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## DEMOGRAPHY OF LIONS (PANTHERA LEO) IN TARANGIRE NATIONAL PARK, TANZANIA

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### Abstract

*Tarangire lions reveal similar population characteristics to most of other lion populations in other protected areas in Africa. Tarangire lion population was estimated to be around 155 individuals as in June 2013 based on individual identification facilitated by the use of Radio telemetry coupled with the use of GPS to get information on individual lions within a specific pride to determine their location and characteristics. The population had a density of 7.5 lions per 100 square kilometers. The sex ratio was 1 male to 1.2 females more in favor of females but cubs had a sex ratio of 1 male to 1 female. The age composition was dominated by pre-reproductive age class (cubs and sub-adults), which constitutes 63.9% of the whole population. There was a total of 9 prides residing the park, the number of lions in the pride ranges from 2-38 individuals with the mean of 17.2 individuals. Cub survival was high with the average of 70.8% of all cubs born survived to year one. The overall population trend shows declining curve which suggests more conservation efforts are needed to make it stable.*

**Keywords:** African lion; Cub; Pride and Sex ratio; Age composition.

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### Introduction

Lions are the most social of the cats [1]. They live in groups known as prides, which consists of related females, their cubs of either sexes or related and unrelated males forming coalitions competing for tenure over prides. Average pride size (including males and females) is four to six adults; prides generally break into smaller groups when hunting [1]. Lions tend to live at higher densities than most other felids, but with a wide variation from 1.5 adults per 100 km<sup>2</sup> in southern African semi-desert to 55 adults per 100 km<sup>2</sup> in parts of the Serengeti [2].

The lion is considered to be the most abundant large predator in African savannah and plains ecosystems after the spotted hyena [3]. Depending on prey density, in a given area there can be anywhere from 1 lion/4.8km<sup>2</sup> to 1 lion/80.1-161.3km<sup>2</sup> [3]. However, the lions and other large carnivores have showed a marked reduction in numbers and distribution during the past few decades [4]. They have disappeared from the Northern regions while in the Southern areas only few populations are left [4]. In the remaining part of the African continent they are mainly confined to National Parks and the surrounding areas. This decline is mainly attributed to an increased conflict with human and habitat loss [4-7].

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Previous studies conducted in Tarangire lions focused on the human-lion conflicts showed that lions and other carnivores contribute to livestock loss in pastoral communities around the park through depredation and people retaliate by killing lions [5-8].

This situation threatens the survival of the main African predator by reducing its number and by isolating the lion populations, increasing the risk of inbreeding making lion conservation even more difficult. Information on large predators' population trends as well as movement patterns is crucial for their effective conservation. The objective of this study was to describe the lion demography in the Tarangire National Park, to collect data on distribution and movement patterns as well as home ranges.

## **Materials and Methods**

### ***Study area***

Tarangire National Park is located between 3°40' and 5°35' South and 35°45' and 37° East at an elevation of 1200 to 1600m above sea level with a total area of 2,850km<sup>2</sup> [9]. Its climatic condition is characterized by high variability and periodic droughts. The annual rainfall pattern generally consists of short rains from October to December followed by a short dry spell in January, with long rains occurring anytime from February to June. Although the rainy season officially runs from November to May, comparatively speaking the total rainfall in the park per year is low, at about 600mm [10]. The park provides habitat for large diversity of fauna and flora. During the dry season (June to October) the park serves as a refuge and harbours largest concentrations of wildlife.

### ***Radio telemetry***

Lion locations were obtained on daily basis from 0600 to 1800 hours primarily by homing in and sighting the animal. All telemetry work was done from the ground using a four-wheel drive vehicle. The location of the collared lion was confirmed using a hand held GPS where the coordinates were marked and recorded in a notebook. Other information such as individuals seen, group size, composition and female reproductive status (pregnancy, or lactation) were collected as well.

### ***Individual identification***

Members of the pride were identified through the patterns of whisker spots [11], natural markings [12] and acquired marks such as ear notches, broken teeth or kinky tails since they are unique and differ from every individual. With the aid of a pair of binoculars and digital camera, details of whisker spots, ear notches, eye coloration, coat color and persistent scars were confirmed from an identification card for each individual. Outlines of the faces of unrecognized lion were drawn on a notebook to aid in the identification process later and ID card making. Since lions only associate with their pride-mates, it was fairly simple to compare the spots of each individual in the group to the ID cards for that pride.

### ***Sex and age determination***

The conspicuous sexual dimorphism exhibited by lions was the criteria used in differentiating sub adult and adult males from females. Sexual dimorphism is not well pronounced in young cubs. However, at the age of three months, male cubs started to grow larger in size than female cubs. Age has been estimated using body size [13, 14], percentage of blackness of the nose [15] and by the amount of tooth wear [13].

### ***Data analysis***

Data on demography and ecology such as population size, characteristics, home ranges as well as movement patterns were analyzed. Data used in this study were from a 7 year data set (January 2005 to November 2012) from the long term population monitoring by the Tarangire Lion Project, supplemented with data collected during this study (January 2013 to July 2013). Data on cub survival were grouped based on water year calendar (Table 1). One water year

represent two-years period of 12 months of dry season and 12 months of wet season. The following population parameters were determined;

**Table 1.** Water year calendar

Water year	Starts	Ends
2004	01-Nov-03	31-Oct-05
2006	01-Nov-05	31-Oct-07
2008	01-Nov-07	31-Oct-09
2010	01-Nov-09	31-Oct-11
2012	01-Nov-11	31-Oct-13

**Population size**

Long-term studies involving marking and/or photographic recognition of individuals are perhaps the ideal methods for censuring lion populations [11]. Using data on lion sightings and demography collected by the Tarangire lion project as well as during this study, the population size parameters such as total number of lions in the park, lion population density, number of lions in each pride, number of females per pride 3 years and above, survival (number of cubs born and survived to year 1 for each water year) were determined using STATISTICA and Microsoft Excel 2010 computer programs. Disappearance of a lion from the park for more than 12 months was regarded as emigration or death and the individual was not counted in the population.

**Population characteristics**

From the dataset, population characteristics parameters such as sex ratio of adult, sub-adult and juvenile males to females, age composition, pride composition, cub survival as well as the impact of seasonal migration on population were determined.

**Results**

**Lions Population size**

The average number of lion population in Tarangire National Park's within the study area of 2000 sq. km was giving a density of 7.5 lions/100km<sup>2</sup> with the standard error of 2.6353 (Table 2). Throughout the study period, Tarangire National Park maintained a stable population. Hence, there was no significant variation in densities between years from 2005 to 2013 ( $\chi^2 = 0.001$ ;  $p > 0.50$ ;  $df = 3$ ).

**Table 2.** Tarangire lion population density (2005-2013).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Mean	SE	Density per 100km <sup>2</sup>
2005	163	179	166	167	170	183	199	199	201	206	199	188	2220	185	4.5460	9.25
2006	177	189	187	180	180	180	177	166	165	162	137	136	2036	170	5.0727	8.5
2007	134	136	136	136	136	144	148	157	155	152	152	159	1745	145	2.7398	7.25
2008	163	164	163	163	161	164	163	163	162	160	160	161	1947	162	0.4105	8.1
2009	154	152	155	156	154	150	140	120	122	126	126	125	1680	140	4.3152	7
2010	132	134	134	134	133	133	130	126	120	125	134	134	1569	131	1.3378	6.55
2011	132	130	121	127	139	123	121	118	117	123	134	128	1513	126	1.9519	6.3
2012	122	122	124	124	126	125	130	137	142	142	150	155	1599	133	3.3442	6.65
2013	155	155	155	155	155	155							930	155	0	7.75

**Population characteristics**

In June 2013 there were 1.24 females to each male in the population (n = 133) shown in Table 3. The sex ratio for sub-adults varied from year to year and was measured at 1.33 females to each male in June 2013 (n = 35). The cub's sex ratio was 1 female to each male. Cub's sex ratio seems to be equal 1:1 unlike sub-adult and adult in which there were more females than males. Sex representation in the population was not significant ( $\chi^2 = 2.38$ ;  $p > 0.20$ ;  $df = 3$ ).

There were more adult females than males. On the other hand the Tarangire lion population had more sub-adult females than males. The male to female sub-adult sex ratio was 1:1.3 but the difference was not significant.

**Table 3.** The sex ratio (male: female) of lion in Tarangire NP in June 2013

	Adults	Sub-adults	Cubs	Overall
Number	25:31	15:20	21:21	61:72
Ratio	1:1.2	1:1.3	1:1	1:1.2

### *The age composition*

The Tarangire lion population was dominated by the pre-reproductive age classes, which comprised of sub-adults and cubs that constituted 63.9% of the population (Table 4). The reproductive class (adults) was 36.1% as indicated in table 4.

**Table 4.** Age composition of lions in Tarangire NP, June 2013.

Date	Adult (4+ years)	Sub-adult (2-4 years)	Cub (0-2 years)	Total
June 2013	36.13%	25.81%	38.06%	100%
Ratio	1.00 n=56	0.71 n=40	1.05 n=59	155

### *Pride composition*

On average pride had 2.8 adult males and 3.4 adult females with the standard error of 0.67 and 0.77 respectively (n = 9 prides) (Table 5). The number of lions in the pride ranges from 2 to 38 individuals with a mean of 17.2 with the standard error of 3.61. The largest pride was Tarangire hill with total of 38 individuals. The greatest number of adult females in the pride was 7 in Tarangire hill and Silale pride. Of the 155 lions that were identified most of them reside in prides. In fact, only 8 were considered nomads because were seen just once and / or never seen within any other known pride.

**Table 5.** Pride composition of Tarangire lions in June 2013

Pride	AM	AF	SAM	SAF	JM	JF	JUNK	TOTAL
Altipiano	4	1	2	2	-	2	-	11
Wazi	1	3	3	3	2	2	-	14
Tarangire Hill	2	7	6	2	12	9	-	38
New Tarangire Hill	5	4	4	2	5	4	-	24
Kuro	2	2	-	-	3	2	3	12
New Silale	-	1	-	1	-	-	-	2
Old Silale	1	4	6	10	1	-	-	22
Silale	4	7	1	-	10	2	-	24
Nomads	6	2	-	-	-	-	-	8
<b>TOTAL</b>	25	31	22	20	33	21	3	155
<b>Mean</b>	2.8	3.4	2.4	2.2	3.7	2.3	0.3	17.2
<b>SE</b>	0.67	0.77	0.84	1.36	1.84	1.15	0	3.61
<b>Range</b>	0-6	1-7	0-6	0-10	0-12	0-9	0-3	2-38

AM=Adult male (4+ years), AF=Adult female (4+ years), SAM= Sub-adult male (2-4 years), SAF=Sub-adult female (2-4 years), JM=Juvenile male (0-2 years), JF=Juvenile female (0-2 years), JUNK=Juvenile unknown sex.

### *Cub survival*

Cub mortality is normally high during the first year (Schaller, 1972). The best way to measure cub survival is to count number of cubs born and survived to year 1. The cub survival in the Tarangire lion population was high in year 2008 in which 75% of the cubs born survived to year 1. In year 2004 the cub survival was low, only 62% of cubs survived to year 1. The average cub survival was at 70.8% with the standard error of 2.9825 (Table 6).

Table 6. Cub survival of Tarangire lions as in June 2013

Wateryear	Cubs born	Survived to year 1	Survival (%)
2004	128	79	62
2006	75	54	72
2008	73	55	75
2010	61	45	74
<b>Total</b>	337	233	283
<b>Mean</b>	84.25	58.25	70.75
<b>SE</b>	14.9073	7.2729	2.9825

## Discussion

### *Population size*

The lion population estimates of 117 to 155 individuals for Tarangire National Park as in June 2013 might be minimum figures since lion population estimates are difficult. The explanation for this in Tarangire National Park is due to seasonal migration of prey species outside the park boundaries during wet season (November to May), lions as well follow the prey during this period making it difficult to sight them. Other studies show that estimating lions population is ambitious exercise with a number of uncertainties [1, 13, 16]. Tarangire lion population had a density estimate of 7.5 lions/100km<sup>2</sup>. The density was high (9.3 lions/100km<sup>2</sup>) in year 2005 and was lower in the year 2011 (6.3 lions/100km<sup>2</sup>). These densities are lower compared to that of Lake Manyara NP, which was, 45 lions/100km<sup>2</sup> highest density recorded than any other park in the world [1, 17, 19]. The explanation for such highest density might be due to the fact most of the area in Lake Manyara NP is covered by the waterbody especially during the wet season in which the the lake covers up to 200km<sup>2</sup> of the 325km<sup>2</sup> of the park area, human activities surrounding the park boundaries also forced the animals in Lake Manyara NP to confine within the park boundaries. Stander [16] reported the density of 1.6 to 2 lions/km<sup>2</sup> for Etosha lions in Namibia. These densities are lower compared to what was observed in Tarangire NP during this study. Lions of East Africa have higher densities compared to those in most protected areas in West Africa, the explanation for this is due to relative low pressure from human induced disturbance and mortality, both via persecution and trophy hunting compared to most protected areas in West Africa in which these factors are intense [20, 21]. The variation in population densities between different protected areas is the result of differences in resources availability and competition [16].

### *Population characteristics*

The sex ratio (male:female) for Tarangire lions was 1:1.2. This sex ratio is less in favour of females than data presented by Smuts [13] for Kruger lions which was 1:1.6. The sub-adult sex ratio for Tarangire lion was around 1:1.3, it is more twisted towards females compared to that of Etosha lion reported by Stander [16] which was around 1:1 wherein both sexes were equally represented. Lion's sex ratio normally skewed more in favour of females due to high male mortality especially during sub-adulthood [13, 22]. The Tarangire lion population was dominated by the pre-reproductive age classes (0 - 4 years) that comprised 63.87% of the population. The explanation for Tarangire lion populations being dominated by pre-reproductive age class is due to high adult mortality as a result of retaliatory kill by pastoralists [23], also trophy hunting of adult males in the hunting blocks adjacent to Tarangire NP. Thus, the combined effect of retaliatory killing and trophy hunting might be the explanation why Tarangire lion population is dominated by the pre-reproductive age classes since the vulnerable groups are the adult lions. The figures observed during this study are quite higher than those reported by Stander [16] for Etosha lion population in which only 35.7% were between 0-4

years. On the other hand 43% of Serengeti lion population were in the pre-reproductive age class as reported by Schaller [1].

### ***Pride composition***

Total pride size including cubs (average = 17.2, SE = range 2-38) is quite large compared to those reported by Stander [16] in Etosha National Park with an average of 12.5 and range 9-20. The most stable measure of pride size is the number of adult females [17]. The number of adult females in a pride of Tarangire lions ranged from 1 - 7, a figure which is lower compared to those from other findings that pride units are composed of two to eighteen related females [1, 14, 18, 19, 24]. Adult males in the pride ranges from 0 - 6, the number is low compared to that of females. This observation of fewer adult males may reflect high off-takes from trophy hunting that encircle the Tarangire NP or greater numbers of males being killed in retaliation for cattle killing (human-lion conflicts). Each pride retained the same males from the time of the beginning of the study to the end (i.e. January- June 2013). No coalition take over was observed during this study period. The small pride size observed in this study was New Silale with only two pride members; the explanation for such observation is probably due seasonal movements of other pride members to the communal lands, or retaliatory kill as a result of depredation of livestock in the villages [23]. Other contributing factors might include diseases, old age and agonistic encounters [1, 19, 25].

### ***Cub survival***

The average cub survival (0 - 1 year) in Tarangire lion population was 70.75% (Table 6). This means that cub mortality was low to around 29.25%. Unlike that of Kruger National Park in which around 50% of cubs died [13]. Similar results were also reported in Nairobi National Park in which 50% of the cubs born died within their first year of living [26]. In Etosha National Park cub mortality was around to 40% [27] whilst a figure of 67% was given for the Serengeti [1]. The reasons for high cub mortality in other parks can be linked to starvation and infanticide by male lions during pride takeovers. It has been reported that infanticide alone accounts for 27% of cub mortality [1, 23, 28-30] The trend of cub mortality observed in this study in Tarangire lion population are in contrast with those reported in Serengeti by Schaller [1] that around 80% of cubs will die before the age of two years.

## **Conclusion**

Key results from this study showed that Tarangire lion population estimate is around 155 individuals as in June 2013. These estimates are accurate and realistic since are based on individuals and groups recognition. Pride and group size are similar to most of the protected areas in Africa with little variations on densities that are quite lower compared to that of Lake Manyara national park. Age and sex distribution for Tarangire lion are similar to that of other populations from elsewhere. More managerial efforts are required towards lions conservation for a healthy and viable population.

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