Behaviour-ecology and Conservation of desert-adapted Lions

2007 Progress Report of the Kunene Lion Project, Namibia

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Introduction

Desert-adapted lions in Namibia occur mostly outside protected areas in the Kunene Region. The unique landscapes of the northern Namib Desert, abundant wildlife, and high levels endemism, makes the Kunene Region an important area for tourism. The lion is an important flagship species for the growing tourism industry. Although the desert-adapted lions are valuable to tourism, the local communities have to share their land with these free-ranging large carnivores. Lions often prey on domestic livestock and farmers respond by shooting or poisoning lions, to protect their livelihood. The local communities have to bear the costs of living with lions, but they do not always share in the benefits from tourism. There is a need for sustainable-use of lions through eco-tourism, with tangible benefits to the communities, and for proactive management of human-lion conflicts. The conservation of lions in the Kunene Region is therefore essential to address Human Lion Conflict, and to conserve a flagship species for the tourism industry. The Kunene Lion Project contributes to this process by studying the density, demography, and population ecology of lions. Through applied research and monitoring, the study collects sound scientific data to guide management strategies and the implementation of a National Lion Conservation Strategy.

Study Area

The Kunene Lion Project covers an area of 51,380 km^2 in the Kunene Region that includes the Palmwag, Etendeka & Hobatere Concessions, the Skeleton Coast Park, and bordering Communal Conservancies (Figure 1). The area falls in the Etendeka Plateau landscape of the northern Namib Desert, with an annual rainfall of 0 - 100 mm (Mendelsohn et al. 2002), and stretches from the Atlantic Ocean in the west, to the edge of human settlement and livestock farming in the east. The Kunene River runs along the north, and the Omaruru River forms the southern border of the study area.

Methods

Large carnivores, such as lions, are generally difficult to study, especially in a desert environment such as the Kunene Region. The study area is covered systematically by tracking spoor, setting out bait and using sound playbacks to locate and capture individual lions. Adult and sub-adult lions are captured and individually marked with a hot brand, and several lions in each group are marked with a radio collar. A light aircraft is used to systematically locate radio-collared animals. Aerial locations are followed-up by ground observations to record group composition in relation to individuals and age/sex structure, and the ratio of marked to unmarked individuals. Life tables are constructed and updated to compute survivorship and mortality rates (Schaller 1972). The population dynamics of lions are evaluated by monitoring, since 1999, a core group of 13 radio-collared lions. These analyses include several population parameters, such as birth rates, mortality, fecundity (Harris et al. 1990).

Figure 1. Study area of the Kunene Lion Project in Namibia.

Results

Historical records of lions in the Skeleton Coast Park

Records of lions inhabiting the northern Namib and along the Skeleton Coast are well documented in the literature. In 1934 Shortridge (1934) observed that lions were common in the coastal regions, mountains, and ephemeral rivers, between the lower Kuiseb River and the Kunene River. In the Kaokoveld and along the Kunene valley, however, Shortridge believed them to be plentiful (Figure 2). The Skeleton Coast Park was proclaimed in 1967 and sporadic sightings of lions were recorded. Bridgeford (1985) observed lions foraging along the beaches, eating seals and cormorants, and in 1984 Steve Braine photographed a male lion feeding on a beached whale.

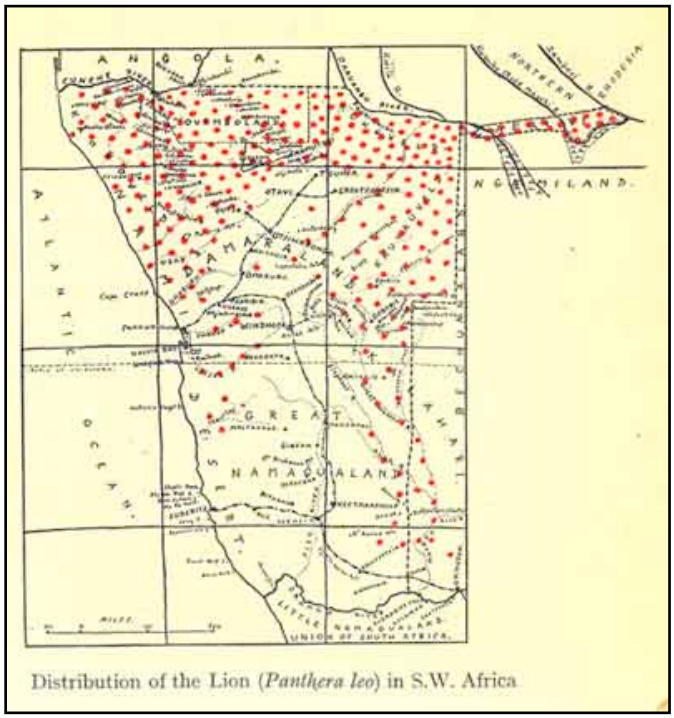


Figure 2. The distribution of lions in Namibia in 1934, after Shortridge (1934).

Figure 3. Example of "punch-cards" completed by conservation officials.

Conservation officials, employed by the Ministry of Environment and Tourism (previously Department of Nature Conservation) kept good records of game counts and patrols in the Skeleton Coast Park. Early records were recorded on "punch-cards" (Figure 3) and more recent observations had been captured on a database. The Park Warden (J Patterson) kindly made both the electronic data set and the old "punch-cards" available for analysis.

Between 1970 and 1991 (22 years), there were 238 observations of lions and a total 477 lions were recorded (Table 1). The frequency of sightings was highest during the 1980s (Figure 4), with an average of 18 sightings per year (range: 5-37). It was not possible to control for the potential bias associated with variable effort between years. As a result, the substantial peak in the number of sightings during the 1980s may partly be a function of increased patrol effort and vigilance by Park staff, instead of an increase in the number of lions.

Table 1. A list of the people that recorded lions in the Skeleton Coast Park between 1970 and 1991.

Observer	No of records	Period
Berry, H.	6	1986-1987
Braby, R.	32	1985-1991
Braine, S.	37	1982-1987
Brehem, P.	3	1989-1990
Bridgeford, P.	19	1979-1983
Cooper, T.	12	1974-1976
Davis, R.	3	1990
de Wet, P.F.	4	1974-1975
Erb, K.	1	1983
Hillen, K.	2	1990
Joubert, A.	5	1988-1989
Karlowa, E.W.	6	1970-1976
Kleynhans, J.	2	1987-1989
Loutit, B.	1	1981
Loutit, R.	31	1979-1987
Matthee, A.	1	1988
Meyer, J.	1	1983
Owen-Smith, G.	1	1979
Paterson, J.	8	1983-1990
Rudman, D.	1	1995
Schoeman, J.L.	4	1982-1987
Stander, P	41	1984-1990
Tarr, P.	16	1982-1986
Viljoen, P.J.	1	1982
Totals	238	1970-1991

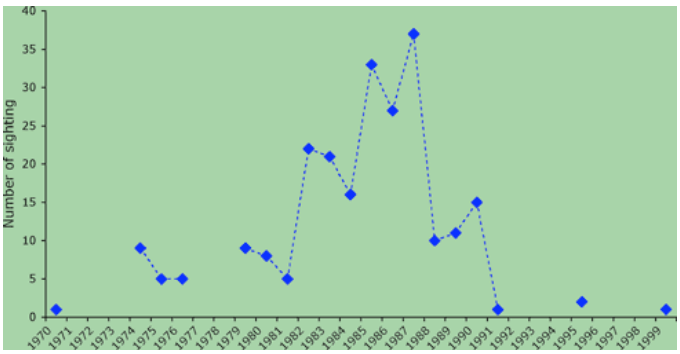


Figure 4. The number of lion observations in the Skeleton Coast Park between 1970 and 1999.

Overall the average group size of lions observed is 2.1 lions (SD = 1.61, range 1-9). The mean annual group size, however, appears to decline between 1974 and 1991 (Figure 5). This may suggest a steady decline in the size of the lion population when considering the Resource Dispersion Hypothesis (Macdonald 1983), where group size is a function of food richness. The age structures of lions indicate mainly adult lions, but the records suggest three birth peaks during the 1980s (Figure 6).

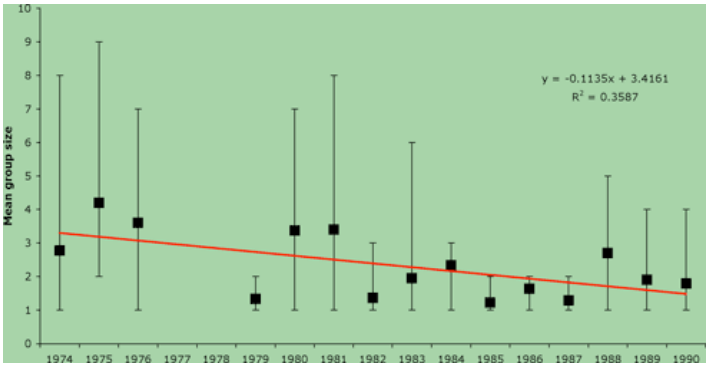


Figure 5. Average group size of lions observed in the Skeleton Coast Park between 1974 and 1999. (Error bars indicate the minimum / maximum range)

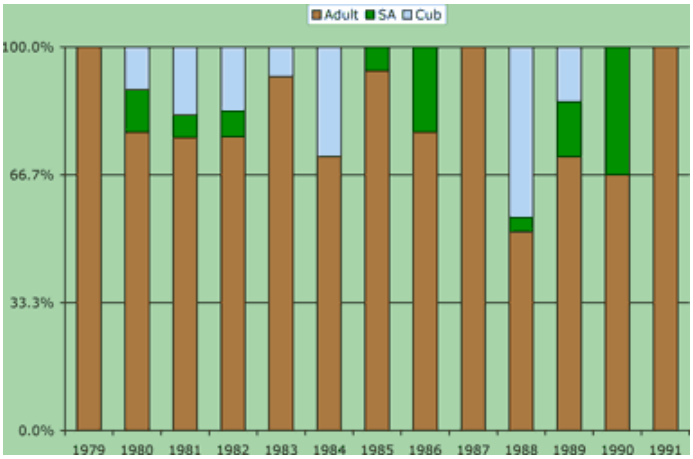


Figure 6. The average age structure per year of lions observed in the Skeleton Coast Park between 1979 and 1991.

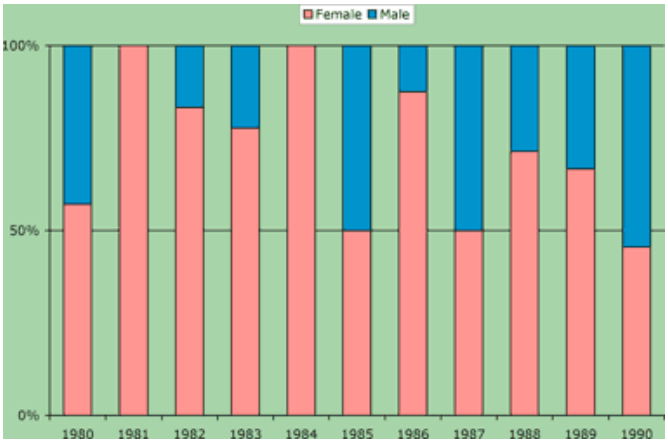


Figure 7. The average sex ratio per year of lions observed in the Skeleton Coast Park between 1980 and 1990.

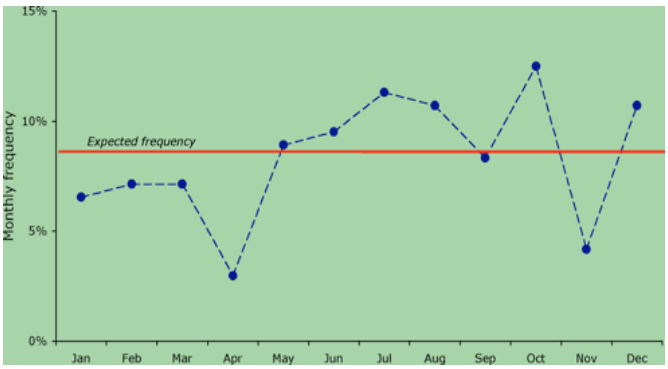
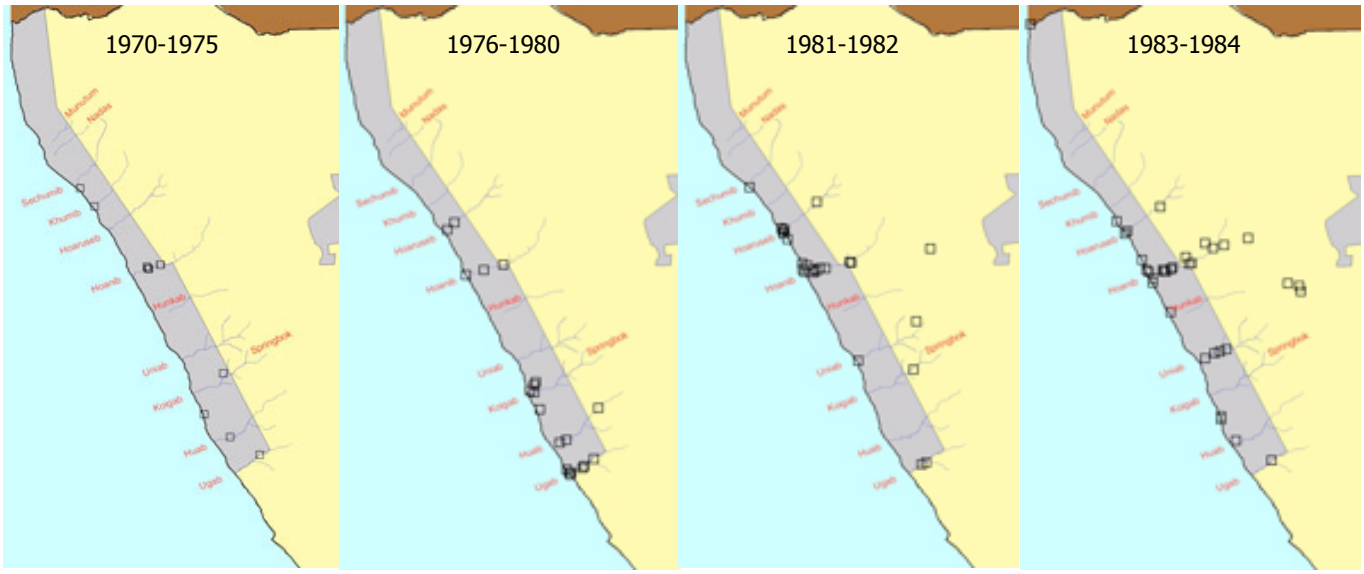


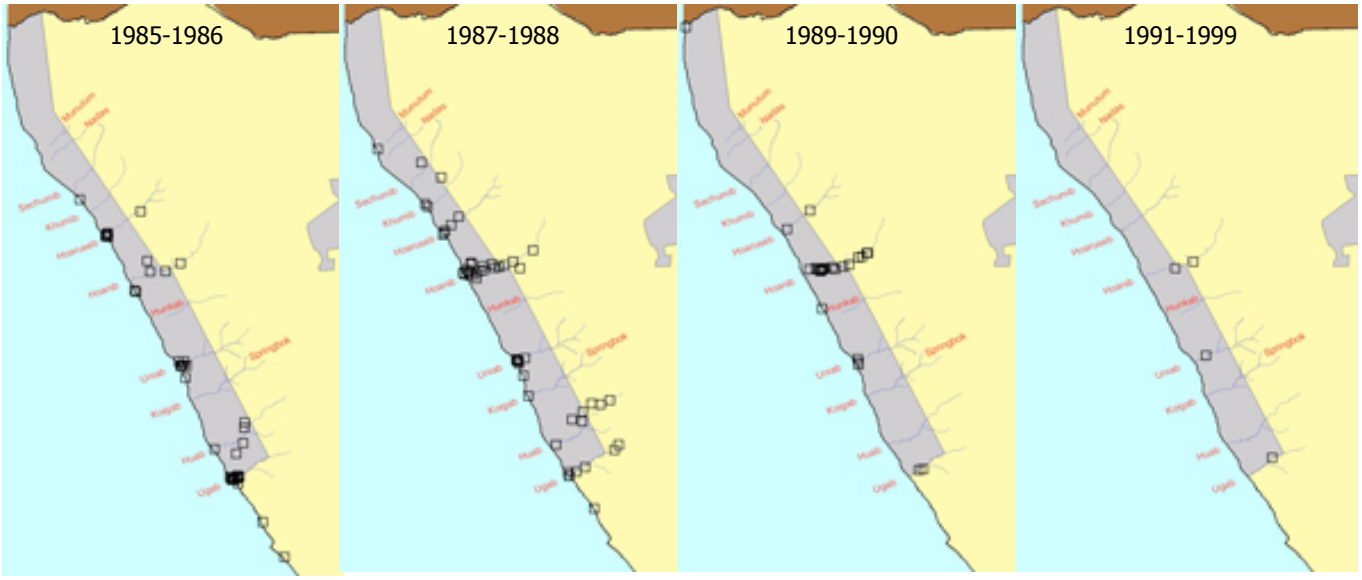
Figure 8. The monthly frequency of lion observations in the Skeleton Coast Park between 1970 and 1999. (Red line indicate the expected frequency).

The preponderance of cubs during observations in 1984 and 1988 is followed by and increase in sub-adults two years later, lending credibility to the data set. The sex ratios of observations suggest an unusual abundance of females (Figure 7). Observations of lions in the Skeleton Coast Park were most common during the dry season (May – October; Figure 8) when prey animals generally concentrate along the ephemeral river systems.

The distribution of observations shows that lions were recorded throughout the Skeleton Coast Park (Figure 9). Lions were most regularly seen in the Hoanib River. The southern river systems (Ugab, Huab, Koigab, & Uniab Rivers) produced consistent sightings throughout the 22-year period. Observations in the northern rivers (Hoaruseb, Khumib, Secumib, Nadas, Munutum Rivers) declined towards the end on the 1980s. It is interesting to note that a single lion was recorded at the mouth of the Kunene River in 1983 (2 observations) and then again in 1989.

Figure 9. The distribution of lion sightings during 8 periods in the Skeleton Coast Park, between 1970 and 1991.





Current demography & population dynamics

Lion density & population size

Since November 1999 a total of 40 lions were radio collared and 86 lions were marked or were individually identifiable (Table 2). Population density was calculated in two intensive study areas where all lions were marked or individually known (see Stander 2004, 2006). Using the Kunene Sampling Method (Loveridge et al. 2001) lion densities were calculated at 0.05 – 0.1 lion 100 km^{-2} for the low-density area and 0.38 - 0.62 lion 100 km^{-2} for the high-density area. The density estimates were then extrapolated to the current calculated areas of low and high density (Figure 10). The population estimates of 9 – 19 lions for the low density area, and 87 – 135 lions in the high density area, coincides with the records of known individual lions, and provides confidence to the total estimate of 96 - 154 lions in the Kunene Region.

Table 2. Density and population estimates of the Kunene lions – 2006.

Study Area (km^2)	±50,000	
Area inhabited by lions (km^2)	40,381	
Number of marked / known lions	86	
Number of radio-collared lions	40	
Lion population estimate	Low density	High density
Lion density (lions 100 km $^{-2}$)	0.05 – 0.1	0.38 – 0.62
Area inhabited by lions (km^2)	18,626	21,755
Population estimate	9 - 19	87 - 135
Total lion population estimate	96 - 154	

Figure 10. The density distribution of lions in the Kunene Region - 2006.

Population growth

In 1999/2000, when the Kunene lions were restricted in their distribution to the central Palmwag Concession area, a core group of 13 lions were marked with radio collars. The life history of these individual lions has subsequently been documented, and forms the bases of assessing population growth and expansion. The population has shown a positive growth rate between 1999 and 2006 (Figure 11). The Log exponential rate of annual growth was high initially (1999 – 2002), but levelled off somewhat thereafter. During the first two years (1999 & 2000) the population increased at a phenomenal rate 22% and 23% per year respectively, expressed by a logarithmic rate of increase (Figure 12). Between 2001 and 2004 the rate of increase remained high (15% p.a.), but dropped to below 5% p.a. in 2005, and increased again to almost 15 % by the end of 2006.

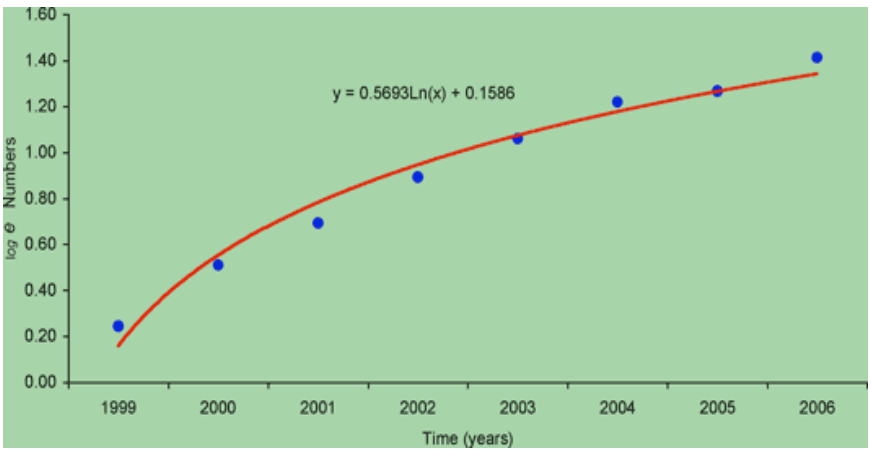


Figure 11. Growth rate of the Kunene lion population between 1999 and 2006.

Age and sex structure

Despite high fecundity and growth there were discrepancies in the age structure of the population during some years (e.g. 2004 - a preponderance of sub-adult and adult lions). However, the composition of age classes is expected to vary, and the annual data, between 2000 and 2006, clearly show this fluctuation (Figure 13). These results may demonstrate the population's ability to self-regulate, but notwithstanding, depicts the characteristics of a healthy and stable population.

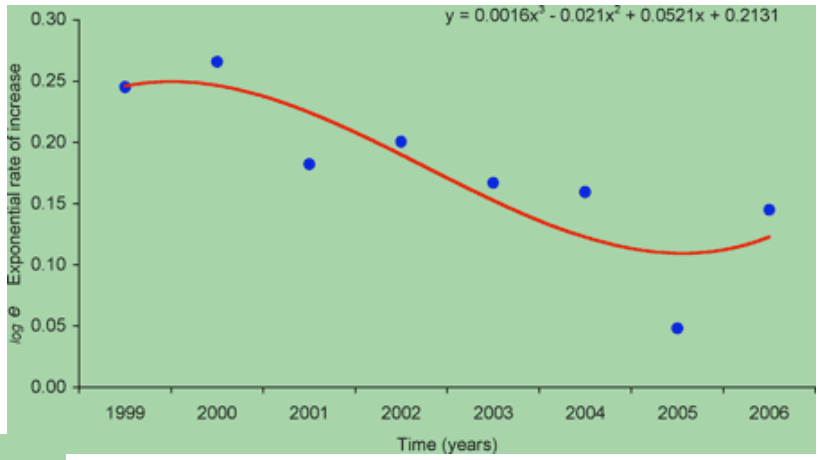


Figure 12. Exponential annual rate of increase of the lion population (1999-2006)

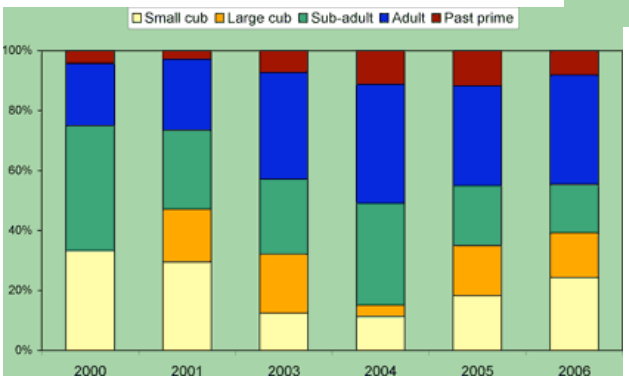


Figure 13. Distribution of age classes if the Kunene lion population between 2000 and 2006. (Small cub < 1 yr; Large cub 1-2 yrs; Sub-adults 2-4 yrs; Adult 4-10 yrs; Past prime > 10 yrs).

Fecundity and mortality

Mortality in the lion population was recorded in all three age-classes (N = 40; Figure 14). Human Lion Conflict was the main cause of mortality (53 %) as adult and sub-adult lions (mainly males) were either shot by local people, or trophy hunted. Cubs died mainly from starvation. Life tables of individual lions were used to calculate mortality rates (Figure 15) and survivorship (Figure 16) at different ages. The probability of survivorship (Figure 16) is highest at birth (P = 1), and then drops progressively over time, so that the older a lion becomes the lower its probability of survivorship. Mortality rate (Figure 15) is a measure of the probability of a lion dying at any specific age. Low cub mortality in the Kunene resulted in a slight reduction of survivorship in the fist year. Interestingly, survival of Kunene lions between 1 and 4 years is high. Elsewhere in Africa, lions at that age are at risk and mortalities are high. For a Kunene lion the risk of dying is highest at three to four years (Figure 15), and as a result, the probability of survivorship is reduced sharply to approximately 50%. These mortalities are all related to Human Lion Conflict. Once lions overcame the critical period, between 3 and 6 years, when they may have acquired the skills to avoid conflict with humans, mortality rates drop to P < 0.1. The probability of survivorship then remains stable up to the age of sixteen years, when the mortality rate soars. The low sample size at this age may introduce bias.

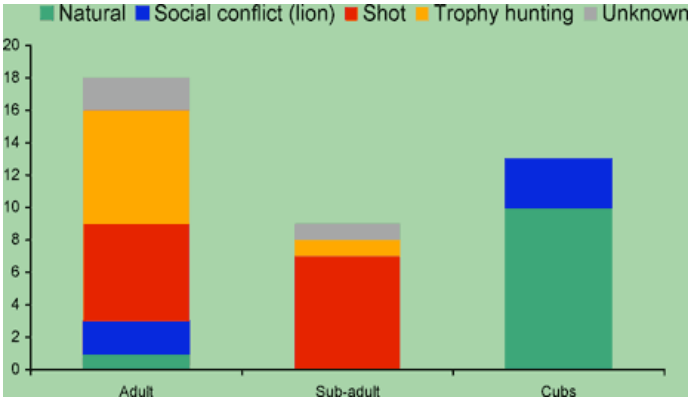


Figure 14. Causes of mortality in each age class of the Kunene lion population, between 2000 and 2006.

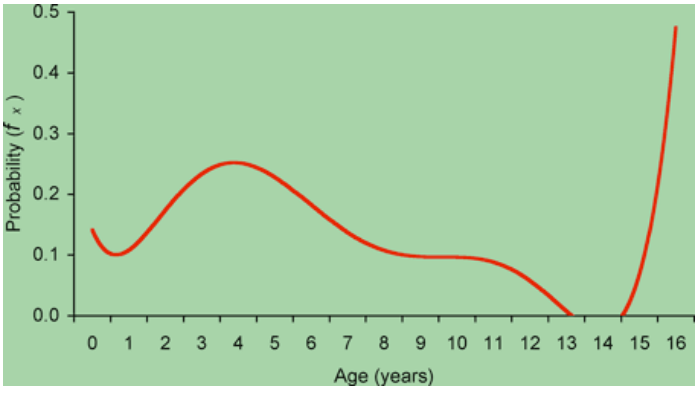


Figure 15. Probability of age-specific mortality rates in the lion population (2006).

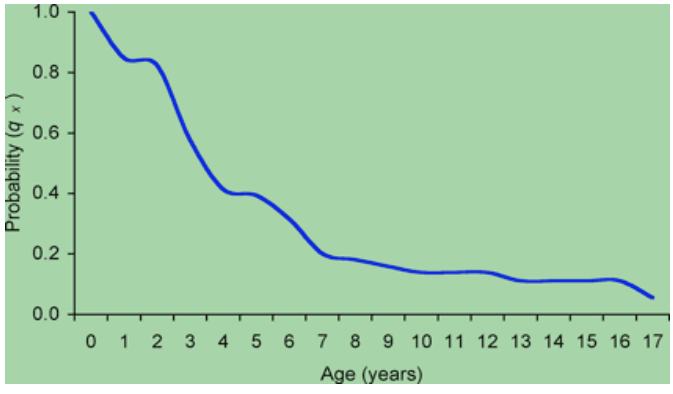


Figure 16. Probability of age-specific survivorship in the lion population (2006).

Behaviour and habitat utilisation

Distances

Between July and December 2006 lions in the Hoaruseb and Hoanib Rivers were kept under visual observation for periods ranging from 24 to 264 hours (1-11 days), following techniques described elsewhere (Stander 1992). During these direct visual observations (N = 721 hrs / 29 days) lions moved an average of 9.85 km per night (SD = 8.53; range: 1-29 km).

A GPS radio-collar was fitted to a lioness (Xpl-25) between the Hoanib and Hoaruseb Rivers in March 2006. The GPS unit recorded 10 fixed per day (17h00 – 10h00) between 3 March 2006 and 3 September 2006 (192 days, 1581 fixes). Geographic Information System (GIS) analysis of these data showed that, similar to the direct observations, the lioness moved a mean distance of 9.95 km per night (SD = 8.9; range: 0.1-48 km; Figure 17).

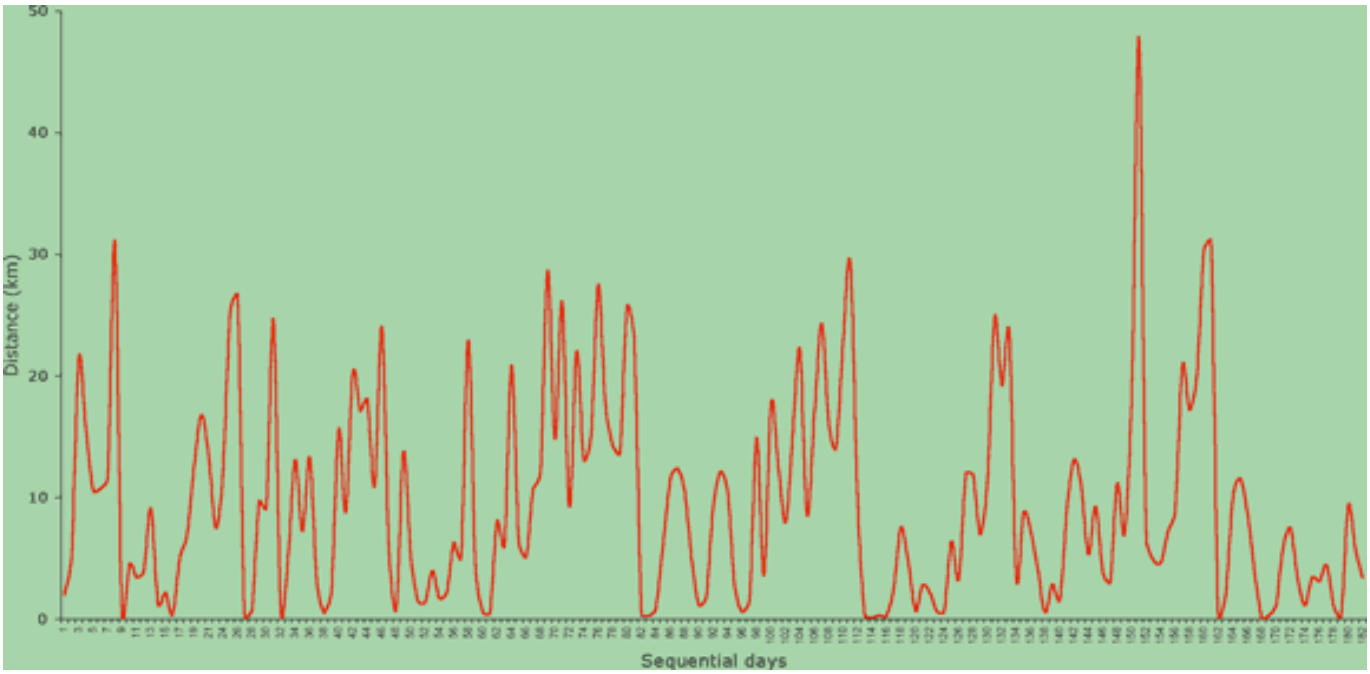


Figure 17. Distances travelled per day by a lioness, during 182 consecutive days.

Activity patterns

During the direct visual observations (see above) lions were active from 17h00, throughout the night, and until 10h00 the following morning (Figure 18). There was a burst of activity before sundown, followed by another peak between 21h00 and 22h00. Notwithstanding, lions were most active between 04h00 and 09h00.

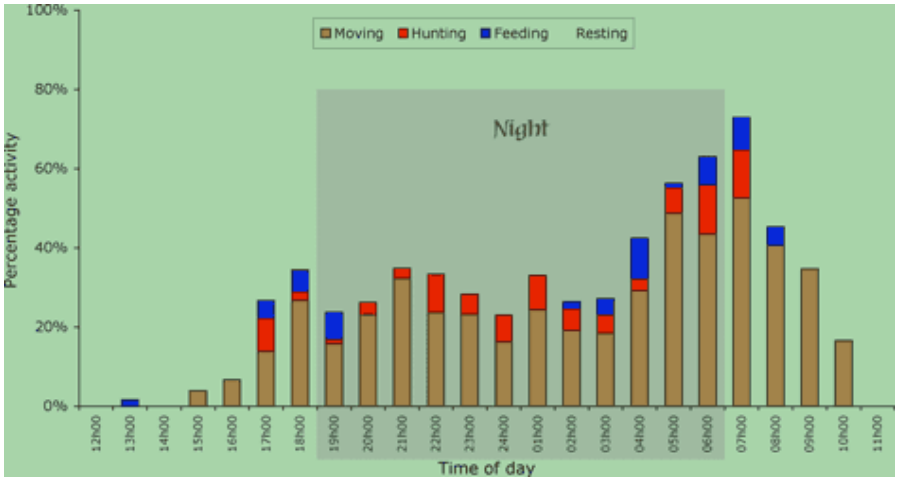


Figure 18. Activity patterns of lions based on direct visual observations (N = 721 hrs).

Analysis of data from the GPS collar (see above) revealed a similar pattern of activity (Figure 19). The distances moved in 2-hour units is interpreted here as an index of activity, and reflect the flurry of activity before and after daybreak also observed during direct observations.

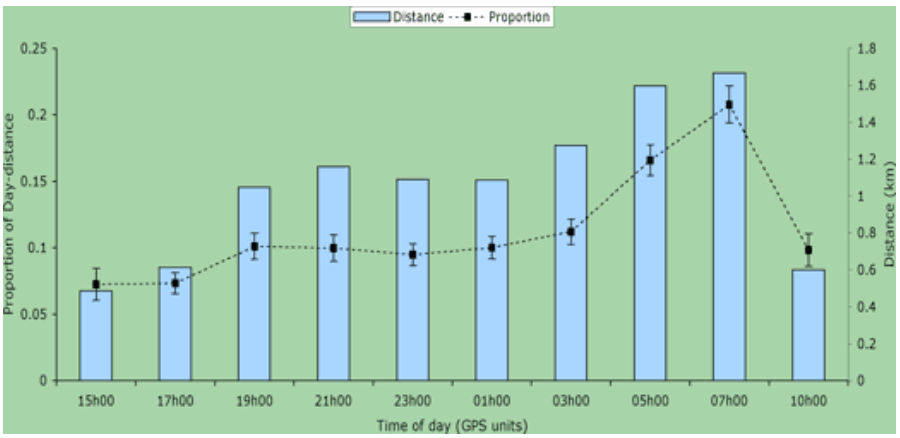


Figure 19. Distanced moved during 2-hour units as an index of activity, based on data collected by a GPS radio-collar (N = 182 days). The Proportion value for each 2-hour unit indicates the mean proportion, and standard error, of the total distance travelled per day.

Lions were most active, as measured by the mean distances moved per hour, during full moon and on nights when the phase of the moon was above half (Figure 20). During the new moon activity decreased, but was higher than the daytime activity. This pattern of increased activity associated with increasing moonlight, remained constant for all the night-time hours (Figure 21).

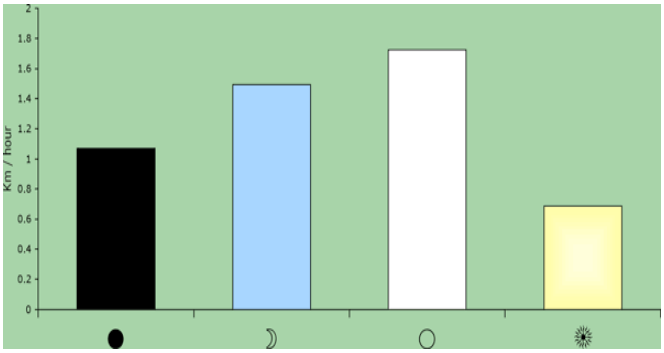


Figure 20. Distances moved per hour, as an index of activity, during different phases of the moon at night, and during daylight.

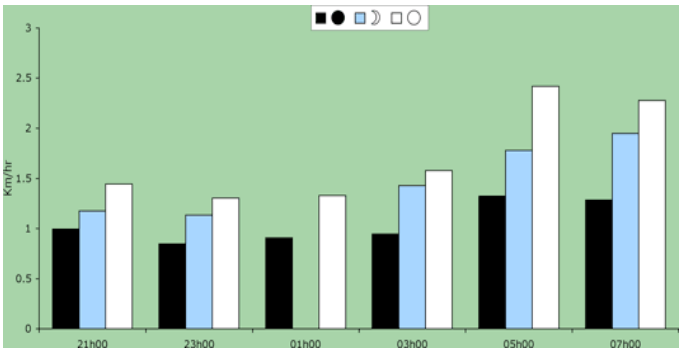


Figure 21. Distances moved (km/h) per 2-hour unit at night, as an index of activity, during different phases of the moon at night.

Predation

Previous records on predation and prey selection by Kunene lions were limited to daytime radio tracking observations. It was feared that these data were biased towards larger prey species and that lions may capture and totally consume smaller prey, like springbok, at night. During 2006 direct visual observations (N = 721 hrs) on lions in the Hoaruseb River presented an unbiased sample of prey selection. Surprisingly the results compared favourably with those based on daytime radio tracking (Table 3). Gemsbok and Hartmann's zebra were the two most important prey species, followed by springbok and ostriches. The number of livestock killed by lions increased during the 2006 observations.

Table 3. Summary of the prey species killed by Kunene lions from 2000 to 2006, and during intensive observations in 2006 (percentages in brackets).

Species	All data	2006 data
Gemsbok	38 (43%)	16 (46%)
Zebra	23 (26)	8 (23)
Springbok	9 (10)	2 (6)
Ostrich	9 (10)	4 (11)
Livestock	5 (6)	4 (11)
Kudu	3 (3)	
Elephant	1 (1)	
Cape fur seal	1 (1)	1 (3)
Total (N)	89	35

The frequency that lions capture prey depends on the size of the prey and the group size of the lions. Visual observations on two lionesses in the Hoaruseb River (see above), feeding mainly on gemsbok, revealed that they killed every 6 – 8 days (n = 18).

Analysis of data from a GPS radio-collar (see above), representing two lionesses in the same area, calculated 6.96 days as the mean frequency between kills (SD = 3.36; range: 3–16 days; n = 27 kills). The distances lions travelled per night increased in a linear fashion with each sequential day following their last kill (Figure 22). On the fifth day since their last kill lionesses started moving further (12 km/day) than the overall mean of 10 km/day. The daily distances moved thereafter, increased to x = 29 km/day on the 15th day. As the lions became increasingly hungry with every passing day, they not only moved longer distances per day, but also did so with more consistency (Figure 23). The variance about the mean, measured by %CV, dropped to below 50% on the 10th day, when the mean distance reached 20 km/d, and decreased to 15% by the 15th day.

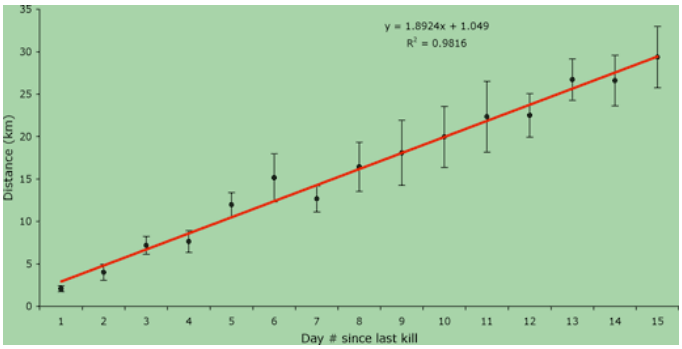


Figure 22. The relationship between the mean distance travelled per day, by two lionesses, and the time (days) since their last kill. Error bars indicate standard error of the mean.

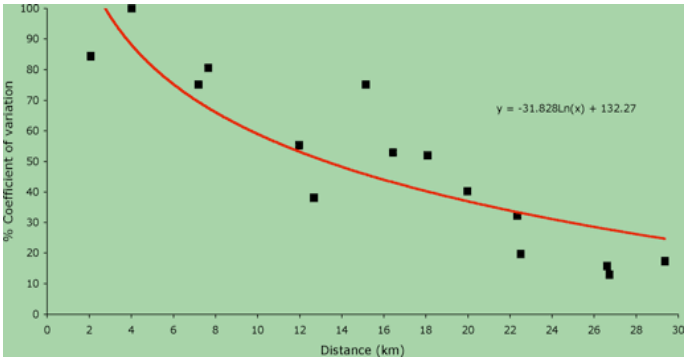


Figure 23. The relationship between the mean distance travelled per day and the amount of variation, measured by coefficient of variance (SD as a percentage of the mean).

Habitat preferences

During 2006, four lionesses in the Hoaruseb and Hoanib Rivers were monitored. They occupied an area of 4,309 km2 between the two river systems (see Figure 29). This area was divided into eight distinct habitat types, using ArcView Spatial Analyst (Table 4). Mountains, rocky outcrops, dunes, and plains comprise 90% if the habitat, whilst the ephemeral river systems and the coastal belt add up to only 10% (Figure 24). Habitat selection by the lions was calculated from 1696 radio tracking fixes using Spatial Analyst. The lions did not use the available habitat uniformly and spent significantly more time in the two ephemeral river systems and the Hoanib floodplain, than expected (Figure 25). Rocky outcrops was the only habitat type that lions used equal to its availability. Lions killed prey animals in all eight habitat types, and mostly in the same

proportions when compared with the time they spent in each habitat (Figure 26). They were most successful in catching prey along the Coast, whilst the Mountain and Hoanib habitats produced less than the expected number of kills.

Table 4. The surface areas of eight habitat types between the Hoanib and Hoaruseb Rivers, and the number of radio tracking fixes and kills in each habitat type by four lionesses in 2006.

Habitat	Area (km^2)	Tracking fixes	Kills
Hoanib floodplain	33 (1)	320 (19)	9 (20)
Hoanib River	65 (2)	62 (4)	1 (2)
Hoaruseb River	68 (2)	428 (25)	14 (30)
Coastal	197 (5)	32 (2)	2 (4)
Gravel plains	577 (13)	92 (5)	3 (7)
Sand dunes	911 (21)	146 (9)	4 (9)
Rocky outcrops	1040 (24)	450 (27)	11 (24)
Mountains	1418 (33)	166 (10)	2 (4)
Total	4309	1696	46

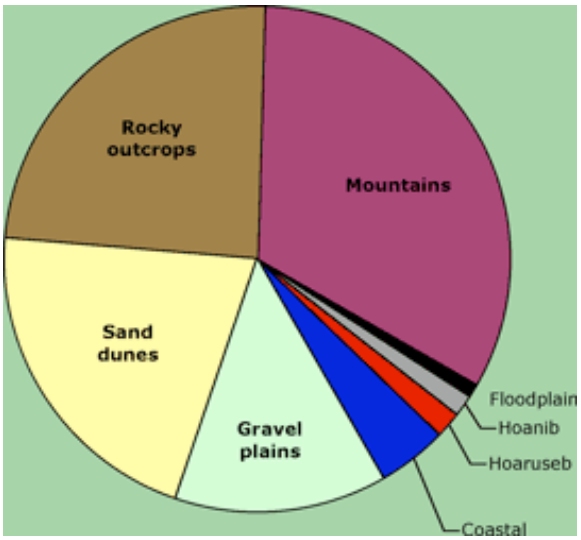


Figure 24. Proportions of eight habitat types in a area utilised by four lionesses between the Hoanib and Hoaruseb Rivers in 2006.

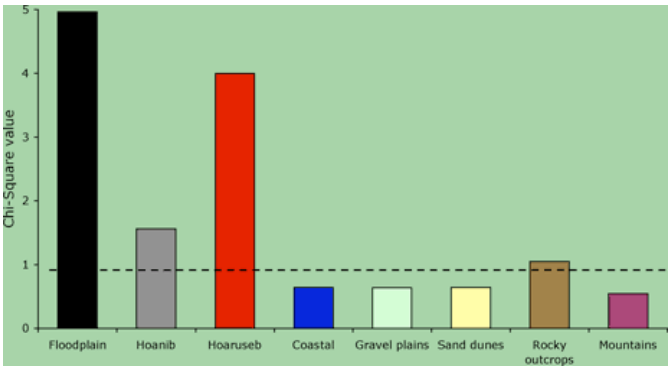


Figure 25. Preferential habitat selection, expressed by the 2 value, of lions between the Hoanib and Hoaruseb Rivers in 2006. The proportions of the eight habitat types and the number of fixes in each habitat were compared using a 2 goodness-of-fit test. If lions selected a habitat equal to the proportional size of that habitat type, the 2 value (√Observerd/Expected] would be 1, and the value would increase if the habitat were favoured.

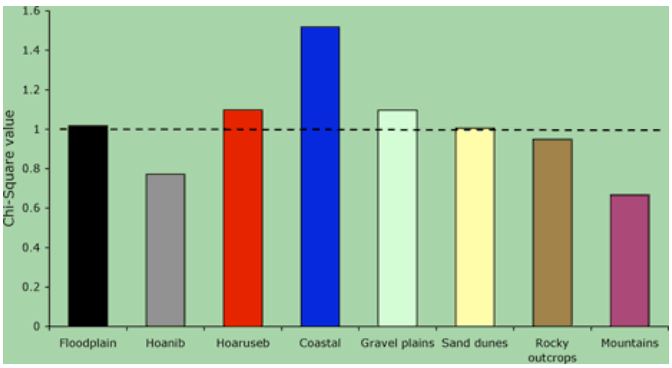


Figure 26. Preferential selection of habitat types, expressed by the 2 value, where lions killed prey animals, between the Hoanib and Hoaruseb Rivers in 2006. The number of fixes and kills in each habitat type were compared using a 2 goodness-of-fit test. If lions killed prey animals in a habitat equal to the number of fixes in that habitat type, the 2 value (√Observerd/Expected] would be 1, and the value would increase if they were most successful in that habitat.

Home ranges

The areas occupied by the Kunene lions are large and dynamic (Table 5). With an increase in sample sizes the two methods (MCP and Kernel) are calculating similar estimates of home ranges size for most individuals. The home ranges of the **Aub** (Figure 27) and **Agab** (Figure 28) prides, that utilise similar habitats, are similar in size, and have not changed between 2005 and 2006. There is extensive overlap between the different groups, and the home ranges of most groups change continuously. Land tenure systems appear to be driven by ecological factors, such as prey availability, and density dependant factors, but more research is still needed to address this.

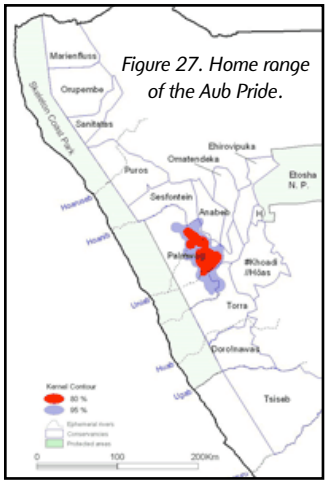


Figure 27. Home range of the Aub Pride.

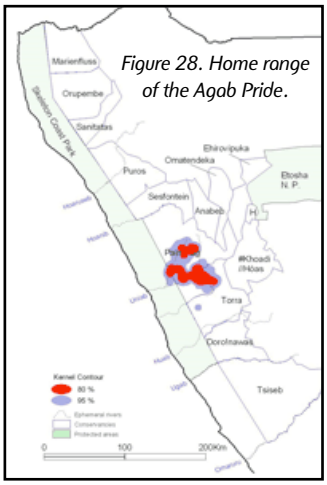


Figure 28. Home range of the Agab Pride.

Table 5. Home ranges of Kunene lions.

Pride / group	ID	Group description	N	Home range (km^2) MCP	Home range (km^2) Kernel (95%)	Accuracy of fixes
Aub	Xpl-2, 5, 9	Pride	189	2,632	2,721	41%
Agab	Xpl-17,18	Pride	147	2,826	2,909	44%
Hoaruseb	Xpl-10	Females & cubs	>500	8,034	6,939	51%
Huab/Ugab	Xpl-16	Male group	85	16,377	13,365	Negative
Hoanib	Xpl-3	Pride	112	9,084	6,543	Negative
Hobatere	Xpl-20	Pride	>500	4,907	3,608	83%
Secumib	Xpl-29	Male group	33	27,650	17,221	Negative

The home range of the **Hoaruseb** lionesses is dynamic. During 2006 the group ranged in an area of 3,604 km2, between the Hoanib and Hoaruseb Rivers (Figure 29). However, the founding female of this group has been monitored since the age of 14 months, starting in October 1999. The long-term results highlight a dynamic and evolving pattern of home range use (Table 6 & Figure 30). Xpl-10 was born in the Aub pride (see Figure 27) in September 1998. Up to 2000 she moved in the area occupied by the Aub pride, but dispersed in November 2000, extending her home range to the Hoanib River in 2001. At the end of 2001 she moved to the Hoaruseb where she remained for the period between 2002-2004. During 2005, Xpl-10 expanded her home range to the Okongwe area, south east of the Hoaruseb River. Intensive daily monitoring during 2006 highlights the fluctuating pattern of range-use, and demonstrates a gradual expansion to the Hoanib River that started in May 2006. By September 2006 Xpl-10 were spending most of her time on the Hoanib floodplain.

Figure 29. Locations and home range estimate (Kernel Contour) of Xpl-10 and the Hoaruseb females during 2006.

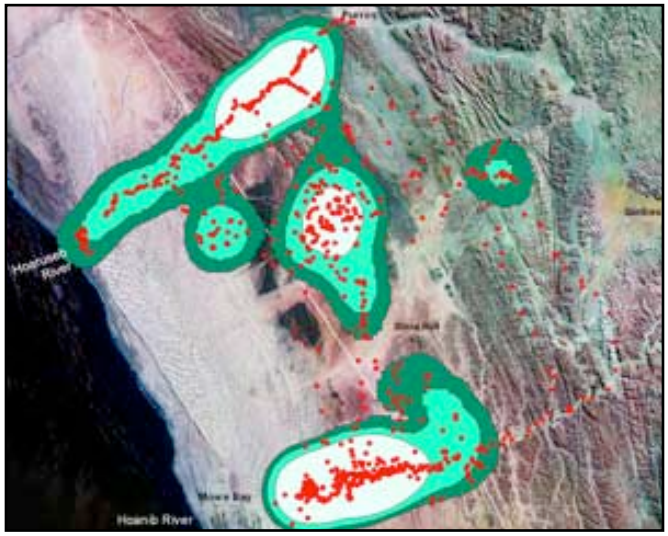
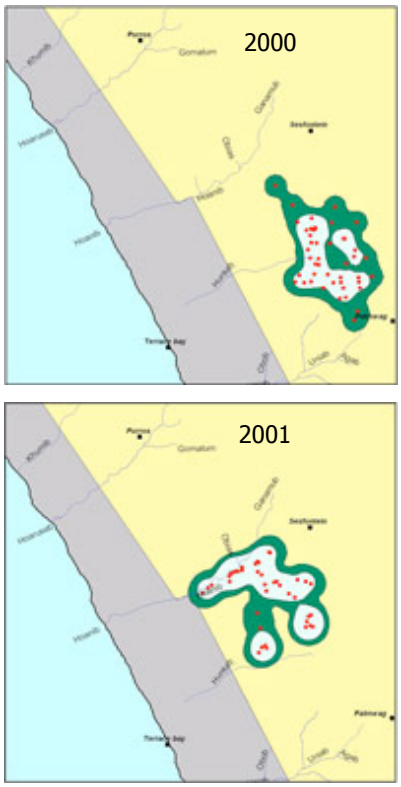


Table 6. The home ranges used by Xpl-10 and the Hoaruseb females during eight periods between 1999 and 2006. (95% Kernel Contour)

Period	Duration	Fixes	Home range (km ^{2})
2000	1 year	52	1,750
2001	8 months	41	1,818
2002-4	3 yrs & 5 mo.	59	980
2005	1 yr & 3 mo.	49	2,122
April 2006	41 days	41	1,578
May 2006	37 days	37	2,599
July 2006	50 days	50	3,225
Sept 2006	50 days	50	782

Figure 30. Locations and home range estimate (Kernel Contour) of Xpl-10 and the Hoaruseb females during eight period between 1999 and 2006.



Two male lions (Xpl-19 & 20), born in the Aub pride during August 2000, utilised an area of 2,457 km^2 up until May 2005 (Figure 31). They then dispersed and settled permanently on **Hobatere**. This was the first documented case of lions from the desert population, dispersing towards the east and joining the Etosha population. At the age of five years the two males arrived at Hobatere late in June 2005. They ousted the local male lion, took over tenure of the pride that live on Hobatere and the Otjovasandu area of Western Etosha, and were seen mating with the lionesses on 2 July 2005. Steve Braine of Hobatere Lodge monitored their movements intensively. Since their arrival the two males have remained in the Hobatere Concession (Figure 32), using a home range of only 187 km^2 (95% Kernel Contour).

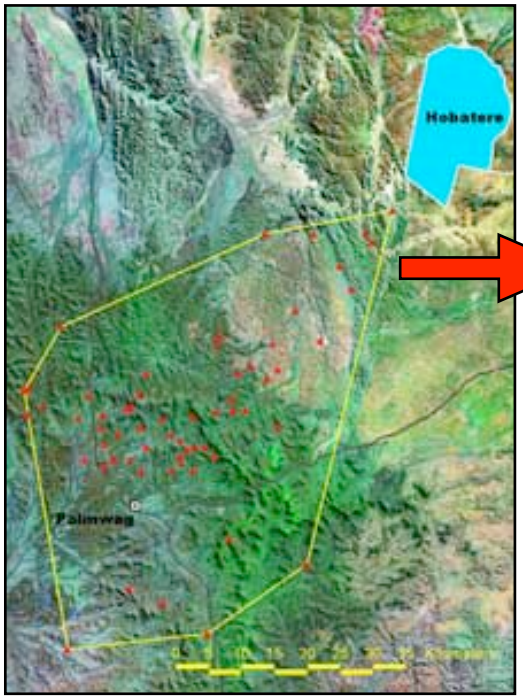


Figure 31. Locations and home range of Xpl-19 & 20 between December 2001 and May 2005, prior to dispersing to Hobatere.

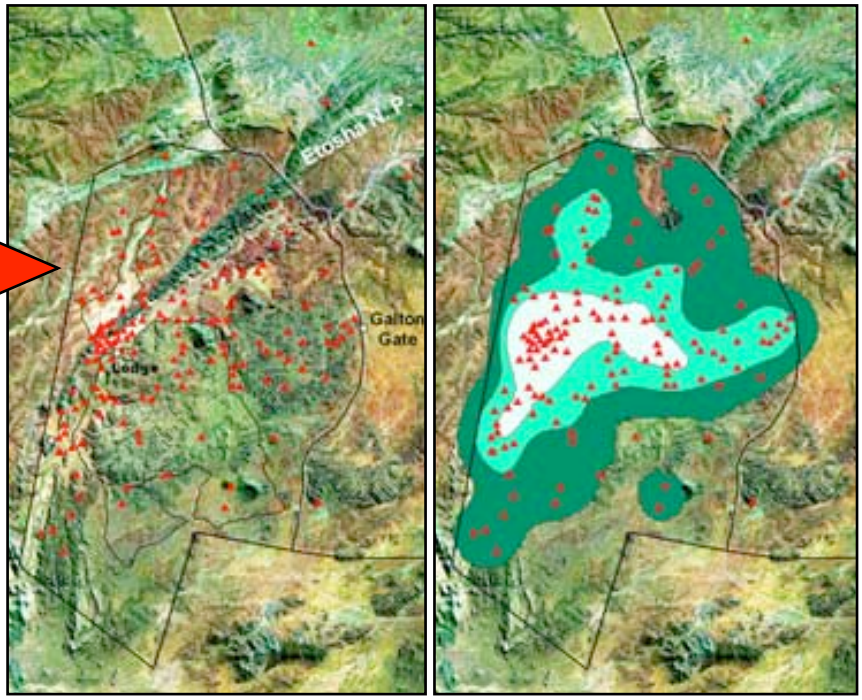


Figure 32a & b. Locations and home range estimate (Kernel Contour) of Xpl-19 & 20 between June 2005 and December 2006, after they dispersed and settled on Hobatere (N = 148, Steve Braine).

Lions in the southern part of the distribution move between the **Ugab** and **Huab** Rivers (Figure 33). An adult male moved to the mouth of the Huab River in August 2006. Little is known about their movements and more research is needed.

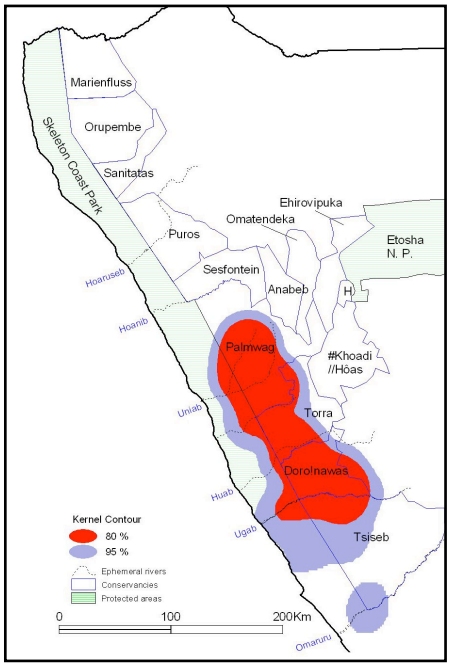


Figure 33. Home range of the Huab/Ugab group.

Dispersal and home range expansion

Intensive monitoring of the Hoaruseb lionesses during 2006 produced valuable data on patterns of dispersal and home range expansion. Data collected using a GPS radio-collar and from direct observations (Figure 34) show continuous nightly movements between March and September 2006. Up to April 2006 the lionesses moved only in the Hoaruseb River and in the northern section between the two rivers.

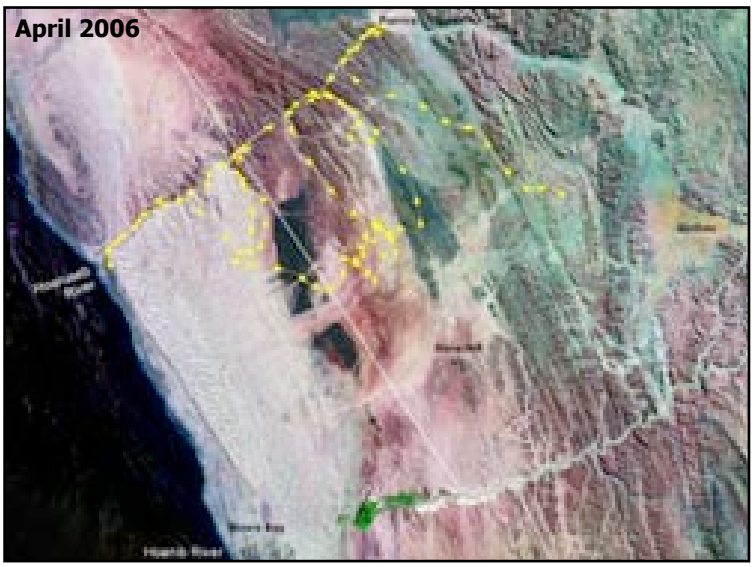
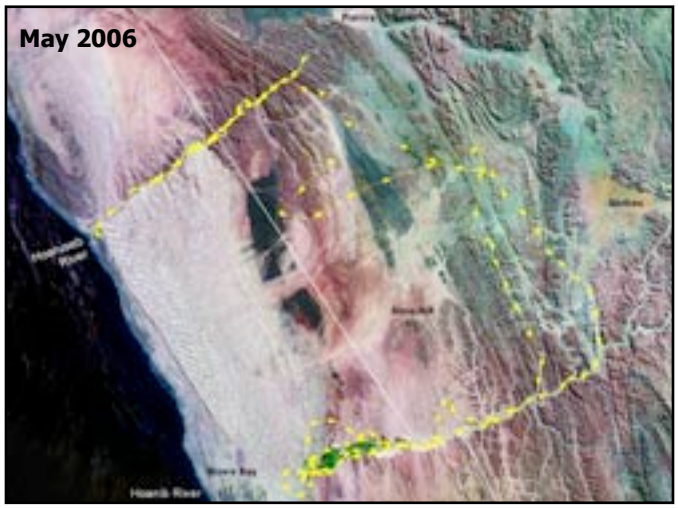
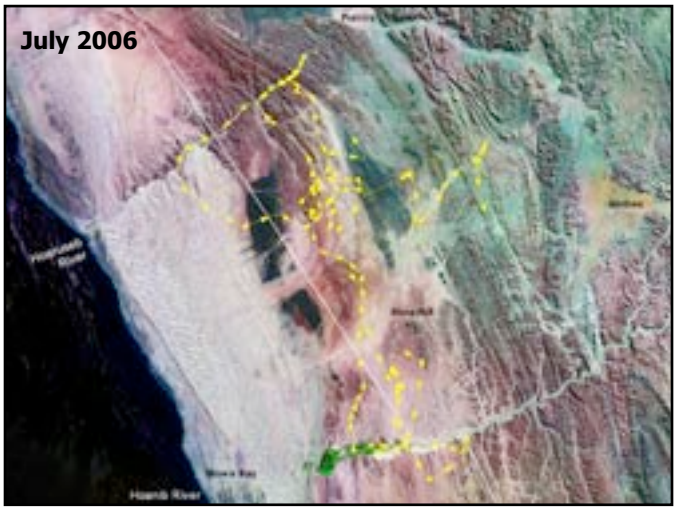
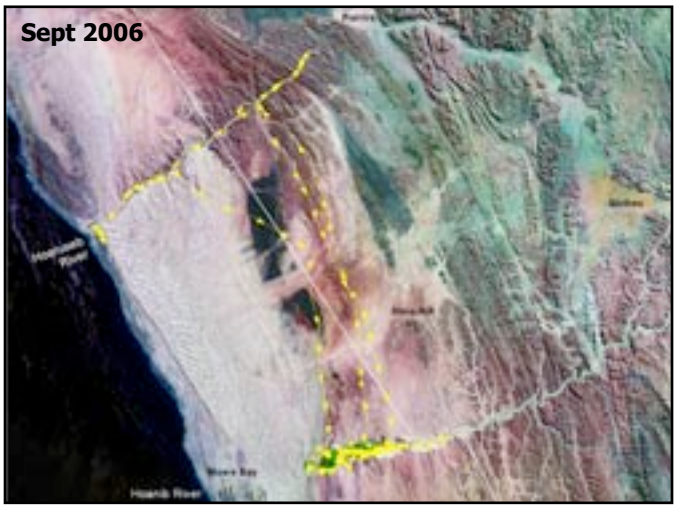


Figure 34. Consecutive nocturnal movements of Hoaruseb lionesses between March and September 2006.

Figure 34. Consecutive nocturnal movements of Hoaruseb lionesses between March and September 2006 (continued).







During May 2006 they moved to the Hoanib River for the first time and also spent time in the southern and northern sections between the two rivers. In June and July 2006 they returned to the Hoanib River for longer periods, moving quickly between the rivers. On 21 September 2006 the lionesses settled in the Hoanib floodplain and were still there at the end of February 2007 (Figure 35).

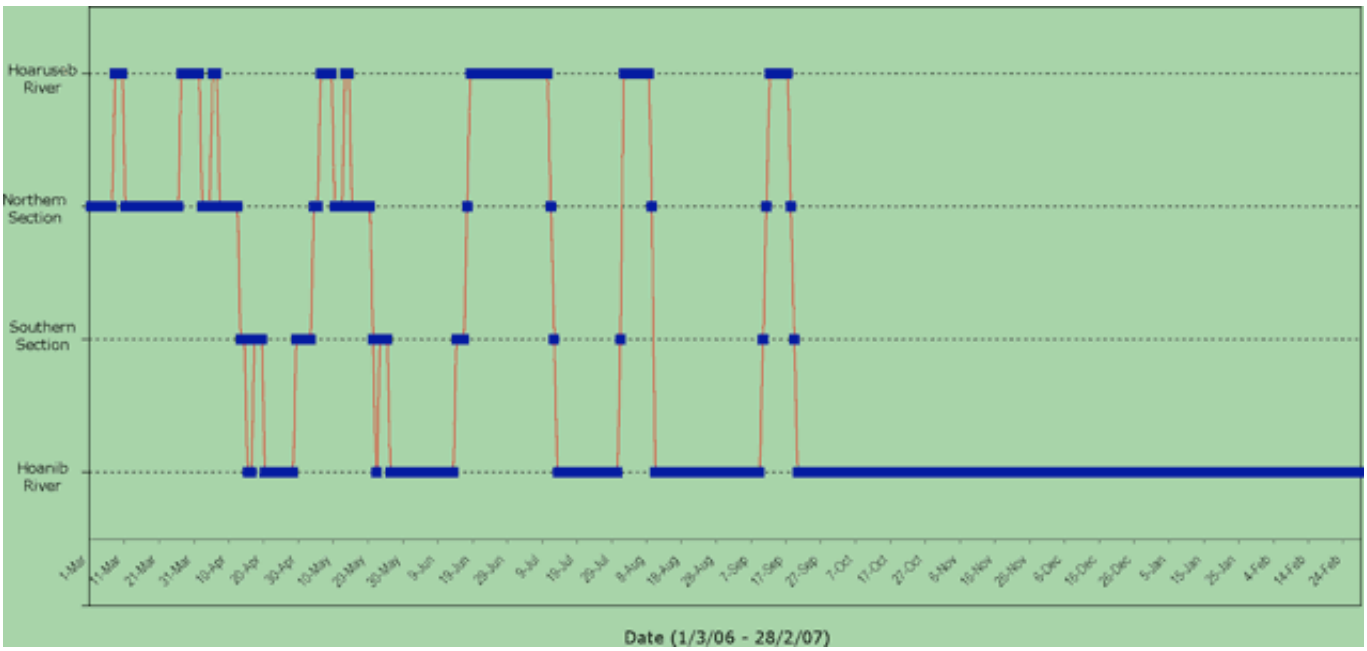


Figure 35. A schematic layout of the days, from March 2006 to February 2007, that the Hoaruseb lionesses moved in. and between, the Hoaruseb and Hoanib Rivers. An imaginary line that runs halfway between the two rivers separates the northern and southern sections.

Coastal movements

During the latter half of 2006 lions moved to the coast at four different locations. In August 2006 an adult male lions, from the Ugab/Huab group, walked down the Huab River and onto the beach at the Huab Lagoon, where he killed and ate a Cape fur seal (Figure 36). An adult male lion visited Sarusas spring and the mouth of the Khumib River in September 2006 (Figure 37). The last recorded record of a lion at this location was on 14 September 1987. The Hoaruseb lionesses were at the mouth of the Hoaruseb River during August & September 2006 (Figure 38) and then moved to the Hoanib River between September and December 2006, where they spent time at Auses spring and in the dunes, west of the floodplain (Figure 38).

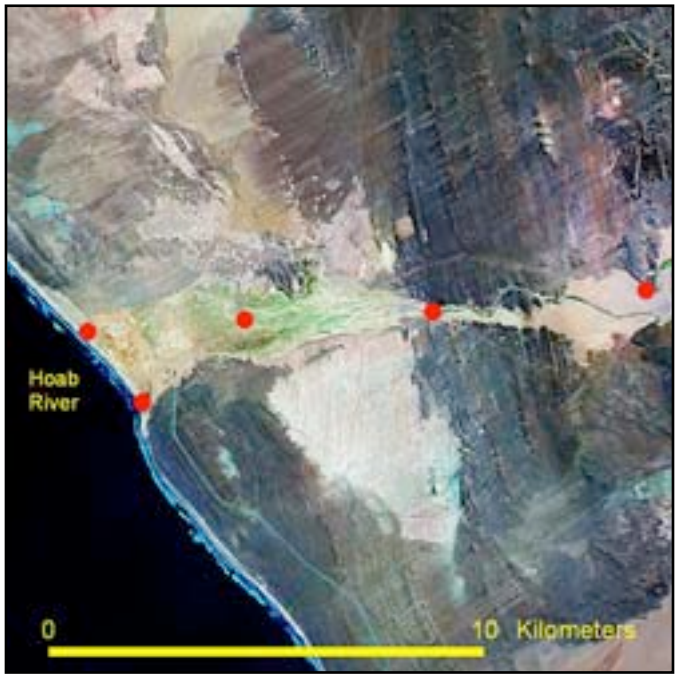


Figure 36. Sightings of a male lion in the Huab River (August 2006).

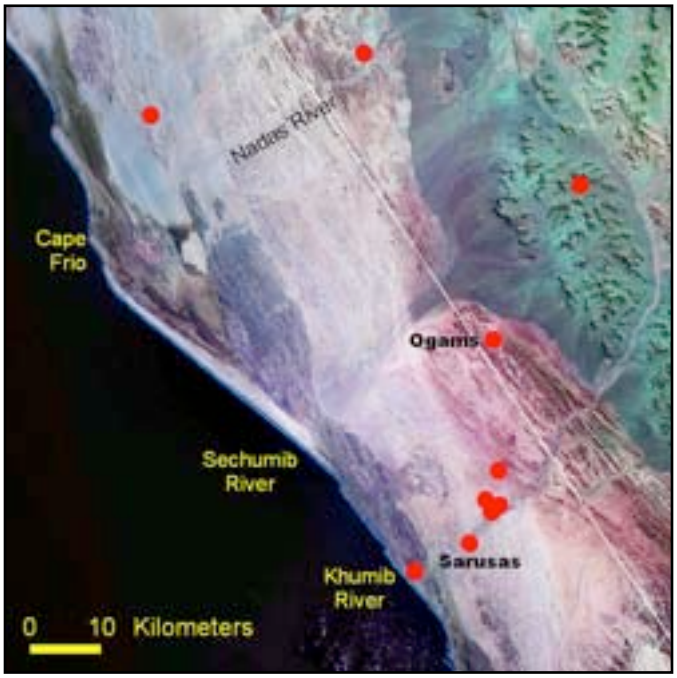


Figure 37. Sightings of a male lion at Sarusas & the Khumib, (Sept - Oct 2006).

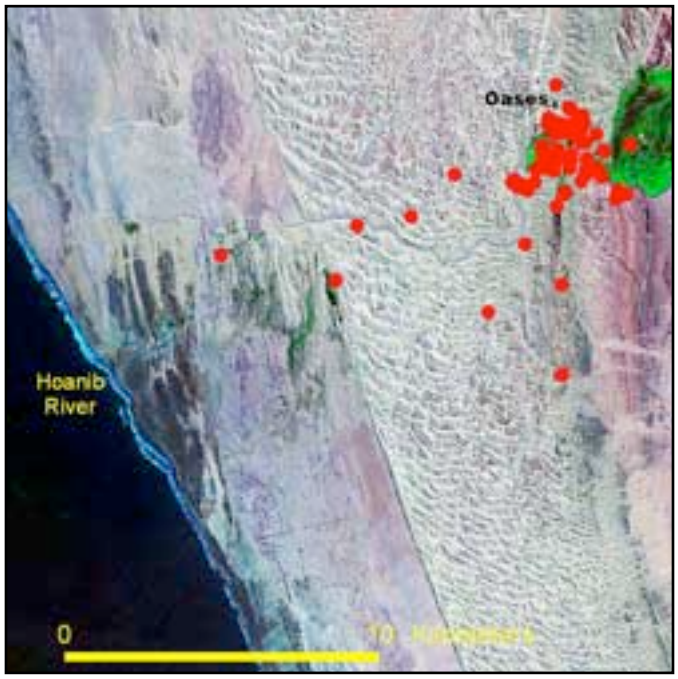


Figure 38. Sightings of Xpl-10 at the Huaruseb Mouth (Aug - Sept 2006).

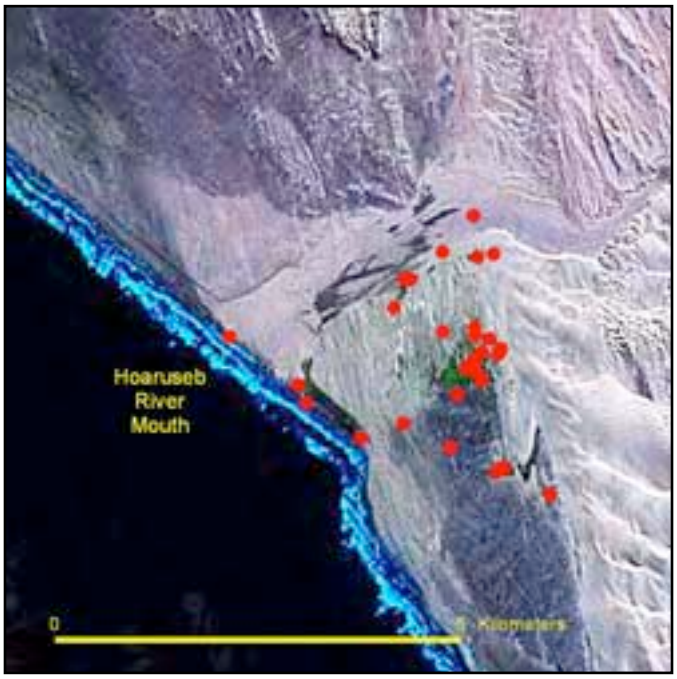


Figure 39. Sightings of Xpl-10 in the Hoanib floodplain (Sept - Dec 2006).

Human Lion Conflict

During 2006 conflicts between humans and lions were assessed in the area north of, and including, the Hoanib River. The distribution of lions overlap with five conservancies: Anabeb, Sesfontein, Purros, Sanitatas, and Orupembe (see Figure 10).

There were 14 incidents of lions attacking or killing livestock. They occurred in four of the conservancies and mainly between July and November 2006 (Figure 40). The community in the Anabeb Conservancy shot one adult male lion. This lion was marked with a radio collar (Xpl-32) and belonged to the Aub pride. Possible solutions to HLC are addressed further under the Eco-tourism section.

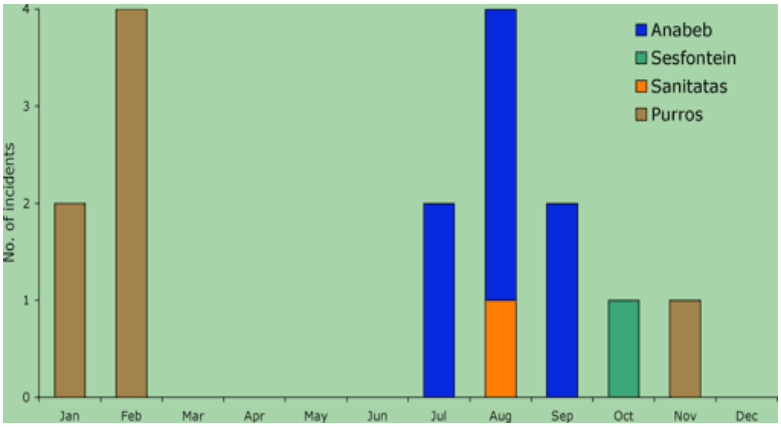


Figure 40. Monthly frequencies of HLCt in conservancies north of the Hoanib River in 2006

Lion Eco-tourism: Purros Case-study

The Purros Conservancy supports a small group of lions that utilise the Hoaruseb River, and occasionally move to the coast. These are arguably the most valuable lions for tourism in Namibia. The Purros Conservancy established a joint tourism venture with an investor (Okahirongo Elephant Lodge). This is the ideal platform to develop eco-tourism of lions with benefits to the Purros Conservancy, the tourism industry, and the conservation of lions.

The philosophy behind developing eco-tourism of lions in the Purros Conservancy is that the sustainable use of lions should generate financial benefits to the Conservancy and the Tour Operator, that out-way the costs of living with lions and contribute to the conservation of the species. This can be achieved by developing an eco-tourism activity, that can be termed "Desert Lion Safaris", consisting of specialised tours offered by the Tour Operator, in partnership with the Conservancy, to track and view lions.

A sound understanding of the habits and behaviour of the lions, such as presented in this report, is essential in developing cost-effective procedures for locating and viewing lions. In the current research programme experiments have been designed to test the reliability of finding and observing lions in the unique habitat by The Tour Operator and the Purros Conservancy. Once completed the results from these experiments will be directed at developing a protocol for the implementation of organised photographic safaris. Notwithstanding, an analysis was done using the available data, and the preliminary results are presented.

Finding and viewing lions near Purros

Between September and December 2006 a total of 68 days were spent searching for lions in the Purros area. Lions were located on 67 days (98.5% success rate) and viewed on 66 days (97%). On most of these days the lions were located in the Hoaruseb River (85%) and occasionally in rocky outcrops approximately 5 – 10 km south of the River (15%). These findings suggest that, with the correct approach and knowledge, lions can be located and viewed with reliability.

The impact of current tourism pressure on the lions was evaluated in the Hoaruseb River during the same period. During 12 days when lions were resting in the River, an average of 4.2 vehicles drove past them each day (range: 1-15 / day). Peak traffic was during mid-morning (09h00-11h00) and in the late afternoon (16h00-18h00; Figure 41). The average distance between passing vehicles and the lions was 74 metres (range: 15-250 m). Surprisingly only 18% of the vehicles saw the lions. This is partly because the lions selected resting spots behind vegetation and other forms of cover (Figure 42). The lions were mostly relaxed when vehicles drove past them, but when vehicles were noisy or caused disturbance, they often walked or ran out of sight (Figure 43).

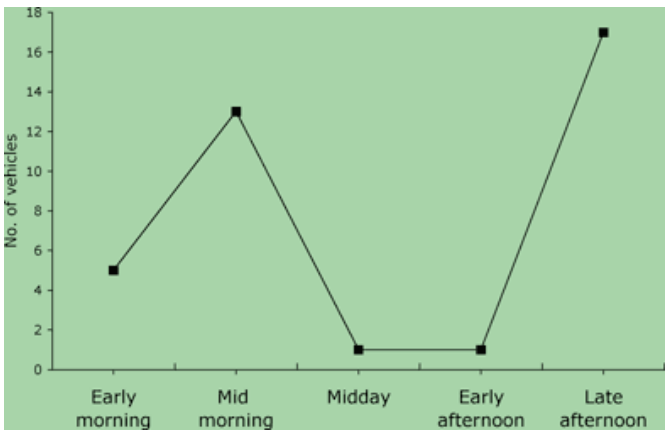


Figure 41. Periods of the day when tourist vehicles drove past lions in the Hoaruseb River.

Figure 42. An example of resting spots (✦)chosen by two lionesses in the Hoaruseb River during three days of observation..

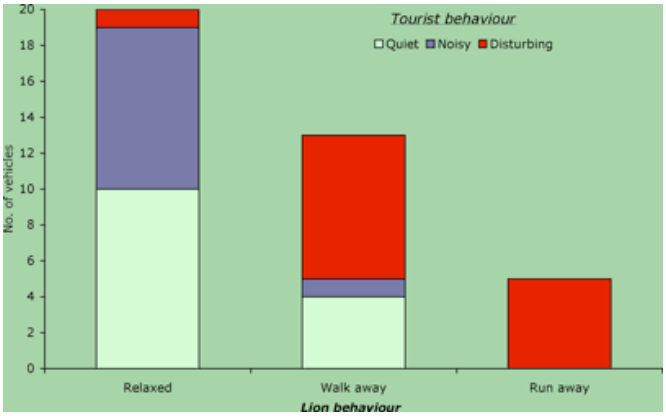


Figure 43. The response of lions to tourist vehicles in the Hoaruseb River.

Based on these findings, selected members of the Purros Conservancy and Tour Operator will be trained in the techniques of locating, by looking for spoor and other signs of lions, radio tracking, and observing lions during the periods that they are most active. The success of this project depends on a) a sound knowledge of the behaviour ecology of the lions, acquired through applied research, b) a well developed and tested eco-tourism package that is based on cost-effective, practical and reliable techniques, and c) extensive involvement and training of the Purros Conservancy, where they will retain ownership with the Tour Operator over the tourism activities and derive direct benefits from lions.

The Purros Conservancy and the Tour Operator should negotiate a "conservation fee" generated from Desert Lion Safaris. The Purros Conservancy should establish a "Lion Fund" to manage the fees paid by the Tour Operator. These funds must benefit the Purros community, counter losses resulting from Human Lion Conflict (e.g. HACSIS), and contribute to the monitoring and conservation of the lions.

Managing HLC in the Purros Conservancy

Coinciding with the Eco-tourism project, there is also a need to develop and implement a Human Lion Conflict Management Strategy for the Purros Conservancy. Limiting the amount of overlap between the areas used for livestock farming and the distribution of the lions, is arguably the most effective management option available to the Purros Conservancy. Lion movements in the Purros Conservancy is restricted to the southwest corner of the conservancy, but includes most of the Hoaruseb River (Figure 44). If this area where to be set aside by the Purros Conservancy for wildlife and not used cattle farming, the conflict with lions can be limited, if not avoided altogether. A wildlife zone (1,090 km2), that includes most of the current range used by lions, is proposed. The Hoaruseb River, however, is a critical zone with high potential for conflict as the Purros Conservancy depend on it for water and grazing. An assessment of lion movements in the River revealed that they

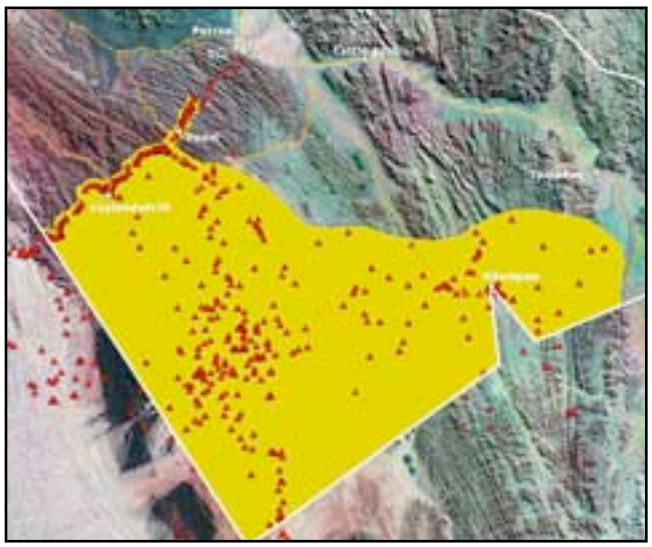


Figure 44. A proposed wildlife zone in the Purros Conservancy that include the

seldom moved beyond a specific bend in the River, approximately 8km west of Purros (Figure 45). This point is therefore proposed, for consideration by the Purros Conservancy, as the boundary between their wildlife zone and the area used for cattle farming. The proposed boundary is 9.6 km west of Purros when following the course if the River, and 7.7 km when measured in a direct line.

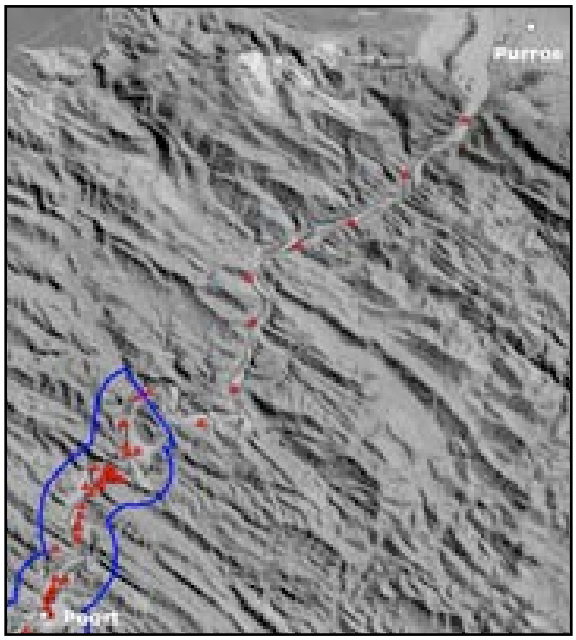


Figure 45. The proposed boundary (blue line) in the Hoaruseb River of a wildlife zone, aimed at limiting Human Lion Conflict in the Purros Conservancy.

Conclusion

The desert adapted and coastal roaming lions of Namibia were believed to have dwindled to alarmingly low numbers after a low rainfall period in the 1980's when many were killed by pastoralists. Improved rainfall patterns during the 1990s and 2000s, and successful conservation programmes, such as the emergence of Communal Conservancies, have seen a significant increase in wildlife numbers. This study presents data on the population status and demography of lions that are in line with, and complement, the trends and recent conservation achievements. Kunene lions live in the most rugged and arid of environments, yet they demonstrated remarkable success, with high survivorship, rapid growth rates, and dispersal. Conflict between lions and the local communities remain the most important ecological, conservation, and economic problem. Developing conservation strategies for the Kunene lions is, among many ecological parameters, dependent on a sound understanding of the factors that drive the distribution, dispersion, and regulation of the population. This research report presents scientific data on key ecological characteristics of the lion population. The study, and its results, is aimed at providing a sound technical and ecological foundation for the development and implementation of long-term and successful conservation strategies.

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