ECOLOGY AND BREEDING BIOLOGY OF LANNER FALCONS

IN THE EASTERN CAPE PROVINCE, SOUTH AFRICA

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CONTENTS

Abstract

Lanner Falcons *Falco biarmicus* are the commonest large falcons in Africa and this study in the coastal area of the Eastern Cape Province, South Africa investigated their ecology from 1984 to 2000. Lanners have recently been categorised as near-threatened and this study was initiated to ascertain if the population was stable. Breeding success of a small population, in different habitat types, was monitored intensively from 1997 to 2000, and the factors that inhibited breeding were investigated. The earliest onset of incubation was 17 July and the latest 16 August, with 2.2 young fledged per breeding pair over the four-year period. Incubation lasted 32 days and young fledged after 42-45 days. All nest sites were on cliffs with a mean height of 114 m, a mean vertical face of 53 m; 45% of the nests were in ravens' nests. The aspect of cliff sites also influenced breeding success. Radio tracking was used to determine home range, habitat use and hunting methods, with prey species identified. Home ranges were between 66 km^2 and 249 km^2. Preferred prey was domestic chickens, pigeons and small birds during the breeding season. Foraging ranges were smaller in intensively cultivated areas with seed crops.

Data obtained from ringing returns showed that no long distance movements occurred in this region, but two juveniles dispersed 152 km and 127 km. Conservation aspects with possible threats to Lanner Falcons such as poisons, electrocutions and direct persecution are discussed with some recommendations made for future research. Evidence from this study indicates that Lanner breeding success is not limited by nest site availability, but by rainfall timing and prey availability. Lanners foraged more in open areas than areas with tall vegetation, and benefited from intensive agriculture. This population appeared to be healthy and in no danger of declining in the near future.

Acknowledgements

Since early schooldays I have had an overwhelming interest in birds of prey, and one way of satisfying this passion was rehabilitating raptors, which lead me to the art of falconry. My parents often had to put up with injured and sick raptors, but they always encouraged my interest. To Ken and Nola, thank you for your patience and understanding, and believing in what I wanted to do. To Sandy, my wife, who often had to shoulder the burden while I was away from home, or out late at night or leaving at abnormal hours to indulge in my forays to look at raptors. Although she often had to share and sometimes compete with my time and energy, she kept the peace albeit with the odd mutter. And to my children who looked after my animals while I was away, thank you. Ray Black for artwork, assistance in the field, countless hours and cups of tea, discussing Lanners and falcons and his wife Pat for being so patient. Ian Hendry, always willing to help and keep me company while sitting at the cliffs, and providing four-wheel drive transport when I needed it. Dave de la Harpe, always enthusiastic and complimentary. They all had to carry climbing equipment and sit for hours without complaining while I tried to trap a Lanner. Good friends are rare people in life, who are always willing to help in a cheerful way.

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CHAPTER 1

INTRODUCTION

Lanner Falcons *Falco biarmicus* (Temminck, 1825; Caffraria = Cape of Good Hope) are the most common and dominant large falcons in Africa (Cade 1982, Brown *et al.* 1982). They form part of the *Hierofalco* or desert falcon group along with the Gyr Falcon *F. rusticolus*, Saker *F. cherrug*, Prairie Falcon *F. mexicanus*, and Lugger Falcon *F. jugger*. Five subspecies of Lanner are recognised (Weick 1980, Brown *et al.* 1982) of which the nominate race *Falco biarmicus biarmicus* occurs in this region, from the Cape Province north to Zaï re, Uganda, Kenya and southern Ethiopia. *F. b. abyssinicus* occurs throughout northern tropical Africa south of the Sahara, from Somalia and Ethiopia west to Senegal. *F. b. tanypterus* occurs from Cyrenaica in North Africa east to Egypt with *F.b. erlangeri* found in North West Africa from Cyrenaica west to Morocco, south to Southern Sahara and Tadmit Plateau. *F. b. feldeggi* occurs in Italy, Sicily, Greece and eastwards along the Mediterranean (Pellegrini *et al*. 1993); it formerly used to breed as far north as Russia but has not bred there since 1949 (Leonardi *et al.* 1992).

Lanners are fairly common in South Africa (Steyn 1982, Tarboton & Allan 1984) and are often in conflict with rural inhabitants in their dispute over resource usage of the domestic chicken *Gallus gallus*. Most rural people can describe the Lanner and especially its habit of snatching young fowls.

Lanner Falcons occur throughout southern Africa, with relatively little seasonal change in reporting rates in the east, but higher reporting rates in the west in summer months. This species was reported in 41.4% of the map grid cells over southern Africa, and was only absent from flat desert areas with little or no vegetation (Harrison *et al.* 1997)

Although Lanners have been described as relatively common, they have recently been listed in the

Red Data Book as a near-threatened species (Barnes & Jenkins 2000). Perceived threats are poisoning, shooting, falconry, electrocution and collisions as well as natural limiting factors such as nest site and prey availability. This study was initiated to determine which factors play an important role in the continuing survival of Lanners in healthy populations. Some recommendations are made in Chapter 7.

Study Area

The study was conducted in the Albany and Bathurst magisterial districts in the southern part of the Eastern Cape Province of South Africa (Fig. 1). The Indian Ocean formed the southern boundary, the Bushmans River to just past Alicedale town the western boundary, and the Great Fish River the northern and eastern boundaries. Several large rivers run through the area such as the Fish, Kowie, Kariega and Bushmans Rivers. It is mostly along these rivers that large cliffs are found where Lanner Falcons breed.

Veld types were classified according to Danckwerts & Teague (1989), from the coast inland, as Forest and Coastal Thornveld, Valley Bushveld, Humid Bush-grass Communities, False Macchia and False Karroid Broken Veld. The study area is unique in that such a small area (*c*. 5900 km^2) includes Coastal Forest, Valley Bushveld, grasslands, mountain veld and Karoo occurring together. A line of hills runs roughly from East to West through the study area from Grahamstown to Alicedale with higher rainfall towards the coast and drier Karoo veld on the northern side of the hills due to the rain shadow.

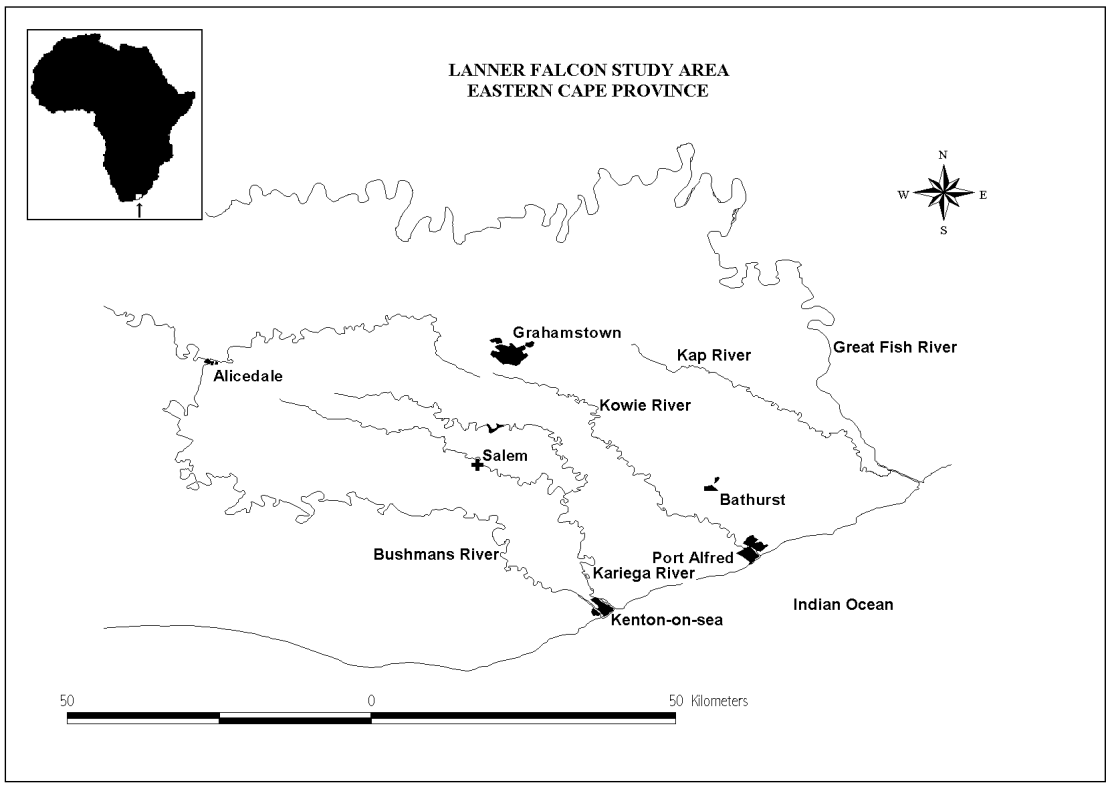

FIGURE 1. Lanner Falcon study area between the Bushmans and Great Fish Rivers in the Eastern Cape Province, South Africa.

Agriculture in this region is a mixture of large and small stock farming, with intensive cultivation along the coast, and small stock farming in the drier areas north of Grahamstown. Game farming is replacing much of the domestic stock farming in the study area.

Climate appears to be a major factor in Lanner Falcon breeding success (Chapter 3), so general climatic data for the study area are presented here for comparison with possible future studies in other areas where there may be differences in climate. Similarly, if future comparative studies are done in this region, climatic conditions can be assessed. This area lies in the transition zone between the summer rainfall region to the East and a zone with spring and autumn rainfall peaks. Significant falls of rain are thus possible at any time of the year. Over a 42 year period a mean annual rainfall of 589.8 mm was recorded, of which 60% fell within the summer months, with peaks during March

and October (Anon 1965).

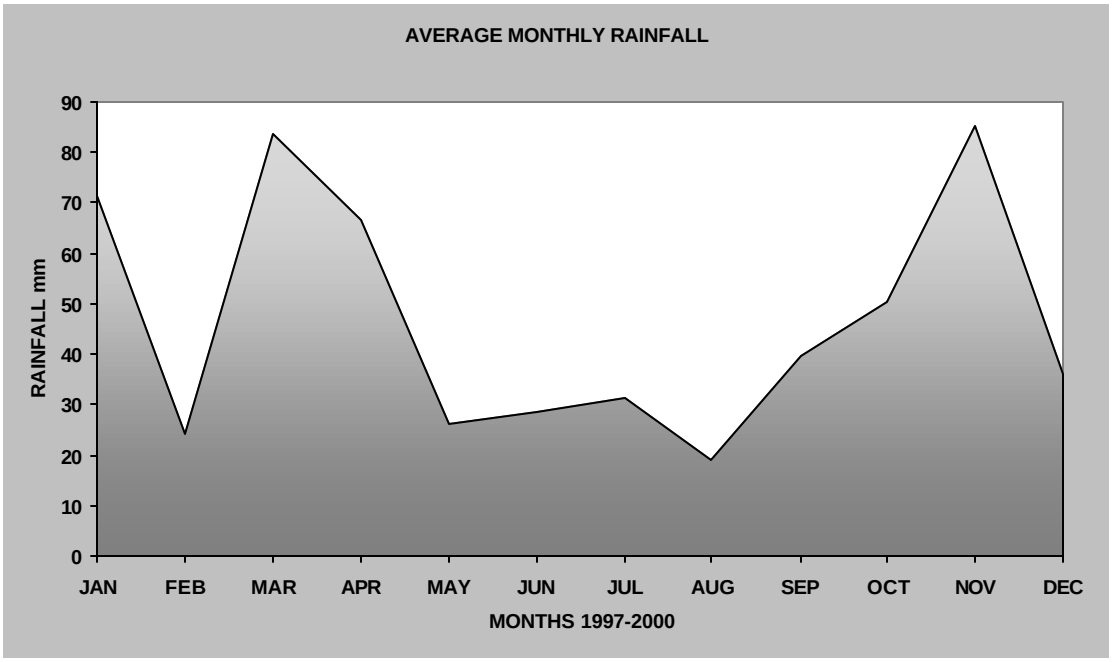

FIGURE 2. Average monthly rainfall for 1997-2000 recorded at Roundhill Nature Reserve situated near Bathurst.

Average monthly rainfall for Roundhill Nature Reserve, situated near Bathurst (Fig. 1), showed peaks in spring and autumn and low rainfall through winter (Fig. 2).

Temperatures range from 40^0 C to as low as -1^0C (Roundhill Nature Reserve-Weather Station) with even lower temperatures further inland, although average temperatures are relatively mild with the coldest months being June to September. December to March are the warmest months. An average monthly minimum and maximum temperature for the period of 1997 to 2000 was plotted from data measured at Roundhill Nature Reserve (Fig. 3). Average (1960-1980) monthly temperatures and rainfall measured in Grahamstown are presented in Table 1 (Stone 1988).

TABLE 1. Average (1960-1980) monthly temperatures and rainfall for Grahamstown (Stone 1988).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min °C	13.7	14.4	13.7	10.5	7.7	4.9	4.3	8.6	7.6	9.7	11.5	12.7
Max °C	26.7	26.8	25.8	23.7	21.7	19.9	18.9	20.3	21.6	22.4	23.3	25.7
Rain mm	62.5	65.6	80.6	53.1	49.3	32.7	31.6	36.8	62.3	74.8	77.6	60.9

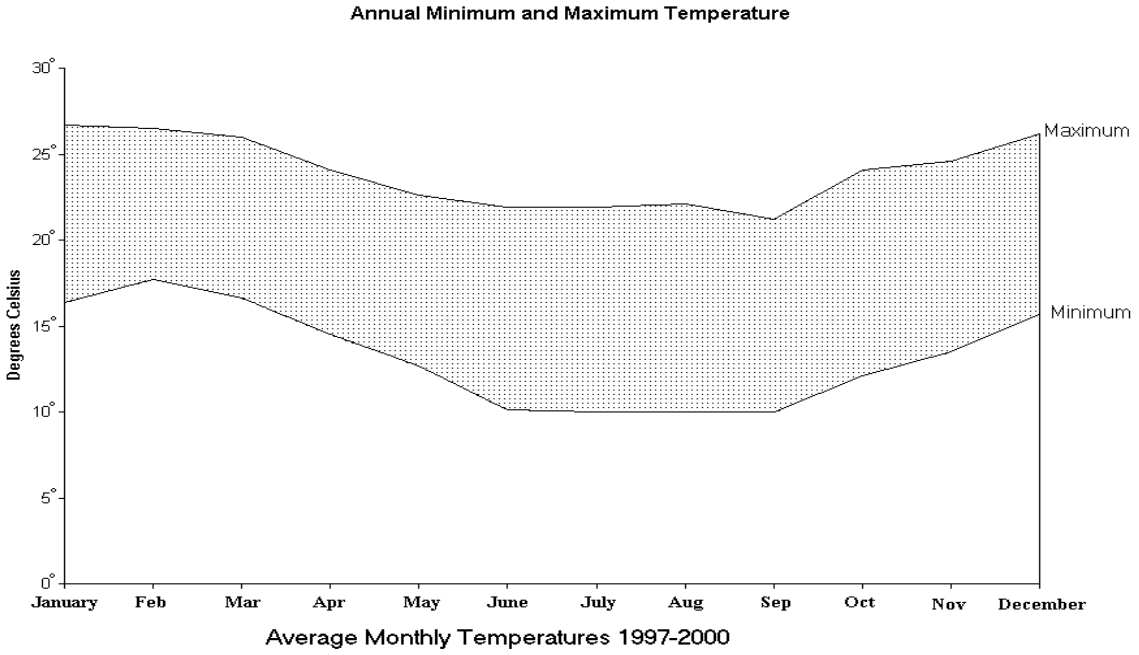

FIGURE 3. Average monthly minimum and maximum temperatures measured at Roundhill Nature Reserve, Bathurst district from 1997 to 2000.

CHAPTER 2

NEST SITE CHARACTERISTICS OF LANNER FALCONS IN THE ALBANY AND BATHURST REGION

Introduction

Lanner Falcons have been known to breed on a variety of nest sites, from large and small cliffs, to old nests of other birds in trees, on electricity pylons and even on buildings (Brown 1970, Steyn 1982, Cade 1982, Brown *et al.*1982). Brown *et al.* (1982) and Osborne & Colebrook-Robjent (1984) hypothesized that Lanners are limited by the availability of nest sites. Lanners do not build their own nests but lay their eggs in a scrape on a bare ledge. Steyn (1982) indicates that Lanners breed on cliffs by preference quoting 68% of 91 nest sites found in the province formerly called the Transvaal (now divided between Gauteng, Northern Province, North West and Mpumalanga). Stick nests in trees, cliffs and electricity pylons of many species such as eagles, vultures, Black Stork C*iconia nigra*, Pied Crow *Corvus albus*, Black Crow *Corvus capensis* and Whitenecked Raven *Corvus albicollis* have been utilised by Lanners (Brown 1970, Steyn 1982, Cade 1982, Brown *et al.*1982, Tarboton & Allan 1984). The same nest sites may be used year after year, especially cliff sites, and in some cases sites that have not had resident birds for a few years will be re-occupied.

Methods

The initial project started in 1984 with limited searching for nest sites. Breeding sites were found by several methods. Sightings of falcons in adult plumage often indicated a nest site nearby and an active search of all cliffs in the area was then undertaken. All large, vertical cliffs were also observed in the breeding season (July – October). Cliffs were found by asking landowners, or by looking at 1:50 000

maps where more than three contour lines came together to indicate a possible cliff and then verified in the field. Additional observations were made when travelling in the area and visiting farmers in my capacity as a nature conservation officer. Many of the suitable cliffs were visited in the breeding season over several seasons to determine whether Lanner Falcons were breeding there. Observations and reports by bird club members were also investigated. An aerial survey from a microlight aircraft flying down all major watercourses helped to locate sites that were otherwise unknown. Records were kept of all cliffs and raptors breeding on these cliffs whenever a visit was possible to these sites. Breeding sites were visited on an *ad hoc* basis up until July 1997, when intensive monitoring began with an accurate assessment of eggs laid, juveniles hatched and fledged. The data are based primarily on four breeding seasons from 1997 to 2000 but the map (Fig. 4) shows all known nest sites.

Aspect

The aspect of the cliff face where the nest was located was measured with the use of a Global Positioning System (GPS) and then verified on 1:50 000 maps. Aspect was divided into eight directions of 45^0, beginning at true North and proceeding clockwise around the compass. The aspect was determined from the nest ledge itself. In some cases the cliff faced a certain direction but the nest itself was in a fold facing in a different direction.

Cliff Height

Measurements of the vertical cliff height and the total height from the top of the hill or slope to the valley floor were recorded at each breeding site where eggs were known to have been laid. Linear measurements were recorded by the use of a Bushnell 400 laser range finder which could measure up to 400 metres with an accuracy of ± 1 metre. Where the vertical cliff had a scree slope, the angle was taken using an angle metre, and then the vertical height was calculated by the use of Pythagoras theorem

and the sine rule. Measurements were rounded off to the nearest metre.

Nest Characteristics

While collecting breeding data from nest sites, additional information such as nest type, aspect and whether or not the nest was sheltered, was also collected. All nest sites were recorded with a Garmin Global Positioning System and the information plotted on a map using the Arcview software program.

Results

Breeding attempts were recorded at 8 different nest sites with a total of 22 attempts during the four-year period from 1997 to 2000. All of the cliffs were situated in river gorges.

Of the 22 attempts at breeding, ten (45%) were in White-necked Raven *Corvus albicollis* nests on cliffs and the remainder were on cliff ledges with sand and stone debris. No tree nesting was found nor were any other structures used.

Eggs were laid in a scrape with no other nesting material. Most nests (20 or 91%) were under an overhang or in a crevice and sheltered from rain. Two nests were exposed to the elements and these nests were used only once each. Of the 22 breeding attempts at eight sites, four nests faced North-East, one East, seven South-East, one South, 6 South-West, three West and none North-West or North. Frequently Lanners changed nest sites on the same cliff. Many cliffs had more than one aspect, where the structure was not uniform. The mean cliff height (Table 2) measured from the valley floor to the crest of the cliff of these breeding sites was 122 m (range 24-246), and the mean vertical section was 49 m (range 11-95m).

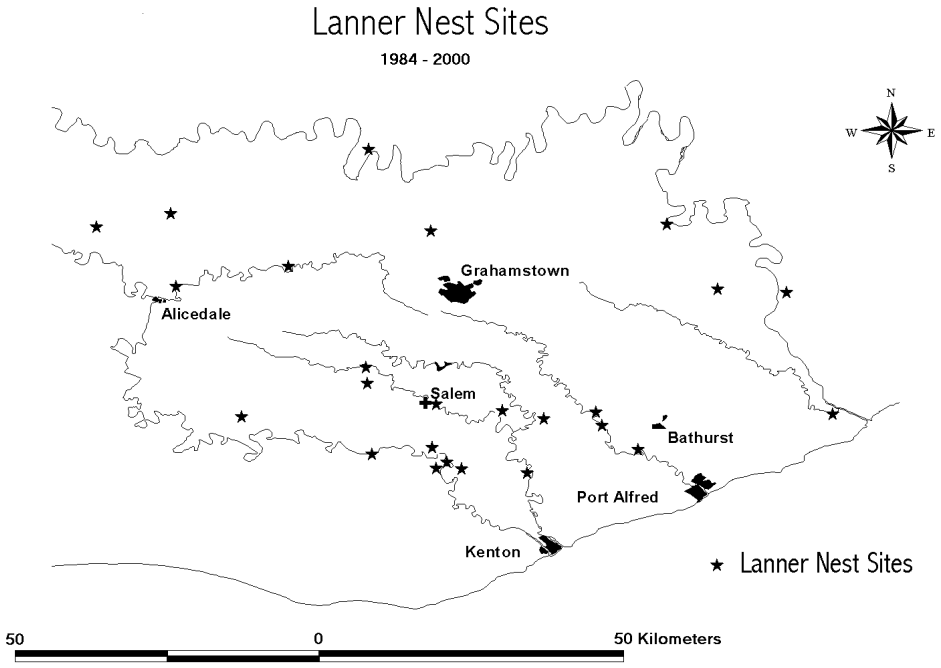

FIGURE 4. Lanner Falcon nest sites in the Albany and Bathurst area of the Eastern Cape from 1984-2000.

The nearest linear distance between the eight active nest sites where pairs bred in the same year was 8.5 km and the maximum was 48 km. The mean distance between active nest sites was 19.5 km.

TABLE 2. Measurements of eight different nesting sites.

YEAR	MEAN CLIFF HEIGHT m	MEAN VERTICAL m
1997 (*n*=3)	99.6	49.7
1998 (*n*=7)	104.9	50.6
1999 (*n*=6)	124.5	50.2
2000 (*n*=6)	128.3	59.3
Mean	114.3	52.5

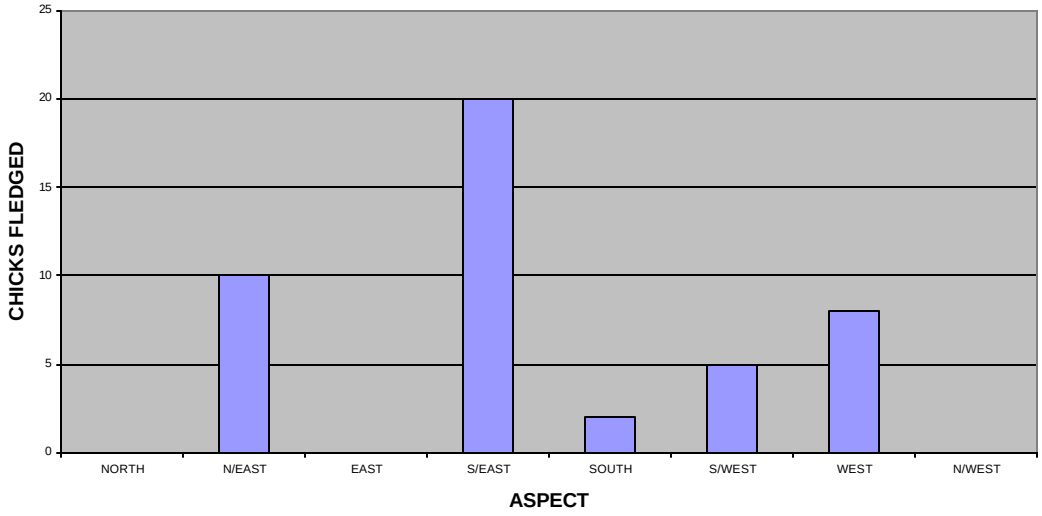

FIGURE 5. Number of Lanner Falcon chicks fledged with respect to the aspect or direction in which the cliff faced.

Discussion

In this study Lanners only bred on cliffs that were inaccessible or sheer, probably to keep out of reach of predators such as baboons *Papio ursinus*, vervet monkeys *Cercopithecus pygerythrus*, genets *Genetta* spp. and many other species including humans. No nesting was observed in trees or man-made structures, although this occurs frequently throughout the rest of southern Africa. In my study area, I found 25 nest sites where Lanners had bred at least once since 1984 (Fig. 4). There is a strong possibility that there were other breeding sites in the study area as there are numerous small cliffs that may have had birds breeding there and been overlooked. Some of the sites were only used once during the study period. At the eight successful breeding sites, Lanners made 22 breeding attempts in four years. Often a pair would change nest sites on the same cliff in successive years. Raven nests were used in 45% of the nesting attempts and pairs used raven nests or bare ledges in consecutive years. Ravens in most cases had other nests, which they would move to after the Lanners had displaced them. Lanners breed up to a month earlier than ravens and were more aggressive in defending the nests at the onset of

egg laying. In one case the ravens did not have an alternative nest site and waited until the Lanner chicks had fledged before they bred successfully. Exposed nests, without shelter from above, were used only twice, in both cases by the same pair, before the pair moved to a sheltered nest site.

Measurement of cliffs was calculated for the vertical cliff face as well as the height of the actual hill as it would appear that even on small vertical faces situated on large slopes, the Lanners could depart and approach with the minimum of energy expenditure by gliding and using updraughts. The large cliffs always had some air movement, which the Lanners could utilise to gain lift, whereas on the small cliffs Lanners had to flap initially or at least until they made it to a ridge where they could exploit the air currents. Jenkins (1998) calculated activity budgets for Lanner Falcons, which averaged 53% gliding, 33% thermalling and only 14% flapping flight. Higher cliffs would therefore assist in less energy-expensive flight. High cliffs were most successful from a breeding perspective and small cliffs were used only twice successfully during the study period. Although Lanners have bred on small cliffs throughout the study area since 1984, those pairs on small cliffs never maintained continuity, with one pair breeding on a small cliff and the site being deserted for several years after that. During the sixteen years of study, several of the large cliffs had successful breeding in most years except where climatic conditions caused general failure. These would appear to be prime sites. In addition, heavy rainfall during the four months of breeding caused a marked reduction in successful breeding (Chapter 3) especially at those sites exposed to rainfall from above or those facing a westerly direction from where the predominant wind and rain came. Thus certain sites could be termed 'prime sites' with others being classified as 'marginal'. Twenty-five nest sites were found in the study area from 1984 of which all were checked during 1997 to 2000. Of these 25 sites, eight sites had 22 breeding attempts over the four years of intensive monitoring. At all of the sites (n=8) in the Karoo veld type, except for the 'Henley' site, which had been

productive in the late 1980's and early 1990's, pairs failed to breed even though birds were occasionally present at these sites. Breeding apparently ceased when ostrich rearing was discontinued. Many farmers had raised ostriches in feedlots, which attracted doves and other seed-eaters into open areas where they were vulnerable to attack by Lanners. The exception was the 'Henley' site, which fledged two chicks. Radio tracking indicated that these falcons had to forage over a large area and subsisted mainly on domestic chickens (See Chapter 4).

There has been debate over competition for nest sites and the exclusion of Peregrine Falcons *Falco peregrinus minor* by Lanner Falcons (Thomson 1984, Tarboton & Allan 1984). Although juvenile and adult Peregrines were observed periodically along the Bushmans River and bred there once successfully, fledging one juvenile, no other Peregrine breeding was observed. Large cliffs were not used by Lanners in some years and an adult Peregrine female took up residence in breeding season at one cliff, but moved on shortly thereafter. Jenkins (1998) found that Lanners do not exclude Peregrines in the Soutpansberg, but that prey availability is probably the limiting factor for Peregrines. It appears that this may be the case in the present study area as well. Lanners in the tropical regions of Africa may be limited by available nest sites (Brown *et al.* 1982, Osborne & Colbrook-Robjent 1984) but this study shows that nest site availability is not a limiting factor for breeding, as several suitable cliffs where Lanners had bred previously remained vacant. However, certain factors such as the aspect of the cliff may be important in breeding success, and larger cliffs appear to have greater breeding success and occupation than do smaller cliffs.

The only other study (Jenkins 1998) of cliff nest sites in South Africa, found that Lanner Falcons used similar nesting habitats to Peregrine Falcons, although Peregrines were less likely to use covered ledges than Lanners. Lanners used only sheer faces, which often overlooked cultivated lands while at Peregrine

sites the scree slope was shallower, and the distribution and structure of vegetation on the slopes was more varied, with more cover for prey than at Lanner sites. Lanners also bred in old stick nests on cliff faces (37%) in Jenkins' study, which is a similar finding to my study (45%). The vertical height of nesting cliffs was 78 ± 40 m (52.5 m my study). In the Soutpansberg study, only one record of a Lanner breeding in a corvid nest on an electricity pylon was observed. In central Italy (Morimando *et al.* 1997) and Israel (Yosef 1991), where Lanners are relatively rare, they breed on cliffs. Lanners thus appear to choose cliffs as the preferred nest site, but may utilize any other structure if there are no cliffs to nest on (Leonardi *et al.* 1992). There is even one record of Lanners nesting on the ground (Bundy 1976).

In the study of Tarboton & Allan (1984) in the former Transvaal, Lanner Falcons nested mainly on cliffs (64%), of which most were on bare ledges (88%, *n*=96). Thus only 12% used other nests, which is considerably less than observed by Jenkins (37%) or my study (45%) of Lanners using raven's nests (Black Eagle *Aquila verreauxii* (5%), Black Stork *Ciconia nigra* (4%) and Jackal Buzzard *Buteo rufofuscus* (3%); no raven nests were recorded). Other nest sites used were quarries, tall buildings, old crow and bird of prey nests in trees and on power pylons (Tarboton & Allan 1984). Data from the South African Ornithological Society nest-record card collection shows that of records throughout southern Africa, 72 % of Lanner nest sites were on cliffs, quarries and buildings, with 28% in stick nests in trees, on power pylons or telephone poles (*n*=113). In the Northern Cape (Anderson 2000), Lanner Falcons have benefited from intensive agriculture, which attracts queleas, and which are utilised by the Lanners. They have also benefited from the availability of artificial structures such as electricity pylons, which are used for nesting sites. Lanner Falcons thus do breed on other structures such as trees and pylons where there are no cliffs, although it appears that cliffs are their primary choice, and in the present study it appears that there were always sufficient cliffs available for the population.

CHAPTER 3

Breeding biology

Introduction

Breeding biology has been relatively poorly studied in Lanner Falcons in South Africa due to the physical and logistical constraints of attempting to study falcons at cliff sites. In southern Africa, two studies on breeding biology were conducted on tree and electrical pylon nesting Lanners (Barbour 1971, Kemp 1993) and one study in the Soutpansberg by Jenkins (1998) included cliff-nesting Lanners. Lanners typically only breed once a year laying 2-5 eggs but usually 3-4 eggs (Brown *et al.* 1982). Breeding success contributes to recruitment of future breeders and this study attempts to determine what the recruitment rate is as well as to provide a baseline for future studies to assist in determining population trends. All aspects of breeding biology were measured including eggs laid, eggs hatched, development of chicks and number and sex of chicks fledged.

Although elsewhere Lanners nest on trees and artificial structures (Barbour 1971, Steyn 1982, Kemp 1993), Lanners in the study area only bred on cliffs along river valleys (Chapter 2). Many of the nest sites were in difficult terrain and spaced far apart, which meant arduous data gathering in terms of cost in time and effort. Surveys of density and breeding success over expanses of typically rugged terrain are laborious and often unreliable (Ratcliffe 1993). Working on farmlands and nature reserves in the study area provided an opportunity to study these nest sites and document breeding success. It also provided an opportunity to interact with farmers and labourers and educate them on raptors in general, as there was often conflict related to the Lanners' tendency to catch domestic chickens. In discussion with farmers and farm labourers there appeared to be regular persecution of Lanners for this reason. Some initial colour ringing of the falcons indicated that there might be a high

turnover of adult Lanners at nest sites (Chapter 6) and this led to a concerted effort to document breeding success in order to ascertain whether the Lanner population was under threat.

Methods

Twenty-five breeding sites where Lanners had bred at least once since 1984 were visited at least once and often twice during the breeding season (August –October) in the four- year study period to determine if Lanners were breeding. Nest sites had been identified as described in Chapter 2. Observations at nest sites, to determine whether breeding was occurring, were by patient observation with binoculars and a 20 –60X spotting-telescope. At most sites potential breeding could be confirmed in an hour or two of observation, where Lanners were seen to move in and out of a nest ledge. At times when the site was occupied but the falcons did not breed, it took more than two visits to verify this. Early mornings and late afternoons were the best times to observe any activity. Where a falcon was seen to transfer food to another at the nest site, or the adults changed over, it was assumed that there was an attempt at breeding. Using ropes and rock-climbing equipment, sites were then inspected to determine if there were eggs in the nest. Most of the cliff sites were situated in river gorges and it was easier to use jumars to ascend the rope again instead of abseiling all the way down and walking out. A record was kept of the number of eggs in each nest. As eggs were counted at any stage up to three weeks after the start of incubation, some eggs could have broken or been removed prior to inspection. Some clutches (n=3) were also measured with vernier callipers to obtain the average egg size for a clutch.

Eggs were assumed to have hatched when adult falcons were observed bringing in food. In most cases the female could be heard to 'chup' repeatedly for the chicks to feed. The chupping sound was loud and repeated at intervals of every two to three seconds. In some nest sites, direct

observation could be made from above and along the cliff with the spotting scope. If direct observations were not possible, the nest was checked by abseiling down to it and recording the number of chicks hatched. Care was taken not to disturb the falcons on cold days to prevent eggs from chilling. Where chicks were present, visits were timed directly after a feed. This was to minimise stress on the chicks and to prevent mortalities due to chilling or starvation. In some cases the nest could not be inspected for several days, until the chicks were at least a week to ten days old. Where nests had no unhatched eggs and a chick was missing, it was assumed that the egg was fertile and that the chick had died at an early stage. Mortality was highest in chicks during the first ten days. After this period fewer deaths were observed. One nest site at 'Mosslands' was checked almost daily to calculate the incubation and fledging period and this was confirmed at other sites. The age of the chicks was used to determine the date of the start of incubation, by backdating 33 days from hatch to determine the onset of incubation within one to three days (Steyn 1982, T. Wagner pers com.). Sexing of chicks and ringing took place from 20 days till about 35 days to ensure accurate sexing. It was observed on one occasion that any disturbance of chicks older than 35 days could lead to premature fledging if they took fright. Chicks were sexed by looking at several factors. If there was more than one chick, sexing was relatively easy by comparison of size alone. A visual comparison of the ratio of eye size to head size was also a good indication of sex, since males appear to have a proportionately larger eye. Females also have larger feet and tarsi than males. In cases where only one chick was present or there was some doubt as to the sex, the foot span between the hind toe and front middle toe was measured (Fig. 6). Males were about 69 mm and females about 76 mm (see results for exact measurements obtained).

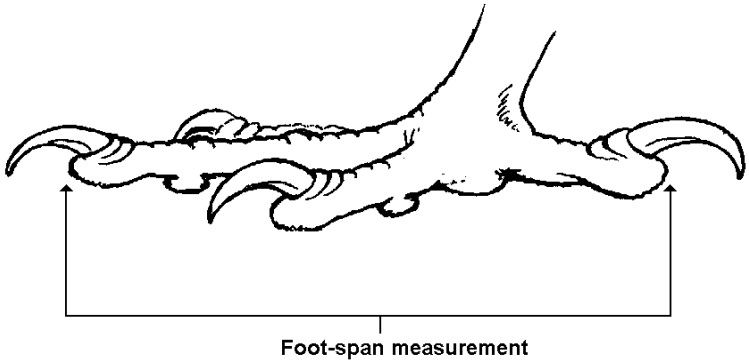

FIGURE 6. Measurement of foot-span to determine sex.

Males were on average, by body mass, 73% the size of females (Table 3). This calculation was determined by comparison of trapped Lanners (males n=14, females n=36).

Although body mass is usually a good indicator of sex for Lanner Falcons, there are times where it may lead to erroneous conclusions. Most published material gives weights in the range of 430-600 g for males and 600-910 g for females (Biggs *et al.* 1979). Kemp & Kemp (1998) give weights of 430-600 g for males and 700-910 g for females. Wing and tail measurements obtained from 24 trapped Lanners do not differ for juveniles and adults and sexing of trapped Lanners in the field by using body mass alone, could lead to problems in sexing individuals (Fig. 7).

Results

Earliest onset of incubation between 1997 and 2000 was 17 July and the latest 16 August. Mean date of start of incubation was 3 August (Table 5). Mean clutch size (*n*=22) was 3.4 eggs per nest (range 3-5, Table 4). Mean number of chicks fledged per breeding pair was 2.2 young, of which 43% were males and 57% females (Table 5). Sixty-five percent of the eggs laid produced chicks raised to fledging age. Three clutches, comprising 10 eggs, were measured. Mean measurements

were 56.6 x 43.2 mm (range 55.2-58.3 x 42.0-44.0). Incubation was taken as 33 days and this was confirmed at two nest sites where start of incubation till hatching of all chicks was 33-34 days. Not all chicks hatched on the same day, but they all hatched within a day of the first egg hatching. Often females brood the eggs (pers obs.) to shelter them from extremes in temperature, and thus appeared to be incubating before the clutch was complete.

Growth and development of chicks and breeding behaviour.

Chicks could be aged reasonably accurately by the onset of a second coat of down at 7 - 8 days with a complete second stage of down by 12 days. Pin-feathers on the tail and wings started pushing through and could be seen at 16 days. The feathers were easily seen at 17 days. The V of darker feathers along the back between the wings appeared at about 22 days. Chicks fledged between 41 and 46 days, with the males usually leaving the nest two to three days before the females.

Two nest sites ('Two Bushes' & 'Mosslands') were observed frequently, 'Mosslands' on an almost daily basis during the breeding season in 1998 where the laying of eggs, incubation and fledging period was recorded. At 'Mosslands' the female laid the first egg on 9 August, second egg on 12 Aug, third egg on 14 Aug, fourth egg on 16 Aug and the fifth and final egg on the 19 August. The female sheltered the eggs and brooded them for short periods after 12 Aug and was very lethargic, being fed by the male. Most of the day she would sit puffed up on the ledge front and occasionally fly out to perch in the sun. She appeared to be brooding properly on 16 Aug and sitting tight, only leaving the nest to accept food from the male. She also stopped chasing the ravens, towards which she had been aggressive a few days earlier. By 24 Aug one egg had broken and was trampled into the nest. At the 'Mosslands' nest the male did no incubation. This may have been because it was a

new or inexperienced male, as the previous male, which was colour ringed, had not returned to the site. At other sites, the males would often incubate after bringing in food for the female. The female would fly out and take food from the male, whereafter the male would go to the nest and incubate for up to an hour. Males at sites where pairs had been colour ringed and bred previously appeared to incubate more than at sites where a new male had taken up residence. In one case ('Curriesdrift') the female had disappeared just prior to the breeding season, and a new female had replaced her. In this case, the male did most of the incubation day and night and after hatching, when only one chick survived, the male continued to incubate an unhatched egg until it was removed when the surviving chick was about 26 days old. The female also acted like a male in that she would do most of the hunting, the male only leaving to hunt when the female did not return with food. This was atypical behaviour and probably due to a combination of an inexperienced female and a competent male that had bred for several seasons with high numbers of progeny fledged (3,4,3), prior to these events. The first chick at 'Mosslands' hatched on 18 September and two additional chicks hatched the following day, making a total of three. The fourth egg was found to be infertile when retrieved a few days later. One chick was weaker than the other two and died after three days (22 September). The two chicks started the second coat of down at six days old and were completely fluffy by 11 days. Tiny pin-feathers were observed at 16 days on the bigger/older chick (both were females). By 18 days, pin-feathers could be clearly seen on the tail and wing. By 22 days the darker V along the back could be seen and the chicks moved around the ledge quite actively, although still a bit wobbly when defecating over the nest ledge. They spent much of the time sleeping but when active frequently flapped their wings. At other nest sites, the males were far more active and alert and could alarm call when 24 days old. At 28 days the wings were well feathered and the tail was

pronounced with the facial feathers and the malar stripe clearly seen. The top of the head was still full of down with the cheeks and side of the face properly feathered. Scapulars on the wing are also evident at this stage. The first female was active in climbing along the ledge and balancing at the edge by 36 days. Fledging of the first chick was at 43 days and 45 days for the second chick. At other nest sites, males fledged two days before the females and one male, fledged at 39 days, was flying well the next day. Within a day or two the juveniles were able to fly well and would fly easily to a ledge or rock when a parent brought in food, although the landings were a bit clumsy.

The male at the 'Mosslands' site brought in food for the chicks and the female during the first 12 days. The female brooded the chicks continuously for the first four days, after which she would sit on the ledge in front of the nest. Twelve days after hatching, the female flew off to hunt for the first time in the vicinity of the cliff and was away for 40 minutes. Thereafter she would be away from the cliff for longer periods of up to two hours.

Aggression at nest sites differed between pairs and depended on the stage of breeding. At the onset of display, the Lanners were very vocal and chased any large bird away from the cliff. Once incubating, the female was quiet and the male would be away for many hours, so that it often appeared as if the cliff was deserted. Once the chicks had hatched aggression levels were high, the female stooping aggressively at any large bird passing close in front of the cliff and alarm-calling if a large raptor was even sighted in the distance. After about 12 days post-hatching, the parents were not so aggressive towards ravens, Booted Eagles *Hieraaetus pennatus* and Rock Kestrels *Falco tinnunculus* when they came past the cliff as long as they were not too close (+-100 metres) to the nest. Any large eagles were immediately chased off. On one occasion at 'Mosslands', a Hamerkop *Scopus umbretta* was struck into the water when passing below the nest site. Crowned Eagle

Stephanoaetus coronatus, Martial Eagle *Polemaetus bellicosus*, Black Eagle *Aquila verreauxii*, and African Fish Eagle *Haliaeetus vocifer* as well as Gymnogene *Polyboroides typus* and Jackal Buzzard *Buteo rufofuscus* were vigorously chased at all times.

Sexing of Lanner Falcons.

Sexing of chicks was determined by measurement of the foot-span of adult falcons of known sex. Males averaged about 69 mm (69.1 ± 4.1 *n*=7) and females around 76 mm (76.4 ± 4.4 *n*=20) between toes spread out flat (Fig. 6). Foot-span measurements were reliable when measured on chicks older than twenty days. This was determined when repeated measurements were taken from chicks when nest sites were revisited. Falcons were also sexed from measurements obtained from falcons trapped in the study area (Table 3).

TABLE 3. Mean body mass, wing length and tail length of Lanner Falcons.

	Adult males	Juvenile males	Adult females	Juvenile females
Body mass g	565 ± 20.4 (530-600) *n*=10	527 ± 25.2 (500-550) *n*=4	749 ± 62.0 (680-840) *n*=20	679 ± 45.4 (605-740) *n*=16
Wing length mm	313 ± 3.9 (308-317) *n*=4	317 ± 1.5 (316-319) *n*=3	346 ± 13.5 (326-361) *n*=11	344 ± 15.8 (314-360) *n*=9
Tail length mm	181 ± 11.0 (170-196) *n*=4	187 ± 6.6 (182-195) *n*=3	202 ± 10.4 (188-218) *n*=11	206 ± 12.2 (183-215) *n*=9

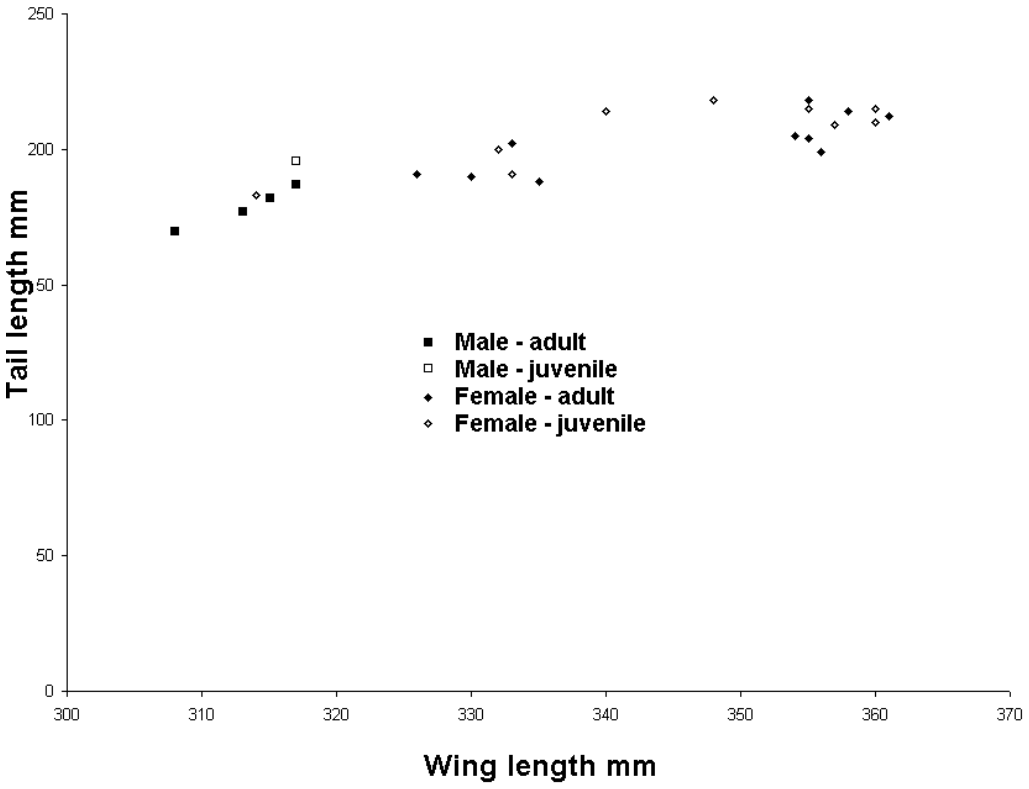

FIGURE 7. Wing and tail measurements of Lanner falcons.

The single juvenile "female" plotted with the males on the graph indicates that it was probably incorrectly sexed and was possibly a male, although it had a body mass of 670 g. A Lanner with this mass is normally assumed to be a female. Another interesting observation is that although juvenile feathers may be longer than the new feathers after the first moult (Cramp & Simmons 1980), a female that was first trapped in January 1994 as an adult ('Two Bushes'), had the same wing and tail measurements when re-trapped a second (May 1998) and a third time (October 2000). Similarly other adults re-trapped at nest sites showed no increase or decrease in wing or tail lengths.

TABLE 4. Summary of breeding at Lanner Falcon nest sites in the Eastern Cape Province, 1997-2000.

		KARIEGA PARK	MELODY	TWO BUSHES	MOSS LANDS	BAT HURST	CURRIES DRIFT	KAP RIVER	HENLEY	TOTALS
EGGS LAID (DATE)	1997	-	-	4 (13/8)	-	3 (7/8)	4 (29/7)	-	-	11
	1998	3 (5/8)	4 (17/7)	3 (28/7)	5 (16/8)	4 (2/8)	4 (23/7)	3 (16/8)	-	26
	1999	-	3 (12/8)	4 (25/7)	-	3 (3/8)	3 (29/7)	3 (10/8)	3 (3/8)	19
	2000	3 (8/8)	4 (4/8)	3 (29/7)	-	3 (4/8)	3 (7/8)	3 (30/7)	-	19
CHICKS HATCH	1997	-	-	2	-	3	4	-	-	9
	1998	3	4	2	4	4	4	3	-	24
	1999	-	3	3	-	3	3	3	2	17
	2000	3	3	3	-	3	2	3	-	17
CHICKS FLEDGED & SEX RATIO	1997	-	-	1 ( )	-	3 (1 ,2)	3 (1 ,2)	-	-	7
	1998	2 (2)	4 (2 ,2)	1 ( )	2 ( )	4 (1 ,3)	4 (2 ,2)	2 (1 ,1)	-	19
	1999	-	2 (2)	3 (1 ,2)	-	3 (2 ,1)	3 (1 ,2)	3 (2 ,1)	2 ( )	16
	2000	0	3 (2 ,1)	0	-	0	1 ( )	3 (2 ,1)	-	7
SITE OCCUPIED	1997	Y	Y	Y	Y	Y	Y	Y	N	
	1998	Y	Y	Y	Y	Y	Y	Y	N	
	1999	Y	Y	Y	Y	Y	Y	Y	Y	
	2000	Y	Y	Y	N	Y	Y	Y	N	

=MALE =FEMALE

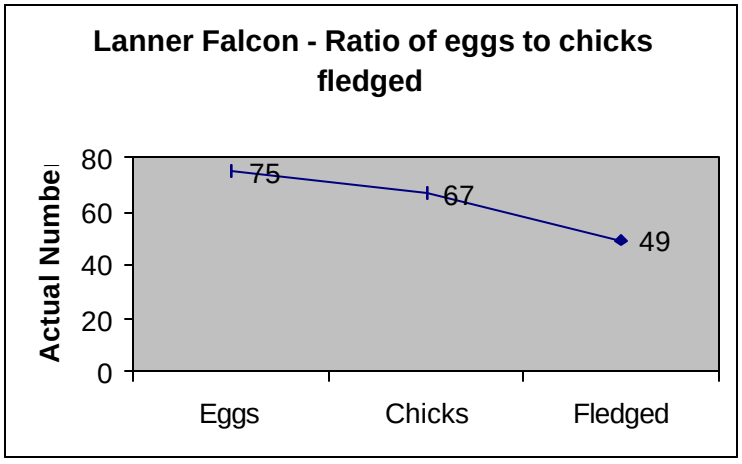

FIGURE 8. Eggs to chicks (65%) fledged ratio from data obtained from 22 breeding attempts from 1997 till 2000.

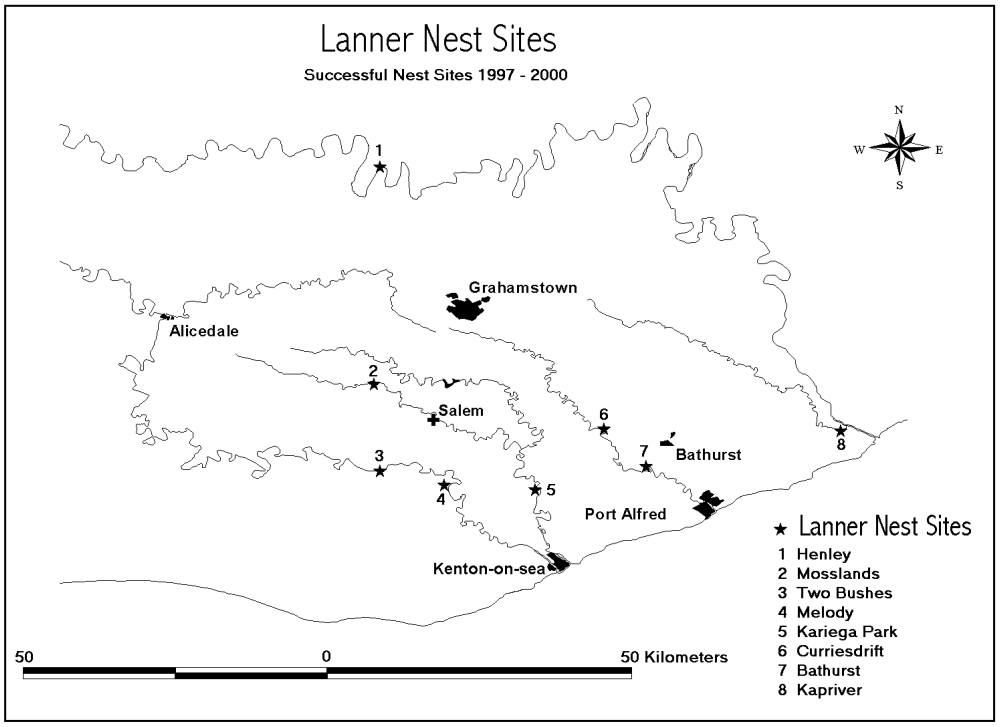

FIGURE 9. Active nest sites from 1997-2000.

TABLE 5. Dates at onset of incubation, number of chicks fledged, and sex ratio.

	EGGS LAID *n*(No. NESTS)	DATES LAID EARLY/ LATE		CHICKS FLEDGED	MORTALITY OF EGG TO CHICK FLEDGED %
1997	11 *n*=3	29/7	13/8	7 (3 , 4)	36% MORT ALITY
1998	26 *n*=7	17/7	16/8	19 (8 ,11)	27% MORTALITY
1999	19 *n*=6	25/7	12/8	16 (6 ,10)	16% MORTALITY
2000	19 *n*=6	29/7	8/8	7 (4 ,3)	63% MORTALITY
Total	75	17/7	16/8	49 (21 ,28)	35% AVERAGE MORTALITY

= MALES = FEMALES

As can be seen in Table 5 mortality was highest in chicks and eggs in 2000 and this can be attributed to high rainfall (Fig. 10) at a crucial stage in breeding. In 1997 there was exceptionally high rainfall in June and this led to only three pairs attempting to breed out of a possible seven potential breeding pairs.

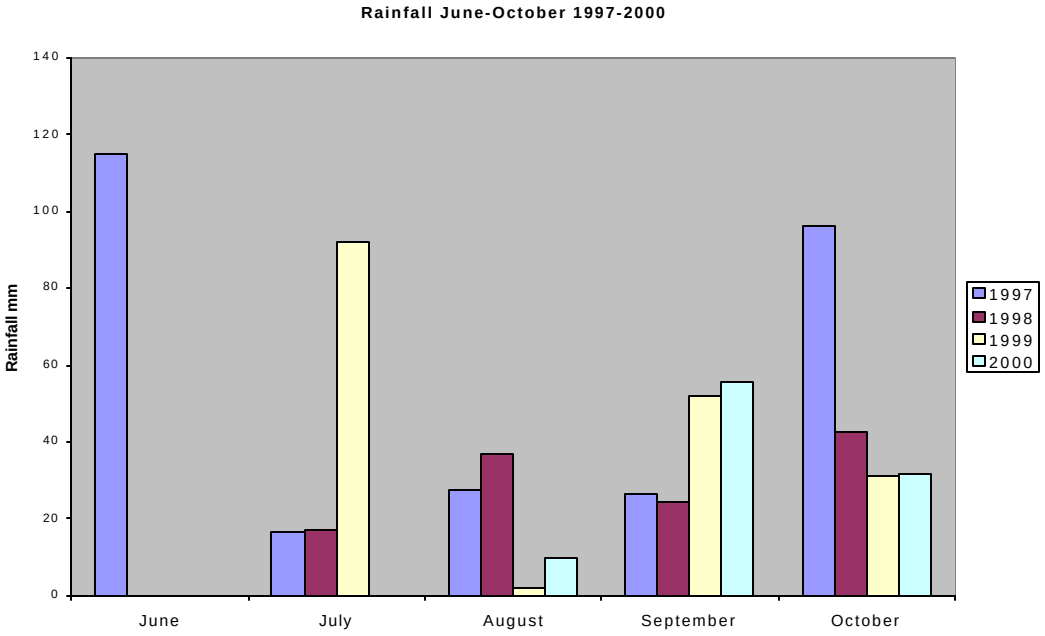

FIGURE 10. Rainfall measured at Roundhill Nature Reserve from 1997 till 2000 for the months of June till October.

Discussion

Chick survival can vary depending on several factors such as rainfall (or more precisely the timing of the rain event), cliff aspect or direction, shelter and food availability. In 1997 only three pairs bred and this can be attributed to long periods of rainfall during the courtship stage when most pairs did not even attempt to breed. In 2000, rainfall was also a significant influence on the number of chicks

fledged: there was heavy rainfall over a period of three days when some chicks were at their most vulnerable (± 10 days old) without good shelter from overhangs and facing into the prevailing weather, and when other chicks were at a stage (18 –30 days old) when they required large amounts of food.

Lanners were not able to forage effectively in this period and high chick mortalities occurred. The 'Bathurst' and 'Two Bushes' nest sites both had three chicks the previous week when checked, and a week later, after the rainfall event, neither nest had any chicks remaining. Both nests were exposed to the prevailing wind and rain from the West. The 'Kariega Park' pair were still incubating three eggs and this nest was abandoned prior to hatching. It is therefore assumed that rainfall was the direct cause of these failures. Although the number of chicks fledged for 1997 and 2000 was the same, many pairs in 1997 did not even attempt to breed as there was heavy rain (Fig. 10) during the courtship phase (June). Other authors have stated that Peregrine Falcons had higher breeding success in dry years and poor breeding in wet years (Jenkins 1998, Olsen & Olsen 1988). Jenkins (1998) observed that Peregrine young fledged per territorial pair, when compared with rainfall in September on the Cape Peninsula, declined from 2.3 young fledged with 20mm of rain, to 0.3 young fledged with 160 mm of rain. Prairie Falcon *Falco mexicanus* reproductive rates were not related to spring rain during the brood-rearing period, however, brood sizes at fledging were related inversely to the amount of rainfall prior to and during the onset of the breeding season (Steenhof *et al.* 1999). Breeding success of Lanners appears to be influenced by rainfall in that wet years depress breeding and dry years promote successful breeding, although the timing of the rainfall is crucial. Heavy and constant rain during the breeding season has detrimental effects on breeding, in particular, frequent, heavy rain immediately before, during and after incubation, may flood exposed

nest ledges, soak and kill fledglings as well as prevent the male from foraging effectively. There may also be a correlation where vegetation is more abundant and longer, after high rainfall, which may offer more cover to prey species. Casual observations indicated that Lanners were more effective catching prey over open areas such as ploughed lands and stubble fields. After high rainfall, these same lands were covered in weeds and Lanners ceased to hunt there.

There appears to be a regular association of Lanners with ravens as the Lanners frequently used raven nests to breed in. At two cliffs ('Kapriver' & 'Henley') there are no ledges that are suitable for breeding on by Lanners because of the structure of the cliff and Lanners are forced to use ravens' nests. Ravens would usually build an alternate nest but on the smaller cliffs they had to wait until the Lanners had fledged their chicks before being allowed to breed. In the former Transvaal, Lanner Falcons had no association with cliff nesting corvids, but used corvid nests on power pylons and in trees (Tarboton & Allan 1984), although Jenkins (1998) found that on the Soutpansberg, Lanners nested in ravens' nests (37%) on cliffs.

Lanners bred in captivity where incubation was recorded accurately, also confirmed the incubation period of 33 –34 days (T. Wagner, pers comm.). Steyn (1982) gives a period of 32 days for wild and captive Lanners. Some confusion can arise in the determination of the incubation period due to not knowing exactly when full incubation started. Eggs hatched in incubators could also be late by a day or two if the incubator was run at a slightly lower temperature than optimal or if the humidity was too high (A. Harvey, pers comm.).

In this study 28 falcon pairs occupied breeding sites over the period from 1997 to 2000, with 22 breeding attempts, which fledged 49 young. If all occupied territories (n=28) are taken into account,

this gives a value of 1.75 young fledged per territorial pair or 2.23 young fledged per breeding pair (*n*=22) over four breeding seasons. Kemp (1993) documented breeding productivity of a declining population near Pretoria, Gauteng that produced 1.3 young per territorial pair. Although this study indicates only slightly higher breeding productivity (1.75), it appears as if there is no danger of the population becoming locally extinct. Future census will however determine if there is a gradual decline.

	This study	Brown *et al.* (1982)	Yosef (1991)	Kemp (1993)	Jenkins (1998)
Young fledged per breeding pair	2.23 *n*=22	2.51 *n*=47	3.6 *n*=5	2.4 *n*=16	2.6 *n*=23
Young fledged per territorial pair	1.75 *n*=28	1.89 *n*=9	-	1.3 *n*=31	2.3 *n*=26

TABLE 6. A summary of the breeding success of Lanner Falcons at different study sites.

No statistics are available for juvenile Lanner survival after fledging, but a congeneric species, the Prairie Falcon *Falco mexicanus*, has been fairly well studied (McFadzen & Marzluff 1996). A comparison of egg to fledging success is similar to Lanners, and although there are no data to support this, fledgling survival may be similar with Lanners (Fig. 11).

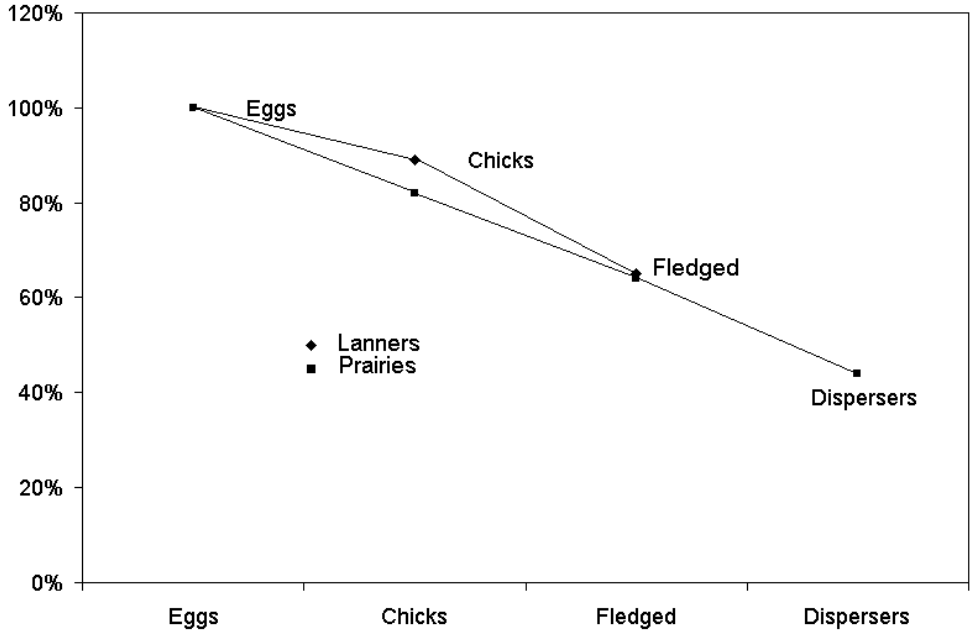

FIGURE 11. Comparison of survival of egg to dispersal of fledglings between Lanner Falcons (this study) and Prairie Falcons *F. mexicanus* (McFadzen & Marzluff 1996).

The mean date at the start of incubation over the four-year period was the 3 August (*n*=22) and Jenkins (1998) found that a population in the Soutpansberg had a mean laying date of 31 July (n=21). There is evidence that Peregrine populations breed later with increasing latitude, but this appears not to be the case with Lanners, based on this study. Although breeding performance was slightly lower in this study (Table 6), breeding biology concurs with other studies that have been done.

Chapter 4

Home range, habitat and hunting methods

Introduction

Habitat is important in determining the foraging success of Lanners, and thus this study attempted to ascertain what habitats were used, quality of the habitat, what area of suitable habitat is required to sustain a breeding pair, and how the Lanners hunted in different habitats.

To determine home range and use of habitat, three falcons were equipped with "backpack" transmitters. Due to financial constraints in purchasing transmitters, only three transmitters were used during the study. No previous radio tracking has been attempted with Lanners in South Africa but recently Jenkins & Benn (1998) tracked Peregrine Falcons in the Western Cape to determine their foraging ranges during the breeding season. Radio tracking of raptors is the most useful technique for determining the movement and foraging ranges (Kenward 1987) as well as determining habitat use. Hunting methods were observed while radio tracking individuals as well as incidental observations while in the field. During the years from 1984 to 2000, a number of hunts were observed. Although no success or failure rate could be estimated as accurate numbers of each hunt were not recorded, it may prove valuable for further research to document these observations. Apart from casual notes, little has been published on hunting methods, except for Kemp (1993). Knowledge of hunting methods could also lead to a better understanding of mortalities caused by collisions. Direct observation by following the instrumented falcons also indicated what habitat and prey was utilized and where hunts were successful.

Methods

Two adult males and one adult female were trapped at separate times and fitted with backpack transmitters. Telemetry is the accepted method to determine home range for raptors (Kenward 1987). Two males in the same season (1998) and one female (1999) were fitted with ATS (Advanced Telemetry Systems) transmitters weighing just less than ten grams respectively. Transmitters were model 2040, 70-day life with a frequency in the 216 MHz. range. The reason for using the 216 MHz. frequency was the shorter antenna length (330 mm) which would not interfere with the falcon's flight or present a potential hazard for electrocution. A Custom Electronics receiver with a folding, three element Yagi antennae was used to track the birds. Transmitters were fitted as back mounts with a harness of 6 mm Teflon ribbon modified from existing designs (Kenward *et al.* 1999, Kenward *et al.* MS in review, ATS technical data). The harness was pre-cut and sewn with measurements calculated for Lanner Falcons according to chest measurements used by Kenward *et al.* (in review) for Saker Falcons *Falco cherrug* and scaled down to fit the Lanners as they are morphologically similar to Sakers. The ends of the ribbon were pulled through the corresponding holes in the transmitter and then tied with a simple overhand knot at the previously marked point. All four knots were coated with quickset epoxy and pulled back against each other in the transmitter base hole.

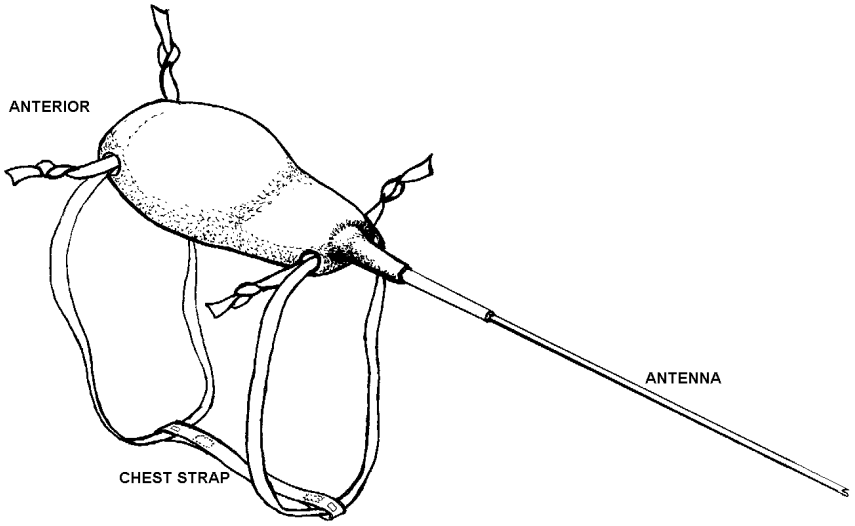

FIGURE 12. Backpack transmitter and Teflon attachment straps for fitment to Lanner Falcons as adapted from Kenward *et al.* (Ms in review). The transmitter was attached on the back of the falcon, with the straps encompassing the body and passing in front of and behind the wings.

Both males were trapped and fitted with transmitters once the females had begun incubation, to determine foraging range during breeding season. With an incubation period of 33-35 days and a fledging period of 45 days, the battery life on the transmitters would last until the chicks fledged. The female was fitted with a transmitter only after the chicks were > 20 days old and both the male and female were hunting for food (The male of this pair was electrocuted shortly after the female was instrumented and the female also electrocuted 28 days after the transmitter was fitted).

The birds were tracked and followed by vehicle and often located visually. Triangulation was not used, as a good system of roads in the study area made it relatively easy to follow the birds and to obtain data on their hunting and habitat selection. Very often the Lanners would forage beyond the transmitting range that could be received near the nest site. Triangulation was also problematic when the falcons were behind hills, with signals being reflected from a direction different to where the

falcon was last recorded. The further the transmitter from the receiver the greater the error in accurate plotting (Springer 1979).

All points were recorded on a Garmen GPS 2+ Global Positioning System and plotted on a map using Arcview to determine a minimum area polygon.

Land use was determined when radio tracking the Lanners. Vegetation was classified according to two types, which could influence hunting success. These were "bush", including tall grasslands with any vegetation tall enough to prevent Lanners from flushing prey or retrieving such prey when struck down, and "open": cultivated fields or short grasslands where Lanners could effectively hunt. The "bush" category included any bush or trees ranging from scrub fynbos to coastal forest or dense bush in the Karroid veldtype. "Open" lands were all cleared areas where crops had been or were planted, including short grass pastures and natural grass veld that had been heavily grazed by livestock. Old cleared lands were in some cases overgrown with thorn trees *Acacia karoo* to such an extent these were considered as bush and in other cases where the acacia thorn trees were small and relatively far apart they were considered as short grassland.

Observations of Lanners hunting were opportunistic at times when the observer happened to be in the right place at the right time. When radio tracking and following the three Lanners fitted with transmitters, several hunts were witnessed. Observations of hunts were made by binoculars and a 20-60X spotting scope to determine prey captured.

Results & discussion

Foraging area for the three birds (Fig. 13) was 66 km^2 ('Two Bushes'), 225 km^2 ('Henley') and 249 km^2 ('Mosslands'). No other published data are available for foraging ranges of Lanners, except from a casual record where Jenkins (1998) found that a Lanner Falcon tracked in

the Soutpansberg, foraged up to 10 km away from the nest site. The congeneric Prairie Falcon of North America was determined as having an average foraging range (*n*=9) of 227.8 km^2 (Haak 1982). Home ranges for Prairie Falcons varied from 34 km^2 to as large as 389 km^2. Pasture habitat apparently provided ideal foraging conditions for Prairie Falcons and those falcons that hunted over pastures had smaller home ranges. Jenkins & Benn (1998) radio tracked Peregrine Falcons (*n*=4) in the Western Cape during breeding season. They found that the average home range was 123 km^2, while males (154 km^2) occupied larger home ranges than females (92 km^2). Adjoining home ranges overlapped by about 20 %, although neighbours tended not to forage in the same area on the same day.

The male falcon tracked from the 'Two Bushes' (Fig. 13 no 3) nest site had a smaller foraging range (66 km^2) than the birds from the other two nest sites at 'Mosslands' (249 km^2) and 'Henley' (225 km^2). The 'Two Bushes' site was surrounded by intensive agriculture with crops producing sunflower, birdseed and chicory. Of the 66 km^2, approximately 34.7 km^2 was open or cultivated lands where the Lanner mostly hunted. There were far more birds available as prey species that fed in the cleared lands than were evident in the other two study areas. Thus a smaller foraging range would have been predicted for this individual. The 'Henley' (Fig.13 no.1) site was situated on the Great Fish River where the vegetation was mainly Karoo veldtype and thicker stands of *Acacia karoo* thorn trees along watercourses. This falcon travelled greater distances to secure food to feed the two chicks. It was also away from the nest site far longer than the other two sites and would sometimes be away for more than 5 hours at a time. During radio tracking this falcon visited farmhouses on a habitual route everyday and all of the prey noted were domestic chickens except for three cases where other birds were caught (2 Redfaced Mousebirds *Colius indicus* and 1

Blackeyed Bulbul *Pycnonotus barbatus*) and these appeared to be caught by chance and not as part of a determined attack. This falcon would forage as far as 24 km away from the nest site in a morning. Although harness-mounted transmitters have shown adverse impacts on survival of other raptors (Kenward *et al.* 1999), of the three falcons instrumented, the two males eventually shed their transmitters and survived to breed the following year. The female was electrocuted 28 days after being fitted with a transmitter, although it presumably did not cause the electrocution as the male from this site was also electrocuted just prior to this. Peregrine males had greater foraging ranges than females (Jenkins & Benn 1998), but because the male Lanner at 'Henley' was electrocuted shortly after the female was fitted with a transmitter, she may have had to forage further, to provide food for the two chicks, than she would have had to, had the male still been alive.

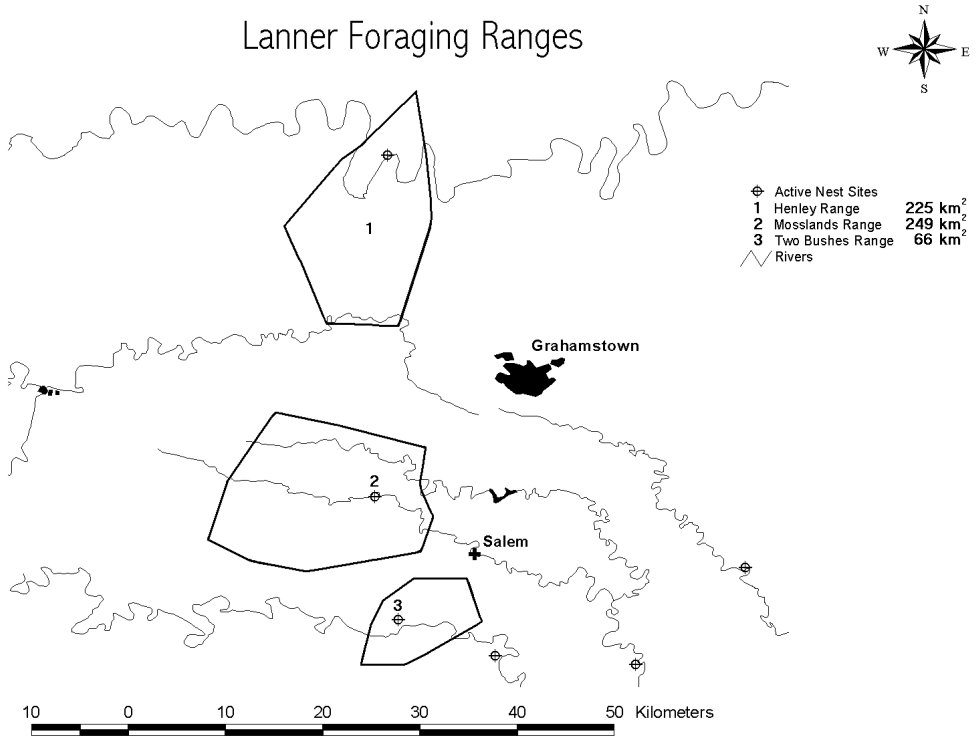

FIGURE 13. Foraging ranges of three Lanner Falcons determined by radio telemetry.

The 'Mosslands' male hunted over mostly short grasslands and old lands. Cultivated lands were mostly for stock fodder or chicory, and bird numbers were visibly lower than at the 'Two Bushes' site but higher than for the 'Henley' site. Observations of prey abundance were purely subjective and were not measured except for personal observations made while tracking the Lanners. Lanners favoured open ground and were most successful when hunting over these open areas. Potential prey invariably escaped into cover if a hunt was attempted over ground where there was cover. It appears that cultivation benefits Lanners' foraging efforts, and this is also probably a reason why the Lanners at sites in the Karoo area failed to breed once ostrich farming had ceased there. In the 1980's and early 1990's many Karoo farmers were feeding ostriches intensively in open feedlots, which attracted birds to the feed. These birds were also then vulnerable to attack from Lanners, as there was no cover to escape from a stooping falcon. In a study done on Saker Falcons *Falco cherrug* by Watson & Clarke (2000), it was found that Sakers benefited from heavy grazing by nomadic herders, but with the collapse of collective farming in Kazakhstan, longer grass reduced the number of susliks *Spermophilus* available to Sakers, causing a decline in breeding. Most grassland species decline with heavy grazing and cultivation, but this may be one case where a species actually benefits. In the north-eastern areas of South Africa (formerly Transvaal) Lanners were thought to have increased and expanded their range as a result of agricultural development which made foraging easier, and the increase of available nest sites in the form of crow nests in electricity pylons (Tarboton & Allan 1984).

The 'Two Bushes' male hunted mostly from a soar unless the wind was very strong, when it would fly at speed and low to the ground in an attempt to catch a bird by surprise. Pigeons were the target most often, with Rock Pigeons comprising a large proportion of the prey caught, and Redeyed

Doves in lesser numbers. The female accompanied this male on hunts once the chicks were older than two weeks. They were extremely successful in catching pigeons, with the female stooping first at the pigeon and the male following higher overhead. The female mostly caught the prey after the male had struck it. The 'Mosslands' male concentrated on smaller birds such as larks in short grasslands and old lands. On two occasions it was seen to follow a vehicle along a road and catch a weaver and a quail finch that were flushed by the vehicles. Both males from the 'Two Bushes' and 'Mosslands' sites would follow a tractor ploughing or harvesting and in this way species such as Quail Finch, Button Quail, African Quail and Orangethroated Longclaw were struck and retrieved. Quail were caught in this way that would have otherwise escaped detection.

During very hot, calm days both the male and female at the 'Mosslands' site would soar very high above the nest site, on some days out of binocular range, for more than two hours at a time. On windy days the female would sit on the cliff, after the chicks had been fed, and the male would cruise along a hill nearby, without hunting, for an hour or more.

Several different types of hunting by Lanners were observed. By far the most commonly observed hunting method was a single falcon coursing low-level across the land at speed trying to flush prey and chase it down. This was observed mostly when a moderate to strong wind was blowing. During the latter half of breeding season, as well as after breeding, pairs often used to hunt together in this manner with a slight variation in that one falcon, mostly the male, would fly much higher than the other, and the lower falcon would flush birds for the falcon flying above to stoop at. When prey was caught by the male, the female would take the prey and either return to the nest site or eat it herself. This hunting partnership was also observed with one adult and a juvenile, with the adult doing the stooping, as well as two juveniles hunting together in February. These cooperative hunts appeared

more successful than when attempted by a single falcon. Pairs were also observed hunting along a cliff, where one falcon would land and flush rock pigeons and the other falcon chased them. Although observed on several occasions, these hunts were never successful except in one case, where an unfledged rock pigeon was retrieved from its nest and taken back to the falcon's nest.

In the second hunting method on calm days, a falcon soared to gain height and launch attacks from almost out of binocular range. During radio tracking this type of hunting was frequently seen, as it is doubtful the observer would have noticed the falcons otherwise. The falcons would target pigeons on passage or birds that had been flushed by other disturbances such as vehicles, cattle and tractors working the lands. Birds were caught in most of the observed hunts during breeding season with the exception of two occasions where flying termites that had emerged after a thunderstorm were eaten on the wing by Lanners. Adults and juveniles were observed out of breeding season in the summer months foraging on the ground and with slow coursing flight, catching locusts and grasshoppers in mown pastures and short grasslands.

No hunting directly from the cliff site was observed, although Peregrines utilize the height advantage of tall cliffs frequently for hunting (Jenkins 1998). Great height has two advantages for hunting falcons in that they have greater visibility of passing birds as well as using gravity to accelerate quickly to overtake and surprise potential prey. Hunts from power line poles were seen where a falcon was perched for some time and made repeated attacks on rock pigeons sitting in a ploughed land. The attacks were powered shallow stoops from the pole, but none were successful. On several occasions while observing hunters shooting at rock pigeons flying past, wounded pigeons

were pursued by Lanners that had been perched in nearby trees or soaring above. It appeared that Lanners associated shots with the availability of handicapped prey, and were attracted to such shooting parties. Where crops such as sunflower and bird-seed are damaged by birds, farmers encourage pigeon shooting to limit crop damage. A similar observation is reported by Steyn (1982), where Lanners followed herders, who were hunting quail by throwing sticks, in the hope of snatching crippled birds.

Lanners have relatively low wing loadings (45.6Nm^2) compared to other bird-catching falcons, such as African Peregrines (60.25 Nm^2) (Mendelsohn *et al.* 1989, Jenkins 1998). Wing loading was calculated by wing area = [wing chord/0.62]2 / 1.93 (Greenewalt 1962). Lower wing loading enables Lanners to soar well and it was these hunts from a soar that were observed while radio tracking. The Lanners' wing shape also facilitated slow flight when coursing low over the ground searching for grasshoppers. This enables Lanners to have several different types of hunting methods, and they are therefore more versatile than African Peregrines in their hunting ability. This study found that adult Lanner wing and tail measurements did not increase or decrease with age, although juveniles have slightly longer wings and tails than adults (Jenkins 1998). This is probably an adaptation to assist juvenile survival during their first year when they are inexperienced in flight and hunting strategies, and mortalities are at their greatest. Lower wing loading also makes normal level flight less energetically expensive (Jenkins 1998).

Other studies of Lanner Falcon hunting methods (Kemp 1993) found that Lanners used four different hunting techniques: stoops after soaring, attacks from a perch, attacks from a fast, low coursing flight and aerial sorties from a perch where a falcon flew up and caught an insect. Pairs also

hunted in combination, although no hunting was observed where one of the pair flushed prey for the other to chase, as was observed in this study. This may have been due to the fact there were no cliffs where the falcons were hunting, as in this study this flush hunting occurred mostly along cliffs. Observations of hunting provided evidence of how easy it is for Lanners to collide with fences, especially single strand large stock fences across open lands. While pursuing prey at speed the Lanners do not see these wires, especially older wire that is slightly rusted and blends in with the background.

CHAPTER 5

Diet

Introduction

Prey caught by Lanner Falcons in South Africa has been documented (Steyn 1982, Kemp 1993, Jenkins 1998) with birds being the primary prey. Cade (1982) states that Lanners have rather catholic diets "like other desert falcons". Prey consists of a variety of small to medium birds, small mammals, reptiles, insects and even bats, although birds make up the bulk of their diet in most places, except in arid regions where insects and reptiles are the main prey items (Goodman & Haynes 1992).

Prey taken was only recorded where the prey species could be positively identified. In many observations of hunts and of prey brought into nesting sites, no positive identification could be made of small prey items while some prey had been plucked prior to being brought to the nest site. While small mammals make up a large part of the Lanners' diet elsewhere, no rodents were observed being taken as prey, although they undoubtedly do form part of their prey base.

Methods

Prey was identified by two methods: by distinctive prey remains which included bones and feathers easily identified that were collected at the nest sites as well as visual observations when adults brought prey to the nest site or were observed hunting away from the nest; and by identifying the potential prey in flight and investigating the site where a falcon had caught prey and fed on it. Prey caught by juveniles out of breeding season was also recorded in this way. Binoculars (12 X) and a telescope (20 – 60X) were used at nest sites and in the field to identify prey caught. No detailed

identification was made of small prey items. Regurgitated pellets or castings at nest sites were not identified, except by casual observation of obvious remains. There is a bias towards larger prey in the collection of prey samples in falcons, depending upon which method is used (Morimando *et al.* 1997, Simmons *et al.* 1991, Watson & Clarke 2000). Smaller prey is frequently digested completely and remains are hard to distinguish, and in the case of direct observations, the prey is completely eaten in a short space of time.

Results

Of the prey items identified, 153 were birds. Two Cattle Egrets *Bubulcus ibis*, one Hamerkop *Scopus umbretta* and a Blackshouldered Kite *Elanus caeruleus* were excluded as they were not eaten, and thus not regarded as prey items. Insects were not counted, as there were too many captures to record an accurate number. Whenever a termite emergence after a thunderstorm occurred, the Lanners did not hesitate to catch and eat them while on the wing. Grasshoppers and locusts were eaten, mostly observed out of breeding season, when adult and juvenile Lanners were seen stalking these insects on foot in short grass and recently cut pastures. Of the 153 birds (30 species) taken as prey, 31 (20%) were domestic chickens, 16 (10.5%) Rock Pigeons, 14 (9%) Redeyed Doves and 11 (7%) Speckled Mousebirds (Table 7).

Domestic chickens taken were all young up to the age of about three weeks old. Larger chickens were ignored probably as the Lanners could not lift them into the air.

TABLE 7. Prey of Lanner Falcons and frequency observed in the Eastern Cape Province.

Species	**Number (*n*=153)**
Domestic Chicken *Gallus gallus*	31
Cattle Egret *Bubulcus ibis*	Twice – not eaten
Hamerkop *Scopus umbretta* *	Struck down below nest
Egyptian Goose *Alopochen aegyptiacus*	Small recently hatched gosling once
Blackshouldered Kite *Elanus caeruleus* *	Struck down onto road once
Common Quail *Coturnix coturnix*	6
Kurrichane Buttonquail *Turnix sylvatica*	1
Crowned Plover *Vanellus coronatus*	1
Feral Pigeon *Columba livia*	8
Rock Pigeon *Columba guinea*	16
Redeyed Dove *Streptopelia semitorquata*	14
Cape Turtle Dove *Streptopelia capicola*	9
Laughing Dove *Streptopelia senegalensis*	4
Namaqua Dove *Oena capensis*	1
Speckled Mousebird *Colius striatus*	11
Redfaced Mousebird *Colius indicus*	4
Ground Woodpecker *Geocolaptes olivaceus*	1
Clapper Lark *Mirafra apiata*	1
Redcapped Lark *Calandrella cinerea*	6
Thickbilled Lark *Galerida magnirostris*	1
Blackeyed Bulbul *Pycnonotus barbatus*	2
Orangethroated Longclaw *Macronyx capensis*	4
Fiscal Shrike *Lanius collaris*	1
Bokmakierie *Telophorus zeylonus*	1
Pied Starling *Spreo bicolor*	4
Greyheaded Sparrow *Passer griseus*	1
Spottedbacked Weaver *Ploceus cucullatus*	3
Cape Weaver *Ploceus capensis*	2
Yellow Weaver *Ploceus subaureus*	1
Redbilled Quelea *Quelea quelea*	8
Common Waxbill *Estrilda astrild*	1
Quail Finch *Ortygospiza atricollis*	8
Redheaded Finch *Amadina erythrocephala*	1

Common and scientific names after Maclean (1993)

* Not considered as prey items.

- The Hamerkop was struck down after passing below the nest when the female Lanner had been disturbed while the Lanner chicks were being ringed.

- The Blackshouldered Kite was struck down twice by an adult female Lanner after it harassed a recently fledged Lanner juvenile.

Carrion was observed being eaten on three occasions. Once an adult male Lanner was seen carrying an ostrich rib bone it had retrieved from an ostrich abattoir. The male was followed a short distance before it was forced to drop the bone by a Black Sparrowhawk *Accipiter melanoleucus*. The bone was then positively identified. On two occasions juvenile Lanners were seen feeding on dead lambs that had died from other causes. They were in the company of ravens on both occasions.

Discussion

The most frequently observed prey item was domestic chickens, which formed a large part of the diet; doves and pigeons were the next most important prey. Jenkins (1998) recorded domestic chickens, Laughing Dove, Crowned Plover and Redeyed Dove as the most important prey species of Lanners in the Soutpansberg. Although Crowned Plover occur in fairly large numbers in the study area, only one was recorded in this study from prey remains at a nest. Laughing Doves are more a commensal of man in the study area and are abundant in towns whereas few are found in the rural areas and this is probably the reason why they do not feature in such high numbers as prey. All of the four prey remains of Laughing Doves were recovered from one nest site at Kariega Park. Particular nest sites appeared to have preferred prey species: 'Two Bushes' Lanners caught Rock Pigeons and Redeyed Doves, whereas the 'Curriesdrift' Lanners had a high number of feral pigeon remains at their nest site. Other studies in southern Africa (Tarboton & Allan 1984, Kemp 1993) also conclude that domestic fowl and doves (columbids) are important prey items for Lanner Falcons, while Goodman & Hayes (1992) indicate a more diverse diet including reptiles. In Israel

(Yosef 1991) found that Chukar Partridge *Alectoris chukar* were the most frequently taken prey (43.1%) while sandgrouse *Pterocles* sp.(12.6%) and doves *Columbia livia* (9.0%) were the most important prey items in a desert environment, although small mammals (5.4%) and insects (16.1%) were also taken.

Male and female Lanners in this study caught similar prey with regard to species and size, with the largest being pigeons. Lanners exhibit reversed sexual dimorphism (RSD), with the males being 71% by mass of the females (see Chapter 3). Several theories to explain RSD have been put forward such as niche partitioning or the ability to utilise a larger spectrum of prey with the males catching smaller birds and the females catching larger prey (Newton 1979, Andersson & Norberg 1981). Others (Cade 1982, Amadon 1975) favour the theory that the larger female can exert dominance over the male during breeding, where both sexes have lethal talons and beaks and aggressive dispositions (Cade 1982). Bird-eating accipiters and falcons show RSD and the more rapacious the species, the greater the RSD (Newton 1979). If both sexes were of similar size, fatal injury could occur. An argument generally accepted in animal behaviour is that damaging fights are most likely to occur between evenly matched animals, whereas marked disparity in size and strength leads to a dominant/submissive relationship without physical conflict. Lanner females appear dominant over males (pers obs.) Another factor which has merit, is that a larger female is a better breeder (Cade 1982) in that she can store more body fat to lay larger eggs, which hatch into larger chicks more able to survive. She can also incubate the larger clutches more efficiently and defend them better than the smaller male. Cade (1982) suggests that the male's size is adapted to ecological conditions to favour the prey base available, and the female's size is adjusted upward to the degree that best adapts her to the "big mother" role.

Morimando *et al.* (1997) in a study of Lanner Falcon prey in Italy, found that from direct observations, passerine birds were delivered to the nest more frequently than non-passerines, whereas in plucked remains, there was an identical number of passerines and non-passerines identified. No remains of small mammals were identified in direct observations or prey remains, but they were identified in pellet remains. In this study no mammals were identified as prey taken or from remains at nest sites, but may have been taken as they are probably consumed where caught. Casual dissection of castings found at nest sites indicated that insects are frequently eaten, as the hard chitin was not digested.

Observations in this study indicate that when breeding, Lanners prey predominantly on birds, but being opportunists, will utilize any prey available. Falcons at certain sites showed a preference for certain prey and this may be learned behaviour, or a response to local abundance of a certain prey species. Young domestic fowls were an important part of the diet, especially during the breeding season. This utilization of poultry may benefit Lanner Falcons, but is also the reason for their persecution.

CHAPTER 6

Movements, mortalities and recruitment of Lanner Falcons

Introduction

Lanner Falcon dispersal and movements have been documented by van Zyl *et al.* (1994) from data obtained from the Safring database of ringing returns. Oatley *et al.* (1998) reported 621 Lanner Falcons ringed in the period 1948–1998 with 30 recoveries. In the central region of southern Africa there appears to be some long-distance dispersal according to the ringing returns, with one adult recovered 2087 km from the ringing site. Along the coastal areas, movement appears to be much less with only one record of a juvenile that was ringed in the Western Cape and recovered 672 km away in the Eastern Cape. During this study I attempted to ring all Lanners in the study area from 1992 to answer the age-old question of where the juveniles go.

Methods

Lanners in the study area were ringed from 1992 onwards with Safring rings. Adult and free- flying juveniles were trapped wherever found by using nets and noose carpets. From 1997 onwards, all chicks in nests were also ringed as well as adults at the breeding sites. Use was made of the Safring database of ringing returns kindly supplied by Safring staff. From 1997 onwards adults at nest sites were also colour ringed with anodised aluminium rings to aid in identification; both members of each pair were colour ringed with anodised aluminium rings at seven nest sites. A 20-60X spotting scope was used to view adults at the nest sites or foraging in the area to confirm whether the adults had remained at the nest site. Because of the difficulty in viewing some of the nesting cliffs, which had

dense forest above and below the cliff site, an 8mm video camera was housed in a camouflaged box and placed near the breeding ledge to obtain footage of the adults and to record ring colours. The video camera was set on long play and with a normal videotape of 120 minutes, four hours of video footage could be obtained. The camera was placed near a ledge, usually in the afternoon as there was more chance of observing an adult falcon bringing in food to the young during this period. The camera was only used once the chicks were between 20 and 35 days old as this was when they consumed the most food and would probably not be in any danger from the disturbance of placing the camera at the site.

Results

From April 1992 to October 2000, 82 Lanners were ringed in the Eastern Cape. Only five were recovered by members of the public of which four were reported to Safring in Cape Town. No long-distance movement was reported, the greatest distance being 152 km where a the Lanner (female) was ringed as a ten-month old juvenile near its nest site ('Two Bushes') and recovered dead, cause unknown, near East London two years later (Fig. 14 no 2). At death it would have been just less than three years old and mature enough to breed. A recovery not reported to Safring but heard by word of mouth, was a nestling ringed at 'Curriesdrift' near Bathurst (Fig. 14 no 4) in September 1999 and trapped alive and in good condition at Parsons Vlei near Port Elizabeth in October 2000 (B. Reeves, pers.com.), 127km from the nest site. Three other birds reported to Safring were all recovered close to the ringing site. Two were adults ringed near their nest sites. One adult male ringed at the nest site ('Mosslands' Fig. 14 no 1) during the breeding season was recovered 14 months later 19km from the nest site after a collision with a fence. This male had bred

twice at the nest site before its demise.

The fourth recovery was an adult female ringed at Cannon Rocks in the company of the adult male and juveniles from the 'Melody' site (Fig. 14 no 3). The male had been trapped at the nest site previously and re-trapped with the female and its ring number confirmed. Although the female could not be trapped at the nest site again, it was viewed with a 20 – 60 X telescope, which confirmed it had been ringed. The female was later recovered (electrocuted) at the same place it was ringed almost three years earlier (2y 9m 8d). The 'Melody' nest site was 20 km from Cannon Rocks. Once the juveniles were flying well, the adult pair, accompanied by the juveniles would move down to the coast near Cannon Rocks and feed on locusts which were abundant in the mown fields.

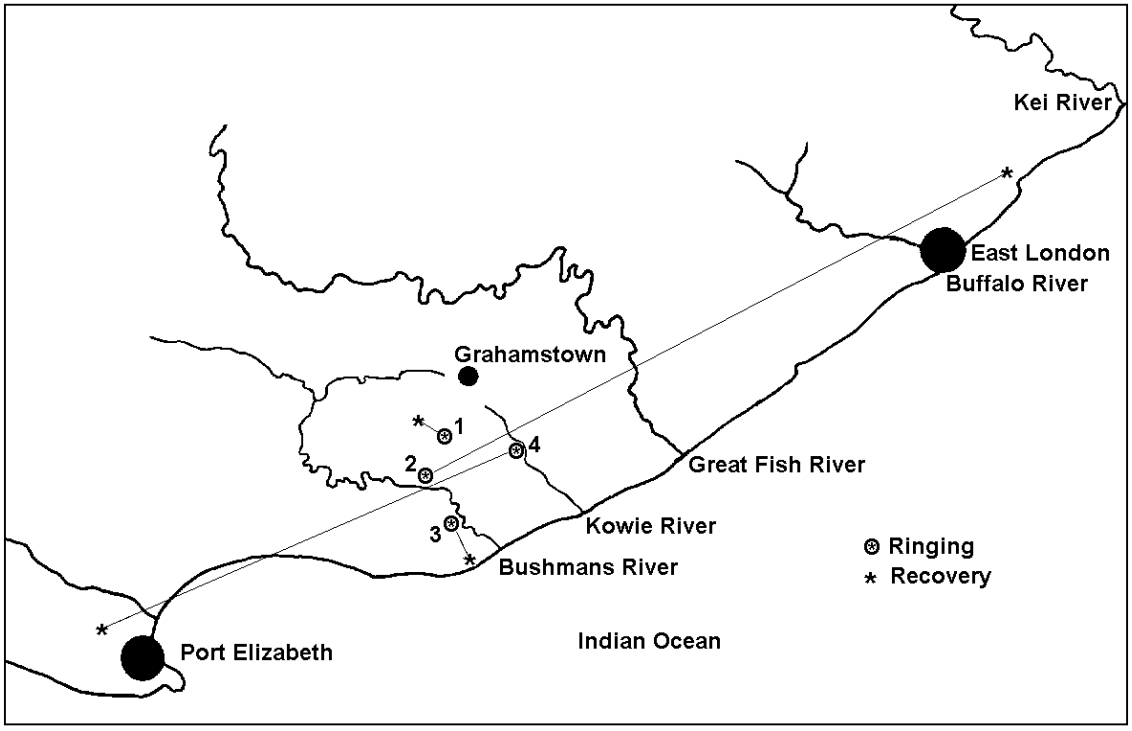

Figure 14. Map of movements of ringed Lanner Falcons in the Eastern Cape Province.
1='Mosslands' - 19 km, 14 months after ringing. (Adult male)
2='Two Bushes' - 152 km, 25 months after ringing. (Juvenile male)
3='Melody' - 20 km, 33 months after ringing. (Adult female)
4='Curriesdrift' - 127 km, 13 months after ringing. (Juvenile male)

Other Lanners ringed at nest sites were controlled by re-trapping, with the pair from the 'Two Bushes' site being of particular interest. The female was ringed in January 1994 as a breeding adult with fledged juveniles, trapped again out of breeding season in May 1998 and for the third time in September 2000 (Table 8). The male of the pair was first ringed in August 1998 and re-trapped with the female in September 2000.

TABLE 8. Adult occupation and turnover at nest sites.

Nest site	
'Curriesdrift'	Male and female trapped at site October 1997, both present 1998 & 1999. New female trapped September 2000 with old male.
'Henley'	New pair in 1999. Male was electrocuted November 1999 and female early December 1999. No birds seen in 2000.
'Kapriver'	Ringed male in September 1998. Could not trap female. Trapped female September 1999. Both birds still at nest site 2000.
'Melody'	Female ringed with chicks near nest site January 1994, electrocuted November 1996. New female could not be trapped. Male colour ringed September1997and sighted at nest site 1998 and 1999. New male 2000.
'Mosslands'	Male & female ringed October 92.Male recovered dead December 93. Female remained at nest site till 97.New male and female ringed September and November 98. Both at nest site in 1999 but no birds in 2000.
'Salem'	Male and female ringed at nest site July 1992 and were present till December 1996, not seen after this.
'Two Bushes'	Male and female ringed at site April 1992. New female ringed at nest site January 1994 and re-trapped at nest site May 1998 and October 2000. New male ringed at site August 1997 and re-trapped at site October 2000

The Lanner which occupied a nest site for the longest time is the 'Two Bushes' female, which has been at the site from 1993 till 2000 and is still in attendance. Apart from the recorded deaths, it cannot be ascertained whether the birds that have disappeared from a nest site have actually died or may have moved to another site. As no marked birds were trapped at different sites, or adult falcons recovered away from their nest site, it is more probable that these birds had died.

In cases where a marked falcon disappeared at a breeding site and was replaced by a new mate, breeding success was invariably lower than recorded for pairs that had bred previously. Similarly, new pairs also had poor fledging rates and this can possibly be ascribed to inexperience in one or both individuals. The 'Curriesdrift' pair was a good example (Chapter 3) where they had bred successfully for three years consecutively, until the female was replaced, and then only one chick was fledged in that year (2000).

Of the six pairs colour- ringed from 1997 till the end of 2000, comprising 12 falcons, six (50%) were replaced during this period. Of these, two pairs failed to return to their breeding sites. Whether they moved on or died is unknown. Further long-term research to determine accurate adult turnover is required.

Of five known cases of mortality in this study, three were caused by electrocution, one bird died as a result of a collision with a fence and one from natural causes.

Discussion

Identification of specific falcons poses a problem in that it was often very difficult to identify colour-ringed falcons at the nest site. This was due to several factors such as no vantage point at large cliffs near the nest site to identify rings, as well as the falcon's habit of tucking up one leg, usually the leg that has the colour ring on it, for long periods of time. The birds would be observed for long periods and the moment I removed my eye from the telescope, the falcon would fly off. For this reason the video camera was used to identify colour rings. In some cases only dark coloured rings could be easily seen, which presented a problem in determining the colour of the ring. The possibility of using microchips, which could be recorded by a scanner lodged at the nest site and which would identify

each falcon individually was investigated. This identification problem was only evident halfway through the monitoring period and as funding was limited and as these scanners are relatively newly-developed and expensive, it was not possible to apply it.

Up to 25 nest sites where Lanners had bred previously were identified: of these only eight nest sites produced young. Several sites had single adult birds roosting on the cliffs but with no breeding attempts. Trapping in the Salem area also produced evidence of many adult falcons that were not trapped again or recorded elsewhere in the study area. This poses the question: what are all these surplus falcons doing and why are they not breeding? Suitable nest sites were available so the presumption is that foraging conditions within range of the nest site were not conducive to breeding. Based on data obtained from radio telemetry, this would have to be within a 25 km radius of the potential breeding site. At several unoccupied sites while watching to see if any falcons were resident, single falcons came to the cliff and perched there. On occasion when a falcon was seen at a cliff, the cliff was checked again with no falcons seen there. It was assumed that hunting conditions in the immediate vicinity were not favourable and that the falcons used the cliffs to roost for a short period and then moved elsewhere. Sometimes two falcons would be seen, and thereafter only one falcon when checked again.

Van Zyl *et al.* (1994) indicated that there was an east–west movement of Lanners, especially in the summer months, based on ringing reports, while Harrison *et al.* (1997) shows a similar trend with higher reporting rates for the summer months in the west but with no reduction in reporting rates in the east. A possible explanation for higher reporting rates for Lanners in the summer months in the west but not a corresponding reduction in the east may be that the population almost doubles after breeding season and these are the excess birds observed in the west. During the onset of winter

when foraging conditions are at their lowest, many of these juveniles and sub-adults may have died, resulting in the lower reporting rate. This would concur with observations in the study area where adults remain in residence year round. Juveniles and second-year falcons will disperse when foraging conditions become unfavourable. Those falcons that have not claimed a territory can disperse long distances depending on foraging conditions. Although data are limited, it appears as if non-breeding birds disperse to where foraging conditions are optimal, while territorial birds remain in the general vicinity of their territory. In arid regions where large-scale fluctuations in prey density and movements may occur, both adults and juveniles may disperse from breeding sites in response to prey availability (Herremans & Herremans-Tonnoeyer 1996). The long distance record (2087km) was for a falcon in adult plumage, but this may not have been a breeding bird as Lanners in their second year have similar plumage to adults. Occasionally some juvenile feathers do not moult out and then a bird can be aged as a second year falcon. Lanners usually breed only in their third year (pers obs. and captive records). Data from ringing recoveries (Oatley *et al.* 1998) although sparse (30 recoveries) indicate a longevity record of 17 years. Mortality rates for Lanners have not been ascertained, but the limited data from the 30 ringing recoveries indicate high mortality in their first year and decreasing mortality with age. Intensive studies on population models for Peregrine Falcons have been compiled: juvenile to breeding age Peregrine Falcons had on average 66% mortality (Newton & Mearns 1988), although this population was increasing after the removal of pesticides. In stable populations where most good nest sites are occupied, the mortality rate may even be higher. Peregrine Falcons in Australia have a 55% mortality in juvenile, first year falcons (Olsen & Olsen 1988). Studies in Europe, Australia and North America show that large numbers of falcons are shot, a factor which is probably under-reported in South Africa for fear of prosecution as

Lanner Falcons are protected by law. More intensive efforts to ring Lanners will provide much-needed data to obtain realistic estimates of mortality rates, which would be used to determine population stability.

Trapping Lanners is a very labour- and time-intensive activity, but if areas such as the wheat fields in the western Cape and waterholes in the Kalahari are targeted, where there are concentrations of Lanners, it could be far more productive and worthwhile.

Reported causes of mortality in ringed birds are collisions (n=7), injuries (n=5), trapping and shooting (n=3), electrocutions (n=3) and drowning (n=1) (Oatley *et al.* 1998, D Oschadleus pers comm., this study). Mortalities and threats for Lanner Falcons in the Northern Cape (Anderson 2000) include direct persecution usually as a result of catching domestic poultry, drowning in reservoirs, electrocution and collisions. These causes may be biased in that only incidents occurring near human habitation may be reported. A negative implication of a high turnover of adult birds is that breeding success is reduced whenever a new bird takes the place of a missing mate.

Chapter 7

Conservation aspects

Introduction

Although the Lanner Falcon has been described as relatively common by several authors (Brown *et al.* 1982, Cade 1982, Steyn 1982) and del Hoyo *et al.* (1994) list it as widespread, generally common and not globally threatened, this species has been categorised as 'near-threatened' in southern Africa (Barnes & Jenkins 2000). Lanners in Europe declined drastically until the 1970's but appear to be stable at present, with some local declines, although the population is a fraction of what it previously was. Reasons given for the decline were poisoning, falconry and shooting (del Hoyo *et al.* 1994). Brown *et al.* (1982) stated that falconry may be a cause for local declines in Sudan, but that Lanners were probably increasing in South Africa through establishment of eucalyptus plantations and pylon lines (with associated corvid nests), and had adapted well to heavily populated countries, for example Kenya, West Africa and Ethiopia. Thallium sulphate poisoning caused the local extinction of Lanners in Israel (Cramp & Simmons 1980) but some pairs are breeding there again (Yosef 1991).

Several anecdotal reports of declining Lanner populations in South Africa (Kemp 1993, Harrison *et al.* 1997) in areas of intensive agriculture in the grassland biome have been published and possible causes for these declines have included widespread use of seed dressings and the subsequent accumulation of toxins in the food chain. In this chapter I will review factors which may affect Lanner populations in the Eastern Cape.

Discussion

1. Problems of estimating numbers.

The conservation status of Lanners appears to be uncertain as they are regarded as relatively common by some authors, but possibly threatened by others. In the Eastern Cape many bird-watchers seldom observe Lanners, even though the Lanners are resident close to regular birding areas. The Diaz Cross Bird Club, with branches in Grahamstown and Kenton-on-sea, has regular outings on which all species seen or heard are recorded: on 77 outings between 1994 and 1998, Lanners were noted on only five occasions (A.J.F.K. Craig pers comm.). Many of these outings (n=17) were in close proximity to known breeding sites and most of the bird club members would certainly recognise a Lanner Falcon if they saw one.

Personal observation at Lanner sites indicates that the birds spend most of the day perched on the cliff and are difficult to detect unless some time is spent watching the specific cliff, waiting for a falcon to move. On calm days they may also spend many hours soaring, often out of sight as revealed by radio tracking. The most effective way of locating Lanners away from the nest site was to find a concentration of birds such as doves and small birds that clustered at a feeding place. Such sites were usually cultivated lands where crops such as sunflowers, bird-seed or maize had been harvested recently and there was an abundance of birds feeding on the fallen seed. Early in the morning or late in the afternoon were the best times to observe Lanners hunting these areas, although in the breeding season they would hunt throughout the day. Similar observations were recorded in the Kalahari Gemsbok Park (pers obs., Cade 1982), where the only surface water is provided by artificial boreholes which attract doves and small birds in abundance. Lanners could be seen at most

times either hunting around these waterholes or perched nearby. Lanners in the Kalahari Gemsbok Park had a higher reporting rate (42%) than in other areas (9%) of the Kalahari (Harrison *et al.* 1997), which could be attributed to the prey concentration, bird-watcher density and the proximity of roads to water holes, whereas the rest of the Kalahari is sparsely populated with relatively few roads. Lanners also have seasonal movements in the Western Cape, Kalahari, Karoo and Botswana (Hockey *et al.* 1989, Liversidge 1989, Van Zyl *et al.*1994, Herremans & Herremans-Tonnoeyer 1996) relating to climatic and other conditions such as food abundance, where high concentrations of Lanners may suddenly occur. Examples of this are locust and quelea plagues. Determining the population size accurately is not easy, as it is dynamic and constantly responding to local short-term changes.

2. Food as a limiting factor.

Lanners are adaptable in that they can take advantage of an artificial food source, such as ostrich and cattle feedlots, which attract birds. Prey availability is probably the most important limiting factor for Lanner survival and breeding success.

Barnes & Jenkins (2000) indicated that breeding pairs of Lanners were most common in Lesotho, KwaZulu-Natal and the Eastern Cape, where concentrations of domestic chickens are abundant, providing a reliable food source for the Lanners during breeding season. In this study Lanners utilised a food source where ostrich farmers intensively fed ostriches in feedlots, attracting large numbers of birds which in turn attracted the Lanners, which bred successfully nearby. Once the ostrich industry collapsed and the feedlots were abandoned, these nest sites also failed and breeding ceased. Similarly, several nest sites where Lanners bred regularly in the 1980's have been

abandoned, the only change in the area being the increase in game farming. Previously many of the farms in the surrounding areas practised mixed farming with grassveld being kept short, as well as ploughed fields, which undoubtedly provided easier foraging for Lanners. With the switch to game farming, most of these farms have planted indigenous grasses in the old lands and with less grazing pressure, veld condition has returned to climax grass with an increase in density and height of vegetation, which provides greater cover for prey species. This change in farming practice has benefited large eagles (pers obs.) as there are more prey species in greater abundance, but has been detrimental to Lanners as the prey species are able to escape into cover.

3. Breeding success.

As mentioned previously, food and climate (rainfall) are probably the most important factors limiting Lanner breeding in the study area, and not nest site availability as proposed for other regions. Lanners can breed on virtually any structure when natural cliffs are not available (Chapter 2). Rainfall is a limiting factor and Lanners breed better in drier years than wet years (Chapter 3). Food availability is probably the most important limiting factor and contrary to expectations, Lanners appear to benefit from agricultural lands and overgrazed grassland (this study, Anderson 2000). There are no historical data for the Eastern Cape to compare with, although Boshoff *et al*. (1983) concluded that there had been no apparent change in the status of Lanner Falcons in the Cape Province from 1700 - 1979. I would suggest that Lanners are probably more abundant now than they ever were in this region. Hopefully this study will be a baseline for comparison in future studies. It is for this reason that maps indicating nest sites are presented. In the past many authors were reluctant to publish known nest sites, for fear that falconers or egg collectors may take advantage of

this. Although this may be the case in other countries or areas, in South Africa most Lanner nest sites are known to falconers. Egg collecting was fashionable up until the early 1970's but at present there is no evidence to indicate that egg collecting is still practised on a large enough scale to endanger Lanners.

4. Poisons.

No evidence of poisoning as a cause of mortality or breeding failure was noted in this study, but no carcasses or eggs were analysed for toxic residues. Bird-eating raptors were found to be more contaminated than mammal eating raptors (Mendelsohn *et al.* 1988) and limited analysis of some raptors (Smith & Bouwman 2000) found that a juvenile Lanner Falcon had appreciably higher levels of pesticide contaminant than Black Shouldered Kites *Elanus caeruleus*, Greater Kestrels *Falco rupicoloides* and a Pale Chanting Goshawk *Melierax canorus* sampled in the same area (North-West Province).

Although seven organochlorine pesticides were found to be present in the blood of the single Lanner sampled, residue levels were low enough to indicate there was no immediate danger from individual pesticides although the cumulative effect of these compounds does pose a continuous hazard. Eggshell thickness of Lanners showed a 4.6 % reduction after the introduction of DDT (post 1947) and organochlorine residues in southern Africa are high enough to have a significant impact on the dynamics of some raptor populations such as Lanner Falcons (Mendelsohn *et al.* 1988).

5. Electrocutions.

The biggest perceived threats in this study were from electrocutions and direct persecution in that

order. Electrocutions of birds were common in the study area. Most problems occurred where transformers were situated on poles, with exposed cables connecting the transformer to the overhead powerline. Escom (Electricity Supply Commission) has shown their commitment in raptor-proofing problem areas by covering bare cables with plastic covers. Power poles also have earth cables running along the tops of poles and down to ground to prevent lightning strikes from damaging power-lines. These earth cables can be cut near the ground and a gap of a few centimetres left so that the pole is not grounded but should lightning strike it would jump the gap and be earthed. Two problems associated with electrocutions are that problem poles go undetected even though there has been wide publicity by Escom to encourage farmers to report such problems. This is often because the poles are in remote places not frequented by people. Secondly, while Escom upper and middle management are extremely helpful, field staff are often reluctant to report problems of this nature, either because of extra work or because they do not perceive there is a problem. In most cases where problems have been brought to the attention of Escom, the problem areas have been rectified.

6. Direct persecution.

Shooting and trapping of falcons is probably under-reported, due to a fear of being prosecuted, as Lanners are a protected species. On two occasions, farmers mentioned that they had heard of ringed falcons in the study area. This can only be from falcons in hand as it is extremely difficult to observe ringed birds in the field. When questioned further, no information on ring numbers or incidents involving Lanners was forthcoming. Several farmers had admitted to shooting Lanners that were taking domestic chickens. On one occasion in 1996, the male Lanner from the 'Two Bushes'

site was fitted with a falconry bell to ascertain where it was breeding and to possibly use the method to identify specific falcons in the field. This falcon was trapped by a labourer on a farm nearby, and hoping to get a reward as he suspected it was a tame bird, he took it to the farmer. The farmer then contacted me and the falcon was released after a small reward was paid. The farmer mentioned that Lanners were a constant threat to chickens and that once a falcon started catching chickens they soon made plans to trap or shoot it. It appears that although domestic chickens make up a considerable portion of the Lanners' diet and contribute to their breeding success, this also often leads to their demise. Most problems occur during breeding season when the adult falcons are hard pressed to feed chicks and once they discover a farm where there are small chickens, they will return to it repeatedly. From a conservation perspective, assistance to farmers can include simple, practical methods to keep small chickens under cover until they are large enough to be less suitable as prey in order to discourage Lanners from catching them. Farmers and labourers can also be educated in conservation, provided there is continual contact, especially where there are problems resulting from raptors preying on domestic stock. This problem occurs throughout South Africa, especially where there are free ranging chickens (Anderson 2000).

Falconry has been cited as a reason for the decline of Lanner Falcons in certain areas such as Sudan (Brown *et al.* 1982). In North Africa, falconry is a hereditary practice, especially among the Islamic peoples. There is also a ready market to trade falcons for sale to the Arabian market, although Lanners are not primarily used for hunting in Arabia, as the larger Saker Falcon *Falco cherrug* is preferred. Lanners are generally used for trapping other falcons (barak) and training apprentice falconers (pers obs.). Unfortunately, many of these birds are not cared for properly and are

smuggled over long distances with the result that few survive. Many of the trapped falcons are adult breeding birds, which has a strong negative impact on breeding productivity.

In South Africa, falconry is practised under strict laws and codes of conduct and only juvenile birds are allowed for falconry. In this study, new (younger) mates had lower breeding success than pairs that had bred previously. Due to the small number of practising falconers, approximately 15-20 Lanners only are taken for falconry in South Africa in any one year. Many of these birds are 'hacked back' at the end of the season in spring. This small number of juvenile birds removed from the wild population, very often early in the season, poses no threat to the population. In contrast, as many of these juveniles would die in their first year, bringing them through the first winter and releasing them again probably increases their chances of survival. Whereas removal of adult falcons lowers the breeding productivity, the removal of some juveniles with a reasonable chance of these juveniles being returned to the wild population probably has little effect on the population.

Future Research

Three possible areas warrant further research to establish the status of Lanner Falcons in South Africa:

- Accurate data on turnover of adult Lanners at nest sites. With the technology improving rapidly in the field of microchips and scanners, this may be feasible, although relatively time-consuming in trapping individual falcons. It should also be done over an extended period of at least ten years to determine trends that are not influenced by climatic and local short-term conditions. More intensive ringing would improve the knowledge we have of Lanner movements, life tables and causes of mortality.

- Secondly, possible pesticides or contaminants in Lanners need to be assessed and evaluated to determine if this is a threat to the population. Samples from all habitat types and areas should be included to identify potential problem areas.
- Thirdly, an assessment of mortalities attributed to electrocutions is needed. Although some work has been done in this field, I believe that it represents a more significant problem than is currently perceived. Although financially it is not feasible to completely change all problem power-lines, further research can identify problem areas, which can be rectified. Constant evaluation and encouragement of field technicians will ensure that most problems are reported so that problem areas can be identified. Training of technicians to identify bird species will also contribute to understanding which areas present problems for particular species.

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