. Furthermore, as was determined in KwaZulu-Natal by Lawson (1989), it would be extremely useful in terms of formulating future predator control policies and educational and agricultural liaison programmes, to determine the perception of local landowners towards predators in general and black-backed jackal and caracal in particular.

CONCLUSION

Problem animal control is often both an emotional and complex topic and as such it should not be the sole responsibility of either landowners or conservation authorities, but rather entail a process of continuous interaction between the two parties. Ultimately, it should not espouse either of the extreme schools of thought regarding this topic, one which favours the total extermination of predators, the other favouring the absolute preservation of all predators. Management policy in this regard, should rather be a combination of the two opposing ideologies.

The Eastern Cape is no longer a pristine ecosystem and Man exerts an ever-increasing influence over the environment. Due to the absence of many of the natural checks and balances which would ultimately control predator numbers, Man has undoubtedly become an important component in the overall ecology of the black-backed jackal and caracal. It would therefore be naive to expect a preservationist attitude towards predators, to find favour amongst landowners. By the same token however, it is both selfish and unrealistic for landowners to begrudge predators at least a certain level of livestock predation, often in the Man-induced absence of natural prey species.

The ideal therefore, is for problem animal control policies to take cognisance of both sides of the spectrum and to support an even-handed approach, one which favours both landowners and conservation authorities. It is felt that the results of this study illustrate that this ideal can best be achieved through the selective removal of positively identified problem animals, as opposed to a method of largely unselective predator removal, which appears to find favour with the majority of landowners in the Eastern Cape at present.

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APPENDICES

Appendix I. Cranial measurements and estimated ages (Stuart 1982), of 45 caracal killed in predator control operations in Eastern Cape farmland (1993-1995).

M = Male
F = Female
TL = Total skull length
ZW = Zygomatic width
BW = Bulae width
JL = Jaw length

Number	Sex	TL	ZW	BW	JL	Age (estimated) Months
		(Measurements in millimeters)				
A6	M	-	-	-	94	24
A8	F	-	-	-	88	10-15
A9	M	-	-	-	96	24
A12a	M	-	-	-	70	5
A12b	F	-	-	-	66	5
A14	M?	-	-	-	87	15-18
A19	M?	127	-	-	-	15-18
A25	F	-	-	-	88	10-15
A30	M	-	99	-	-	18-24
A46	F	-	-	-	83	9-14
B3	M	76	44	-	-	1-2
B6	F	136	99	60	89	old
B7	F	126	85	54	81	adult
B28	M	141	104	60	96	24-36
B41	M	129	89	56	87	15-24
B45	M	147	104	62	98	>48
B46	M	110	77	49	-	5-7
B48	M	123	86	55	84	8-10
B49	M	125	87	55	-	8-10
B77	F	122	87	53	81	adult

Number	Sex	TL	ZW	BW	JL	Age (estimated) Months
		(Measurements in millimeters)				
B78	M	144	102	62	91	36-48
B79	M	116	79	52	77	6-8
B83	M	149	-	62	95	>48
B84	F	123	88	55	83	adult
B123	F	113	80	50	74	adult
B126	M	140	96	60	-	18-24
B127	F	84	55	40	-	2-3
B128	M	82	54	41	-	2-3
B130	F	128	95	56	86	adult
B131a	M	140	98	60	93	20-30
B131b	M	141	99	59	86	20-30
B132	F	122	91	51	80	adult
D1	F	127	89	55	86	adult
D2	F	133	96	55	86	old
D3a	F	86	59	-	-	2-3
D3b	F	87	58	-	-	2-3
D3c	F	87	59	-	-	2-3
D5	?	96	65	45	60	3-4
D6	M	133	96	55	86	18-24
D9	M	129	89	56	83	15-24
D10	F	121	82	55	78	adult
D12	M	132	94	58	88	18-24
D15	M	137	95	57	90	20-24
D19	F	141	101	62	95	old
D24	M	134	99	59	90	18-24