Research Report

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Population ecology of desert-adapted lions in the Kunene Region, Namibia

Photo: Flip Stander

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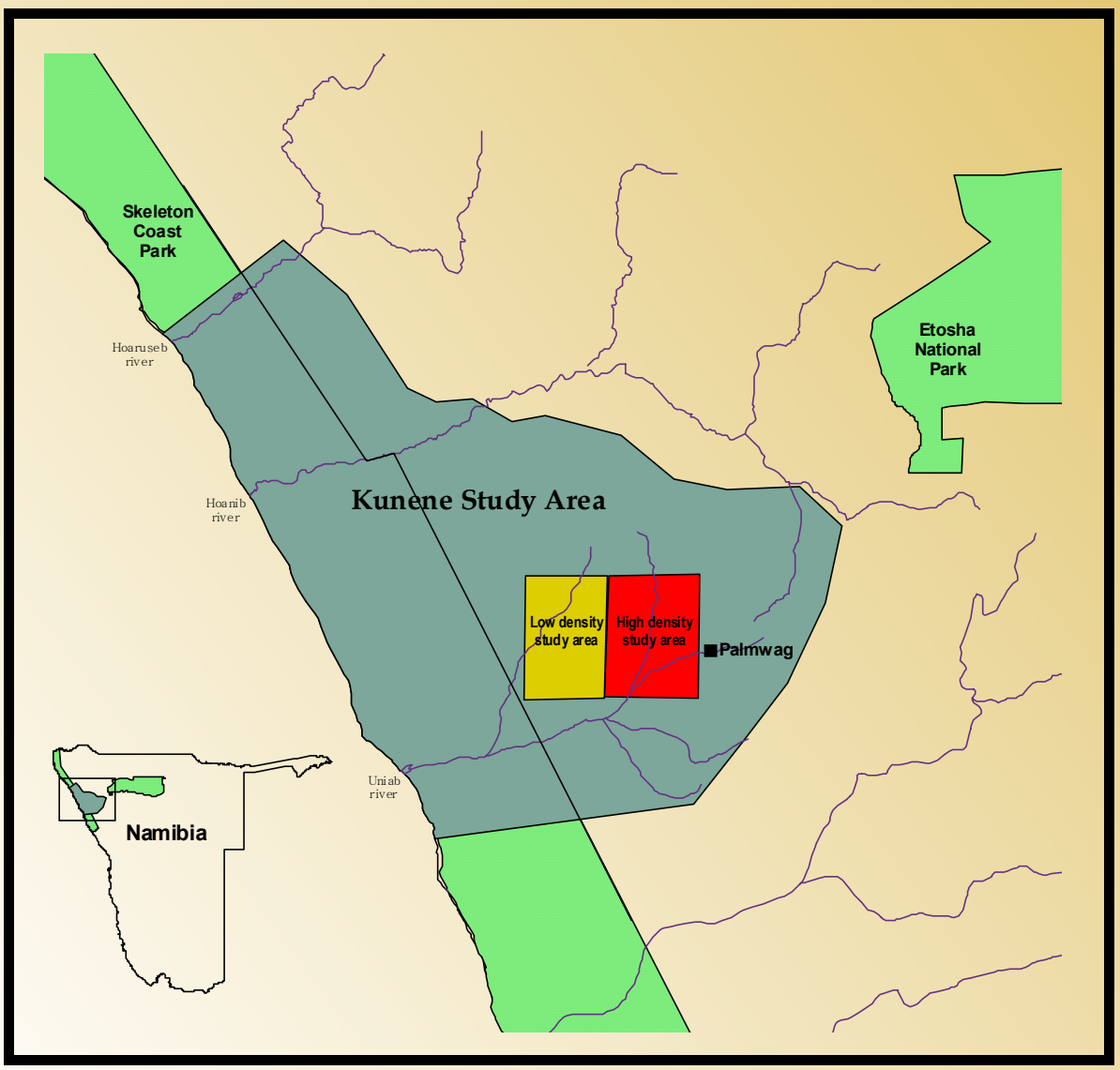
INTRODUCTION

Namibian lions live at low densities and maintain large home ranges in an arid to semi-arid environment (Stander 1991; Nowell & Jackson 1996). In a classic example of adaptation to a harsh environment these lions exhibit unique behaviour, such as individual specialisation and cooperative hunting in Etosha (Stander 1992) and killing seals along the Skeleton Coast (Bridgeford 1985). Lions are of great aesthetic appeal and financial value due to the growing tourism industry in southern Africa. Alarmingly, there is a shortage of reliable and accurate data on their population dynamics and conservation status. It is therefore imperative that sound baseline data on density, demography and ecology be collected to guide the development of long-term conservation strategies. This study aims to provide such data for the desert adapted lions of the Kunene Region, Namibia.

STUDY SITE

The study site of 15 440 km^2 is situated in the Palmwag tourism concession and extends into the Skeleton Coast Park and surrounding communal conservancies of the Kunene Region. 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). The study area stretches from the Atlantic Ocean in the west to the edge of human settlement and livestock farming in the east. The Hoaruseb river runs along the northern boundary and Springbok river in the south.



METHODS

Lions in the Kunene are difficult to locate and observe. To overcome this difficulty all known adult and sub-adult lions are captured and fitted with a radio-collar. The study area is covered systematically by tracking spoor, setting out bait and using sound play-backs to locate and capture individual lions. During immobilisation, following standard procedures (Stander & Morkel 1991), lions are marked with permanent brands and age is determined from tooth wear and eruption (Smuts *et al*. 1978).

Radio-collared animals are located with the use of a fixed-wing aircraft. Aerial locations are then 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. Home range analyses is based on locating the daytime resting spots of lions by radio telemetry with at least 24 hours between fixes. Home range size is calculated using the Minimum Convex Polygon (MCP) and Kernel Contour methods (Harris *et al*. 1990).

Lions feeding on a bait in Barab River *Photo: Lise Hanssen*

Community members assist with radio collaring *Photo: Flip Stander*

Lions are aged by tooth wear *Photo: Lise Hanssen*

A lion is photographed from the air during tracking *Photo: Flip Stander*

RESULTS

Socio-ecology and population dynamics

Since November 1999 we have radio collared 23 lions and a total of 48 lions are marked or individually identifiable .

There are four distinct groups or prides of which the Barab/Aub pride is the largest (Genealogy chart). There are presently 20 animals in the group. All the adult lions from both the Uniab nomad male group and the Hoaruseb group were born in the Barab/Aub pride but they have now separated permanently from the pride.

Two additional sub-adult groups, Xpl-19, 20 & 21 (cubs of Xpl-2) and the first litters of Xpl-9 and 11 (6 lions), have recently left the pride and we are monitoring their movements. The Obab pride appears independent and distinct from the Barab/Aub pride. The Obab pride consists of eight lions but we have substantial evidence that they form part of a larger pride.

All individuals in the same pride have largely overlapping home ranges but they regularly spend long periods apart. Adult lionesses of the Barab/Aub pride frequently spend more than six months apart and a separation of three years was recorded between several of the pride females. Such long separations are unusual in lion social behaviour. The typical fission-fusion strategy has a frequency pattern that is measured in days (Schaller 1972). We suggest that this unusual fission-fusion characteristic is a behavioural adaptation to the demanding condition imposed by the desert habitat. More data need to be collected to address this hypothesis.

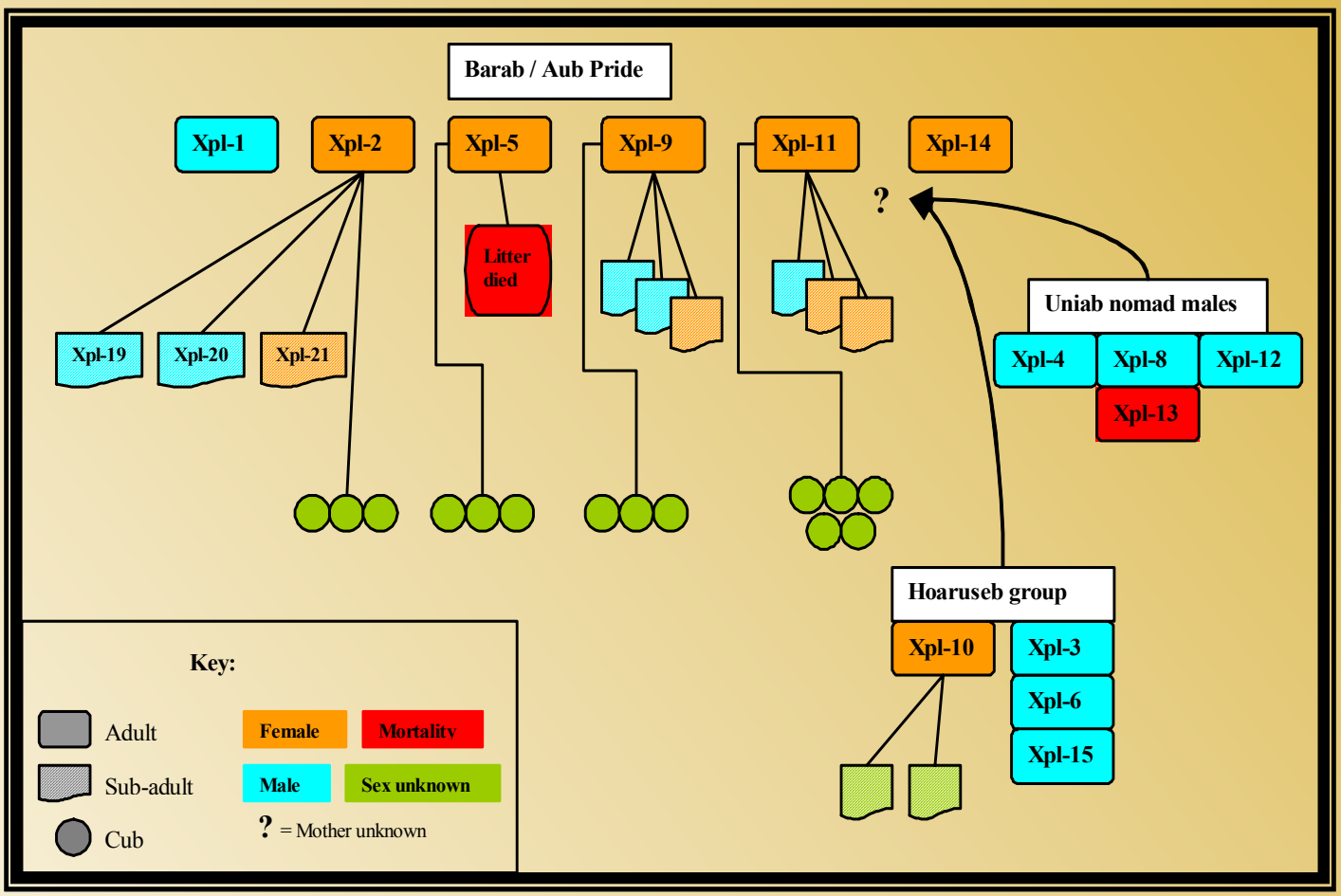
Some individual lions in the Kunene population

Aerial view of Xpl-9, Xpl-11 and 6 large cubs

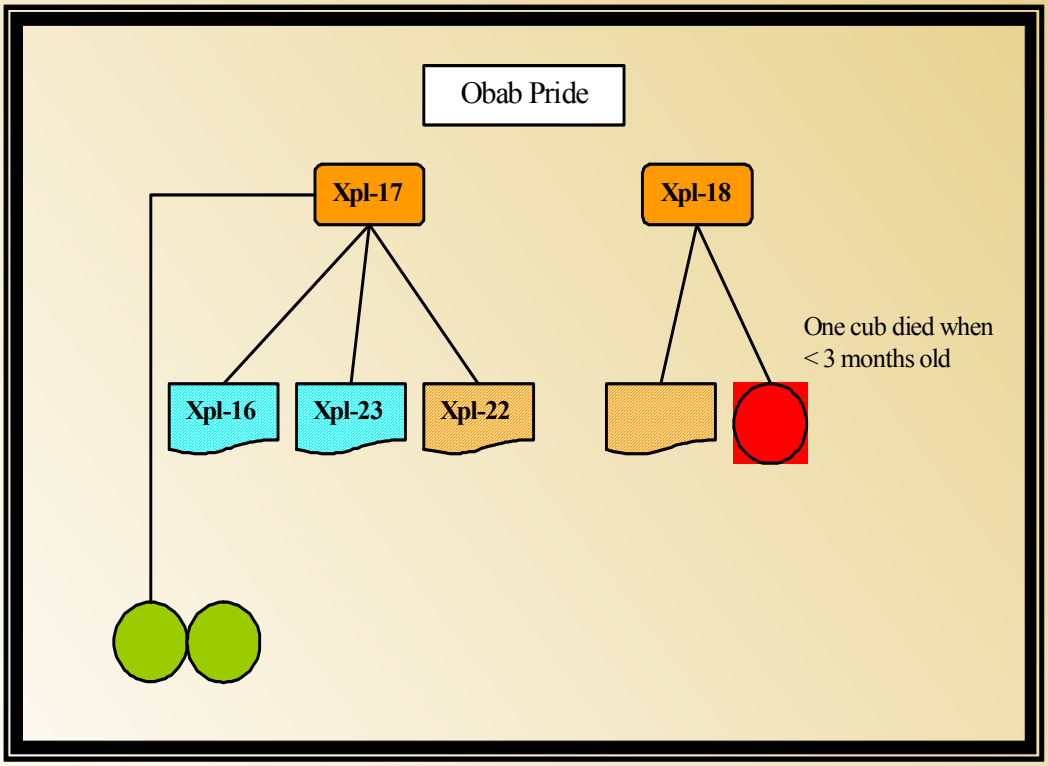
Sub-adult male Xpl-3 *Photos: Lise Hanssen*

Xpl-1

Group structures and genealogy of the Barab/Aub pride and related groups between November 1999 and July 2003



Group structure and genealogy of the Obab pride between March 2001 and July 2003.



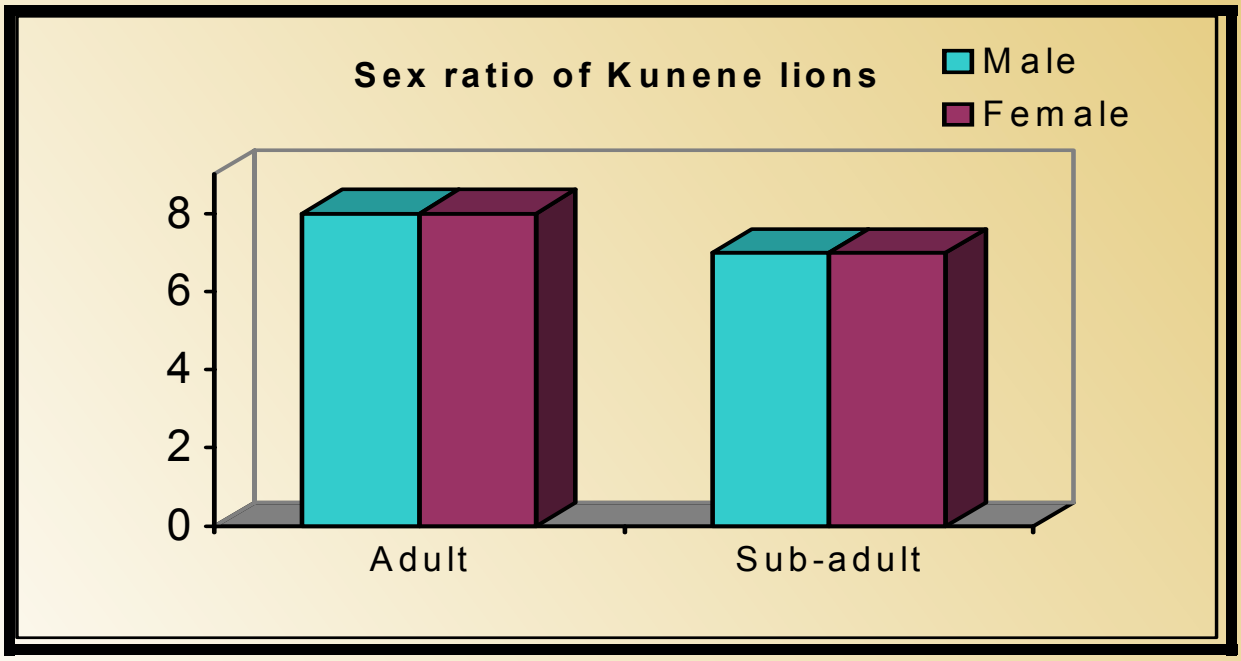
Of the seven radio-collared lionesses, six (85%) presently have dependant cubs. There are 16 cubs in total at an average of 2.8 cubs per female. The population dynamics of these lions were evaluated over a five year period (1999-2003) by analysing birth rates, mortality, fecundity and rate of increase associated with 13 known adult lions. This population of 13 known lions in 1998 increased at an average rate of 22.5% (range 14.6 – 34.5%) to 48 lions in 2003, where the sex ratio is even.

Population density was calculated in two intensive study areas (Study site map) that were surveyed intensively and where we were confident that there were no unmarked or unknown lions. We predicted that the western study area would support a lower density of lions since the habitat is significantly dryer and supports lower numbers of prey species than the eastern study area.

Using the Kunene Sampling Method (Loveridge *et al*. 2001) lion densities were calculated at 0.49 lion 100 km^{-2} for the low density area (west) and 0.71 lion 100 km^{-2} for the high density area (east). Extrapolating these two density estimates, as a range of minimum to maximum, to the total study area the population estimate is between 76 and 109 lions.

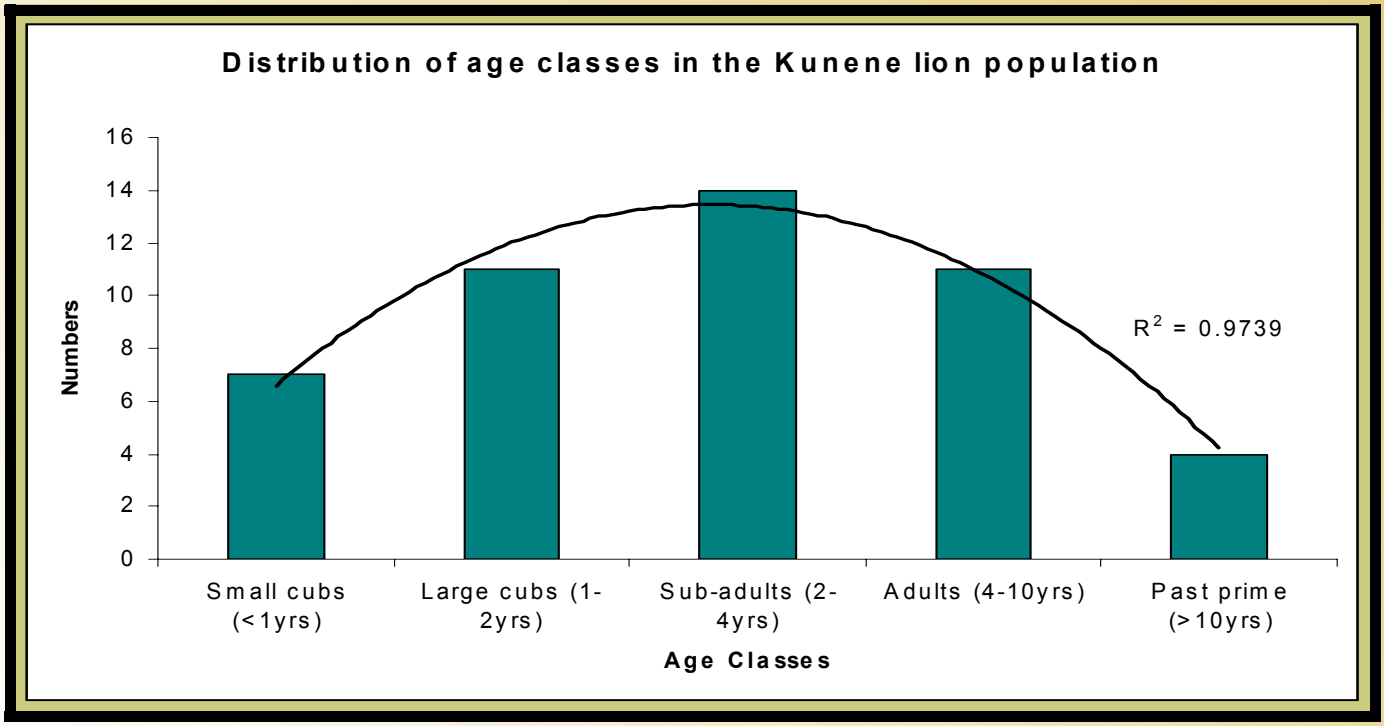
Population demography of the Kunene Lions

Total Study Area (km^2)	15440	
High density study area (km^2)	875	
Low density study area (km^2)	770	
Number of marked and individually known lions	48	
Number of radio-collared lions	23	
Lion population estimate	Low density	High density
Calculated number of lions in study sites	3.8	6.2
Lion density per site (lions 100 km^{-2})	0.49	0.71
Extrapolated estimate for **Total Study Area**	**76**	**109**

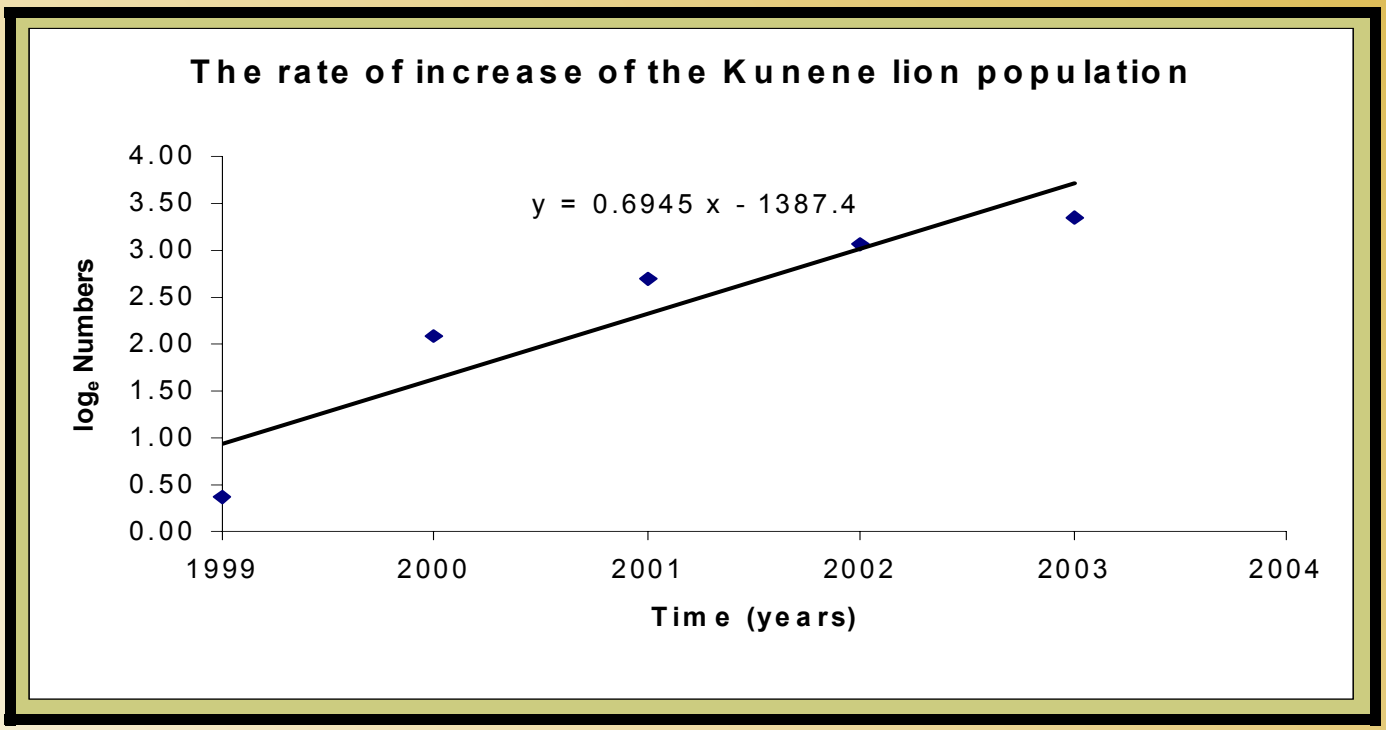


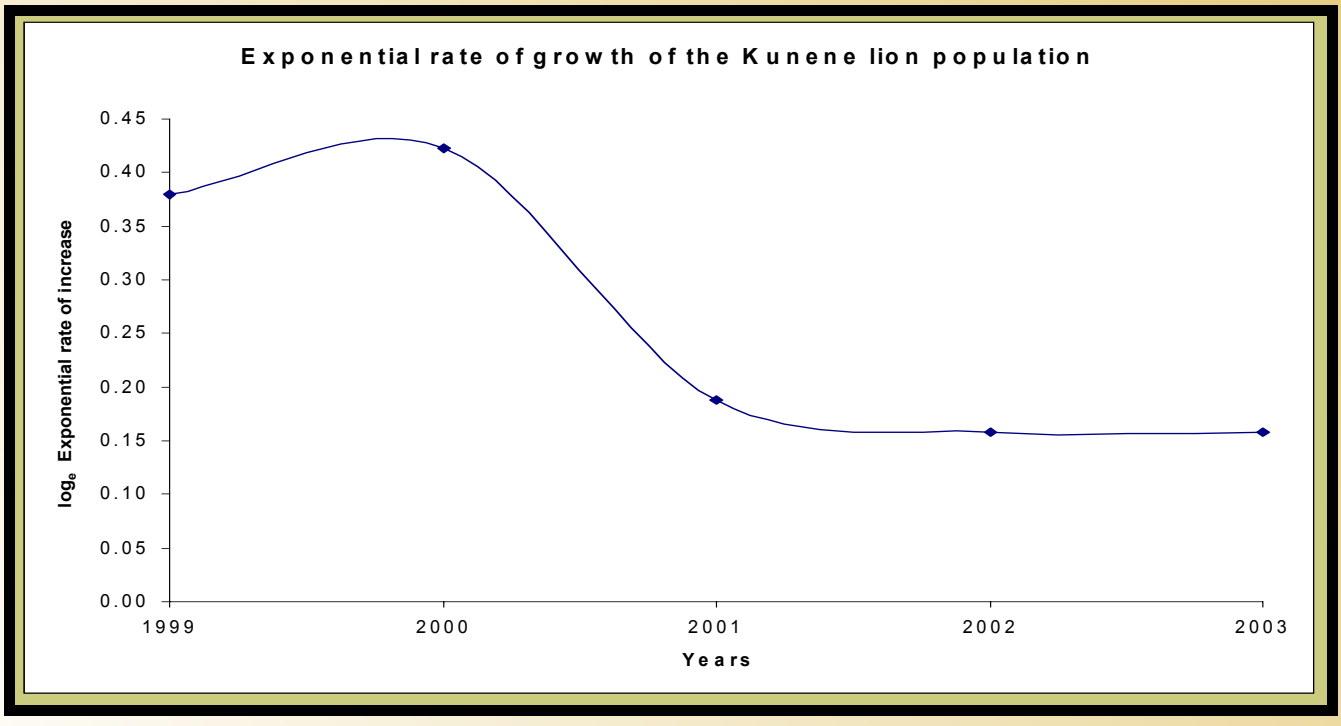
During the five year period six lionesses gave birth to 13 litters totalling 38 cubs. Litter sizes ranged between 2 and 5 cubs with the mean at 3.1 cubs. Cub survival was high, with only 9% mortality up to age of one year (n = 38) and none thereafter. With most cubs surviving, the mean birth interval was 2.2 years (SD = 0.28; range 1.9 – 2.7 years; (n = 6).

With this remarkably high fecundity rate there is a preponderance of young lions in the population when looking at an age distribution graph for 2003. However, when the same data is cast into broader age classes the result depicts the characteristics of a healthy and stable population.



The phenomenal increase of this lion population during the study period is best presented as a logarithmic rate of increase (top) and the annual exponential growth rate (bottom). Population growth was over 30% for both 1999 and 2000. Thereafter it dropped to around 15% for 2001, 2002 and 2003.





Home ranges

Home range sizes are large and range between 626 - 3438 km^2 (Kernel method). The southern and northern home ranges for Xpl-10 and the Xpl-3 subgroup were calculated separately as they were born and spent time in the southern area before dispersing to the north. The number of radio tracking fixes for the Agab pride, the Xpl-3 subgroup, Xpl-10 and the Xpl-19 subgroup are insufficient for calculations since home range estimates increase with additional data. Notwithstanding Kunene lions occupy home ranges larger than in other documented studies.

Pride / group	ID	Group description	N	Home range (km ^{2})		Accuracy of fixes
				MCP	Kernel (95%)	
Barab / Aub	XPL-1	Single male	92	1440	650	76%
	XPL-5	Female & cubs	82	2012	2460	62%
	XPL-2	Female & cubs	81	1792	3422	74%
	XPL-9 & 11	Female & cubs	70	1224	1347	72%
	XPL-19	Sub-adults	13	939	1407	Negative
Hoaruseb	XPL-10 South	Sub-adults	39	2235	2989	Negative
	XPL-10 North	Female & cubs	26	1378	1223	Negative
	XPL-3 South	Sub-adults	50	2378	3438	Negative
	XPL-3 North	Male group	29	122	626	52%
Uniab nomads	XPL4	Male group	70	2573	2447	80%
Obab	XPL-17	Female & cubs	35	1493	2536	Negative
	XPL18	Female & cubs	26	1294	2327	Negative

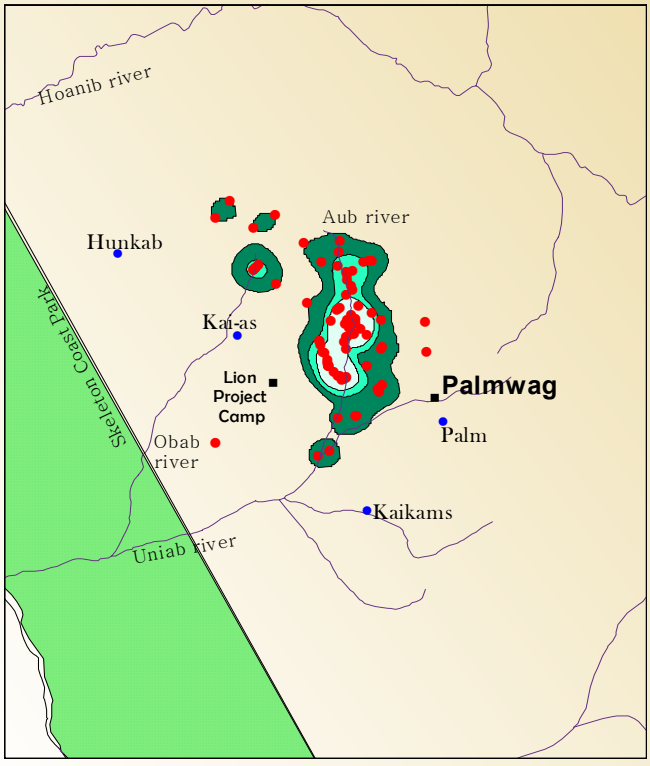
MCP = Minimum Convex Polygon

*The percentage of fixes where the MCP home range estimate reached an asymptote of at least 95% of the total MCP estimate, based on bootstrap analyses.

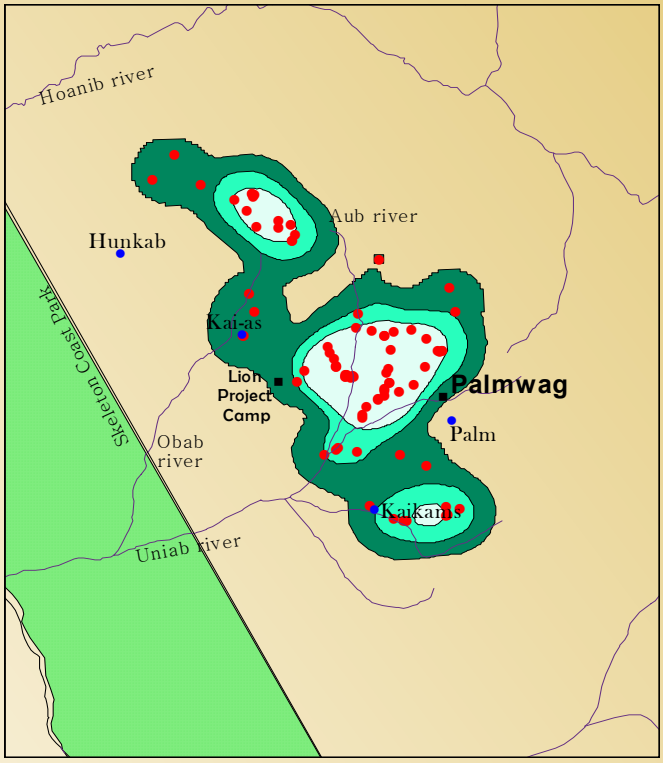
Locations and home ranges (Kernel contours) of individuals and sub-groups

(See key on page 11)

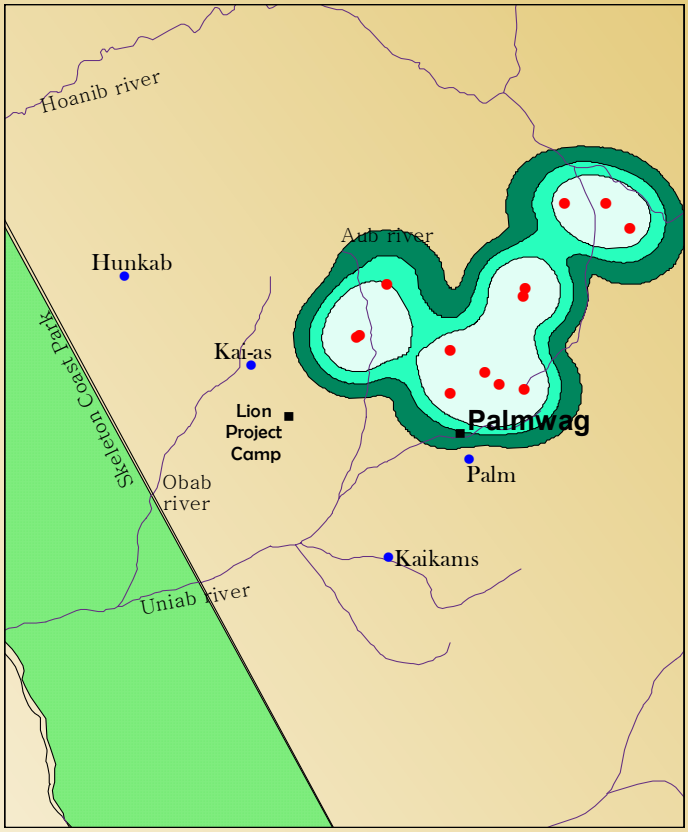
Xpl-1



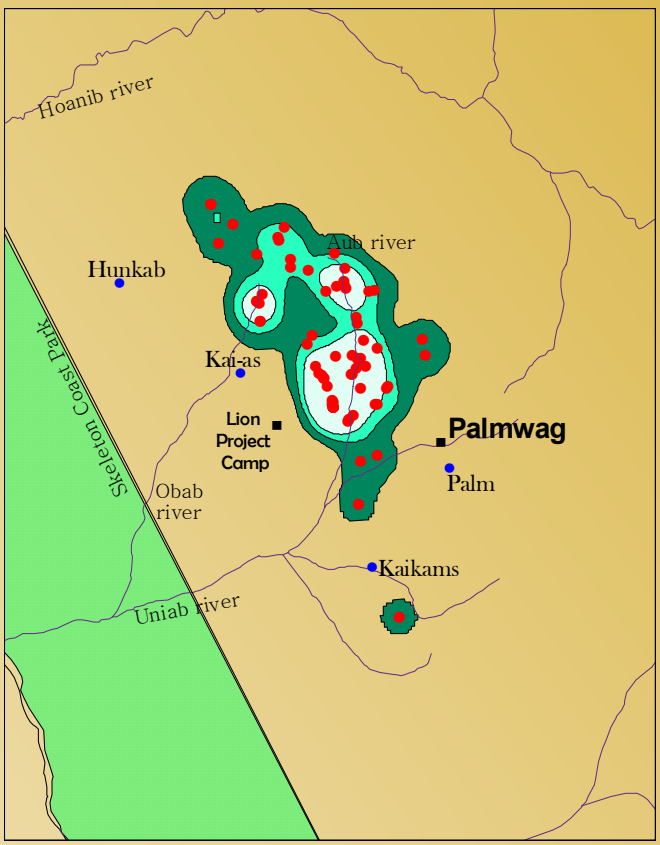
Xpl-5



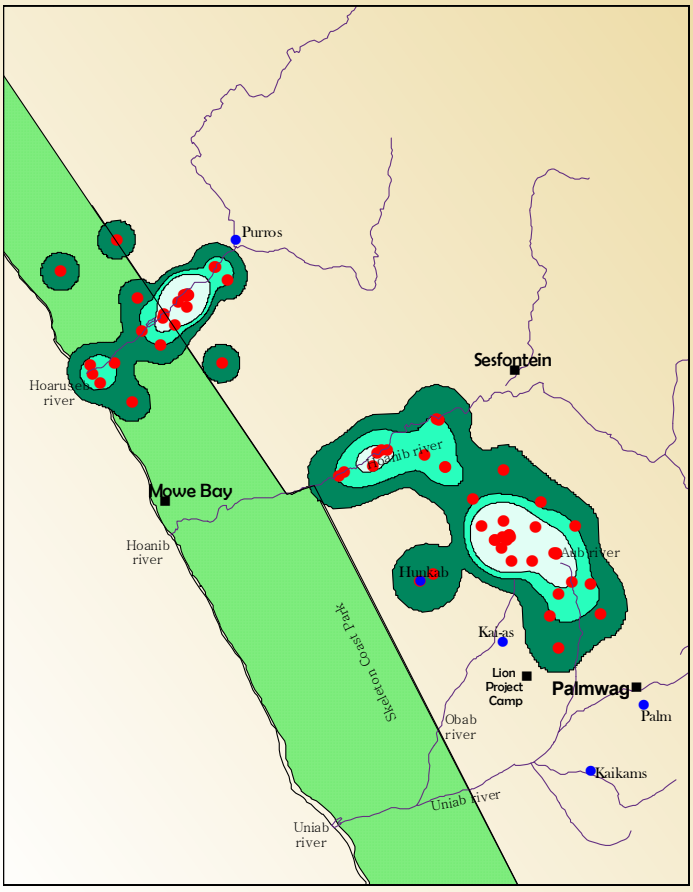
Xpl-19 sub-adult group



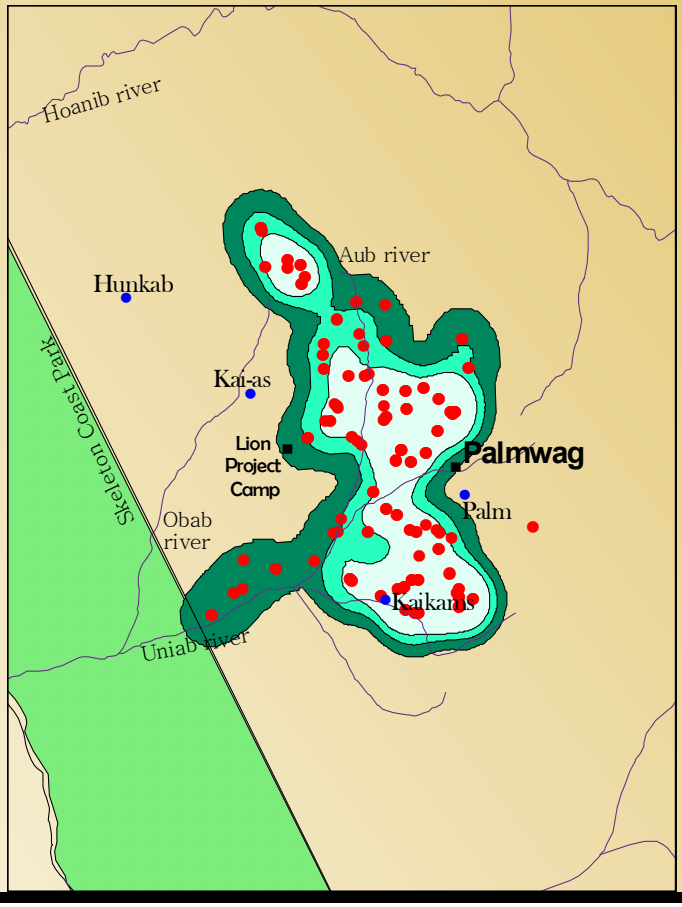
Xpl-9 and Xpl-11



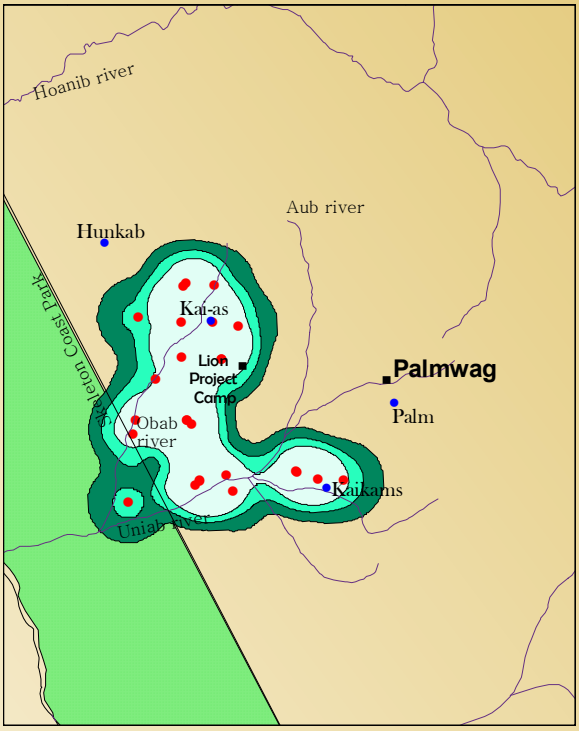
Xpl-10 (north and south)

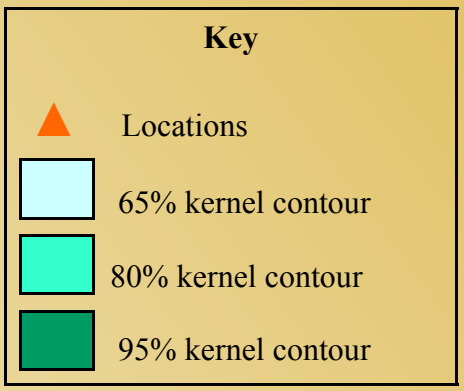


Xpl-14

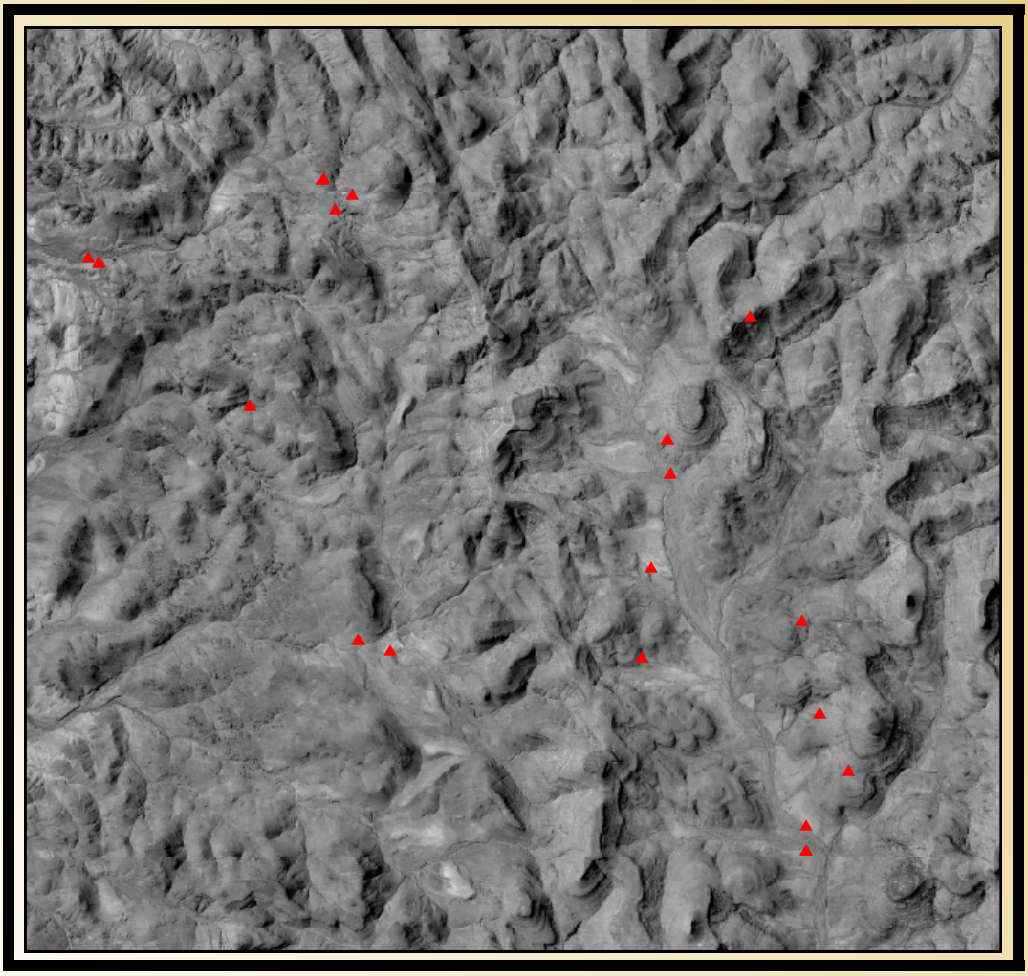


Xpl-18





The locations of Xpl-9 and Xpl-11 (▲) have been superimposed on a satellite image showing the topography of the upper Aub/Barab river. In the next phase of the project, we will incorporate this technology to evaluate habitat use and preferences of the Kunene lions.



Dispersal

Developing conservation strategies for the Kunene lions is, among many ecological parameters, dependant on a sound understanding of the factors that drive the distribution and dispersion of the population. Monitoring the dispersal of individuals from their maternal home ranges provides important information towards understanding these population characteristics. During the present study we monitored the dispersal of six groups of lions. All the groups, with the exception of the most recent dispersal (Xpl-19 group), have settled in a new home range. With the exclusion of the Xpl-19 group, the lions moved an average of 104.6 km (SD = 30.8) from their maternal home range. More data will be collected to allow analyses on the temporal and spatial patterns of dispersal

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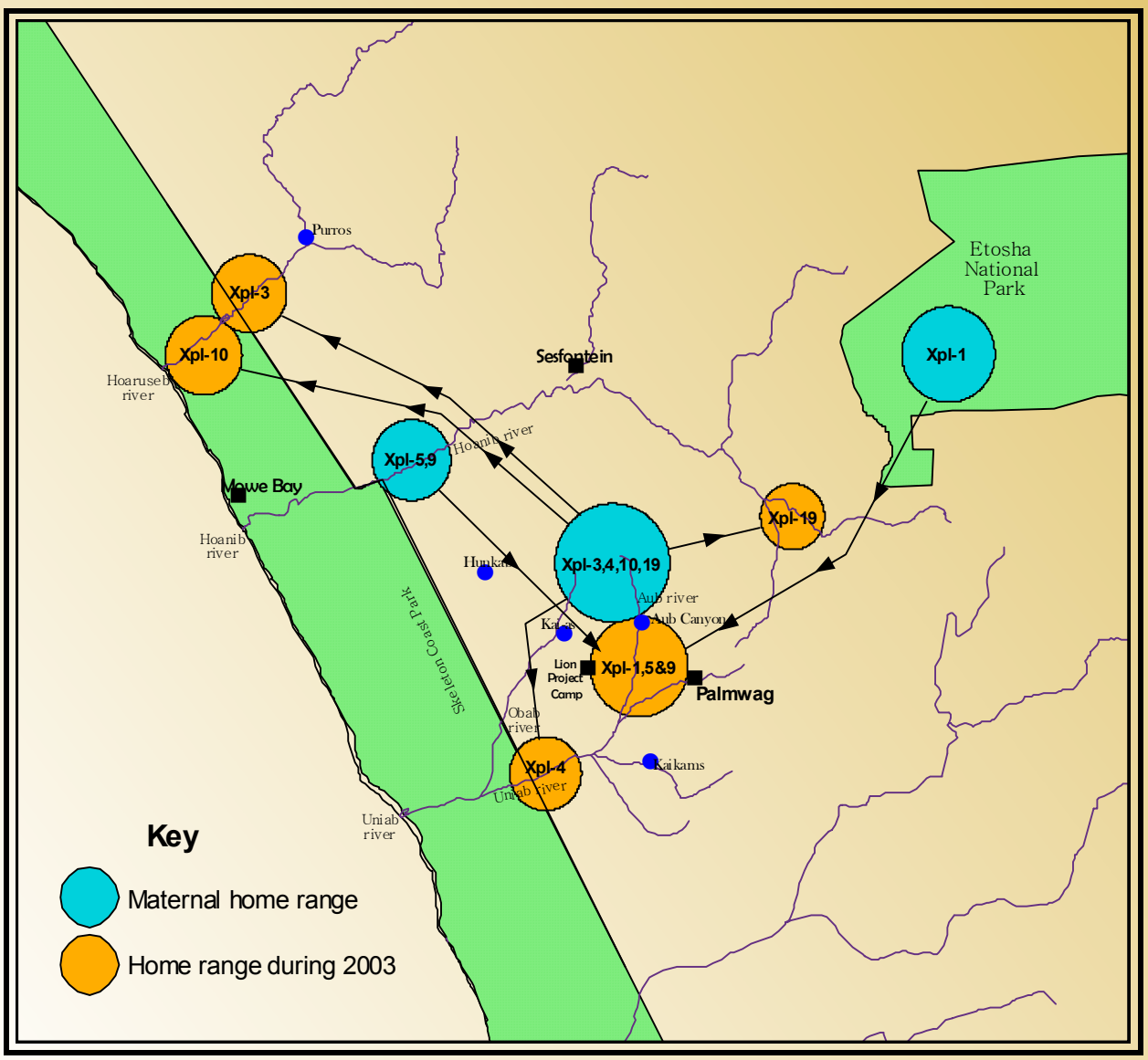
Lion ID	Group composition	Date occupying maternal home range	Direct distance to present home range (km)*
Xpl-1	Adult male	1998	120
Xpl-5 & 9	Adult females	1998	85
Xpl-3,6 & 15	Adult males	1999/2000	130
Xpl-10	Adult female	1999/2000	128
Xpl-4,8 & 12	Adult males	1999/2000	60
Xpl-19,20 & 21	Sub-adults	2001	51



CONCLUSION

This desert adapted and coastal roaming lion population were believed to have disappeared totally after a number were killed by pastoralists in 1988. The results from this study therefore unveil significant features and characteristics of the population. These lions likely live in the most rugged and arid environment anywhere in Africa. The long-term monitoring of individually known lions allowed qualitative assessment of important socio-ecology, population demography and movement characteristics. Some aspects of their behaviour and ecology is markedly different to lions elsewhere. Under these low density conditions Kunene lions produce larger litters (3.1 cubs) than measured elsewhere in Africa (2.4 cubs, Schaller 1972), and cub survival is unusually high. These features contributed to an astounding growth-rate and population increase. We propose that this is due to several years of good rainfall and stable, resident prey populations. The lions live in the largest home range sizes previously recorded, and perhaps as a result, pride members spend long periods apart. Sub-groups of a pride may spend many months apart which contradicts markedly with the daily fission-fusion patterns recorded elsewhere in Africa (Schaller 1972). We suggest that these behavioural and ecological differences are adaptations to the demanding habitat. We intend to continue intensive monitoring over the next five years to identify the mechanisms that drive adaptation. Sound baseline data and long-term monitoring of population dynamics, ecology and conflict with pastoralists will form the basis of a conservation strategy for the protection and sustainable use of these remarkable lions.

REFERENCES

Bridgeford, P.A. (1985). Unusual diet of the lion Panthera leo in the Skeleton Coast Park. *Madoqua*. 14: 187-188.

Harris, S., Cresswell, W.J., Forde, P.G., Trewhella, W.J., Woollard, T. & Wray, S. (1990). Home-range analysis using radio-tracking data - a review of problems and techniques particularly as applied to the study of mammals. *Mammal Rev*. 20: 97-123.

Loveridge, A. J., Lynam, T. and Macdonald, D.W. (Eds). (2001). *Lion Conservation Research. Workshop 1: Survey Techniques*. Wildl. Conserv. Unit. Pp: 2-4.

Mendlesohn, J., Jarvis, A., Roberts, C. & Robertson, T. (2002). *Atlas of Namibia : A portrait of the Land and it's People.* David Philip Publishers, Cape Town.

Nowell, K. & Jackson, P. (1996). *Wild cats: status survey and conservation action plan.* IUCN, Gland, Switzerland.

Schaller, G.B. (1972). *The Serengeti Lion.* Chicago: University of Chicago Press.

Smuts, G.L., Anderson, J.L. & Austin, J.C. (1978). Age determination of the African lion (*Panthera leo*). *J. Zool., Lond.* 185: 115-146.

Stander, P.E. (1992). Foraging dynamics of lions in a semi-arid environment. *Can. J. Zool.* 70: 8-21.

Stander, P.E. (1992). Cooperative hunting in lions: the role of the individual. *Behav. Ecol. Sociobiol*. 29:445-454.

Stander, P.E. & Morkel, P.vdB. (1991). Field immobilization of lions using disassociative anaesthetics in combination with sedatives. *Afr. J. Ecol.* 29: 138-148.

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REPORT CREDITS

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