The AfriCat and Okonjima Leopard Density Study

Title of proposed project: The assessment of leopard (*Panthera pardus*) density and population size via a capture – recapture framework in an island bound conservation area in Namibia.

Project need

Over the last decades human activities have led to the devastating destruction of large parts of natural habitats (Gaston, 2008) leading to the dramatic decrease and threatened status of many wildlife species worldwide.

The leopard (*Panthera pardus*) is classified as "Near Threatened" according to the IUCN Red List of Threatened Species (IUCN, 2014.2.). Leopards occur across wide ranges of sub-Saharan Africa as well as inhabit parts of Northern Africa and tropical Asia (Friedmann & Holzer, 2008). Their adaptability and tolerance towards a wide range of various habitats as well as their secretive and elusive nature had let them survive in marginal areas from which other felid have disappeared completely (IUCN, 2014.2).

Despite their wide distribution throughout sub-Saharan Africa, the felids are declining dramatically in numbers and have disappeared from approximately 36.7% of their historical range (Ray et al. 2005) due to habitat fragmentation as well as intense persecution by humans. While sub-populations in North Africa and Asia are on the verge of extinction, Namibia's population maintains stable numbers (Stein, Andreas & Aschenborn, 2011). With a total of only 17% of protected areas in forms of national parks, game reserves and recreational areas in Namibia (Turpi et al 2010), the majority of leopards occurs on commercial and communal farmland where the sporadic predation of livestock induces an inevitable conflict between man and carnivore. The necessity for the development and expansion of protected areas as well as the implementation and execution of improved livestock farming techniques on farmland are therefore of utmost importance to secure the survival of the Namibian leopard population.

Protected areas maintain a higher density of predators than un-protected areas (Stein et al. 2011). Carnivore abundance is often correlated by the level of inter- and intraspecific competition as well as the availability and accessibility of resources such as water and prey.

Human-caused mortalities and habitat loss are additional factors playing a crucial role in determining felid densities (Khorozyan et al, 2008). Unreliable estimations often lead to wrong management decision; thus, reliable large carnivore estimations are essential for the development of sustainable and long-term management and conservation strategies (Hayward, Brien, Kerley, 2007).

The majority of large felids are nocturnal and characterized by a secretive and elusive nature, consequently most techniques used to estimate species richness and abundance provide unreliable results. The application of camera traps proved to be the most dependable method when it comes to the creation of reliable quantitive estimations of large carnivore species.

Here, we display the results of a camera-trap survey conducted in the Okonjima Nature Reserve in Namibia that is aiming to estimate the total number of leopards in the reserve.

Goal

To assess the density and population size of leopards (*Panthera pardus*) in the Okonjima Nature Reserve using photographic capture-recapture sampling and provide scientific data on their demography as well as spatial and temporal distribution patterns.

Study area

The Okonjima Nature Reserve (Lat/Lon: 20º49'19.36''S, 16º38'21.25''E) is located in central Namibia approximately 50 km south of Otjiwarongo and compromises a total area of 22 000 ha. The study area is semi-arid and characterized by a marked seasonality. The annual precipitation averages approximately 450 mm. The Okonjima farm boundary traces a central plateau, at average an altitude of 1 600 meters, surrounded by the Omboroko Mountains. The vegetation can be mainly described as tree- and scrub savannah, interspersed with Yellow wood (*Terminalia sericea*) and several Acacia-species. Artificially constructed water reservoirs ensure the perennial supply of surface water.

Okonjima was used intensively for the purpose of cattle farming from 1920 until 1993. Since then the private nature reserve has been used for carnivore rehabilitation and non-consumptive use of wildlife through eco-tourism.

The reserve is surrounded by a 96 km electrified perimeter fence, completed in 2010, and is bordered entirely by commercial farmland. An additional fence is erected within the reserve and creates a 20 000 ha reserve for carnivore rehabilitation and a 2 000 ha "lodge area" that includes lodges and campsites as well as the AfriCat headquarters and the Environmental Education Centre.

Leopards as well as brown hyenas (*Hyena brunnae*) occur naturally within the borders while cheetahs (*Acinonyx jubatus*), African wild dogs (*Lycaon pictus*) and spotted hyenas (*Crocuta crocuta*) are part of AfriCat's rehabilitation program that have been released into the area.

Lions (*Panthera leo*) are absent from the study area. Thus, leopards belong to the apex predators in the reserve that are playing an important role in maintaining the health of the ecosystem.

Study Objectives

1. To determine leopard density and population size via a capture-recapture framework using remote camera traps
2. To determine the demography of leopards within the Okonjima Nature Reserve
3. To develop a dataset that can be applied as a baseline for comparisons to similar areas
4. To develop a long - term population monitoring programme

Methods

The 20 000 ha Okonjima Nature Reserve was sub-divided into five approximately equally sized blocks of 4 000 ha (3 692.2 ha ± 510.5). Each sub-block will be sampled sequentially for 50 continuous days and will be monitored by a set number of remotely triggered flash cameras (Cuddeback Triple Flash, model C123). The number of cameras is proportional to the size of each sub-block. A preliminary inspection of the study site was implemented in order to identify suitable camera trap locations and Geographic Position System (GPS) points were taken of every trap site and transferred onto a Google earth satellite map. To enhance accuracy of abundance estimates and to increase the number of leopards being photographed, camera traps are preferably placed in areas that suggest an elevated frequency of leopard occurrence such as dry riverbeds, riverbanks and/or frequently used roads and pathways.

Baited camera stations are used to increase leopard capture frequency. Tall trees at each trap site are selected and baits positioned approximately 1.0 – 2.0 metres above the ground to prevent theft from other carnivores. A single camera trap is placed 2 - 3 metres perpendicular

to the branch on which the leopard is expected to occur to access the bait. Cameras are housed in a protective case (CuddeSafe®) to prevent cameras from wildlife damage. Baits are fastened with double wound wire to ensure that leopards don't remove bait and feed out of sight.

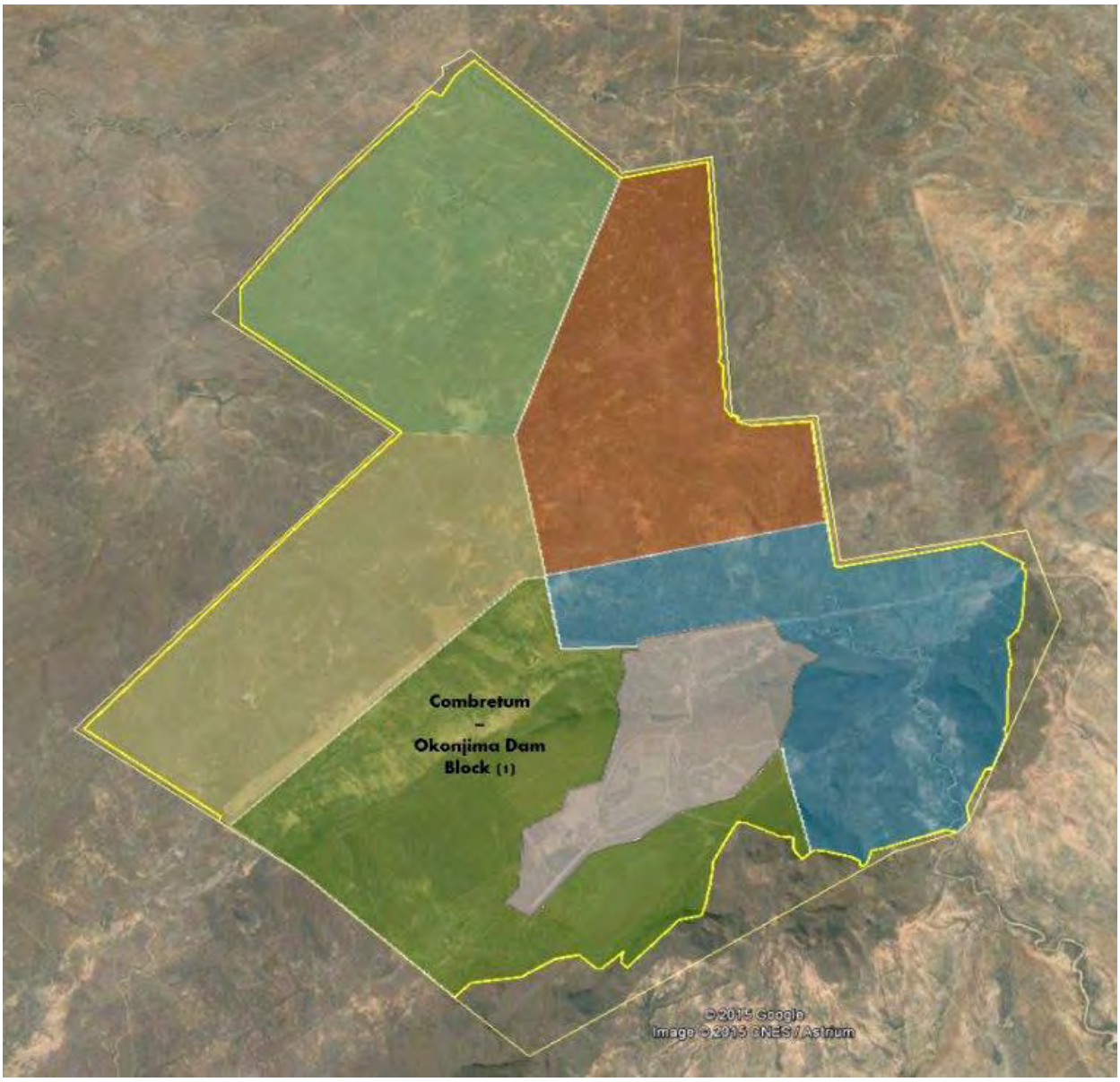
Once triggered, a single camera trap took a series of three consecutive photographs, followed by a delay of 6 seconds.

Cameras are serviced every 6 – 7 days in order to verify battery status, change of SD cards, renew bait and ensure the correct functionality of each trap. Photographs from each trap site will be evaluated. Leopards will be identified via their unique spot patterns.

Each individually identified leopard will be assigned with a unique identification number. If applicable, sex and age class will be recorded. Identification will be performed by two independent observers to prevent bias.

A capture history will be generated for each sub-sampled block and afterwards combined to form one data set for the entire study period (Soisalo & Calvalcanti 2006). Therefore a standard X-matrix format will be used where "1" indicates the presence of an individual during a sampling occasion and "0" the absence during that occasion (Karanth & Nicholas, 2004) (Tab. 1). Due to the fact that leopards are mainly nocturnal, a sampling occasion is defined as a 24-hour period starting and ending at midday (12h00) (Du Preez et al. 2014).

Fig. 1: Overview of study area. The 20 000 hectares study area was divided into 5 sub-blocks of approximately 4 000 hectares each and will be sampled subsequently for 50 consecutive days. The first block, situated in the south-west of the reserve and measuring 3 816 hectares (dark green), was monitored by 20 camera traps for 50 consecutive days (24th July – 11th September 2015).



Preliminary results PHASE 1 Combretum - Okonjima Dam 27 Jul - 11 Sep 2015

The first block within the study area was monitored from the 24th July 2015 - 11th September 2015 and measured 3 816 hectares in size (Fig. 1). The block is situated in the south-west of the reserve and is characterized by a high number of accessible prey. The area consists of

seven natural water points of which five are permanently installed and perennially accessible. The vegetation is mainly classified as thorny bush - and scrub savannah interspersed by a prominent mountain ridge in the north-western part of the area.

20 cameras were distributed throughout the area (Fig.2). Inter-trap distances ranged from 1.1 to 2.2 kilometers (1.59 ± 0.27) to increase the likelihood that no individual could move through the study area without being detected.

Fig. 2: Location of camera trap sites within the first monitored block. Inter-trap distances ranged from 1.1 to 2.2 kilometers (1.59 ± 0.27) to increase the likelihood that no individuals could move through the study area without being detected.

The white area is displaying the 2 000 hectares lodge area that is surrounded by a predator-proof fence and thus, inaccessible for leopards or other carnivores.

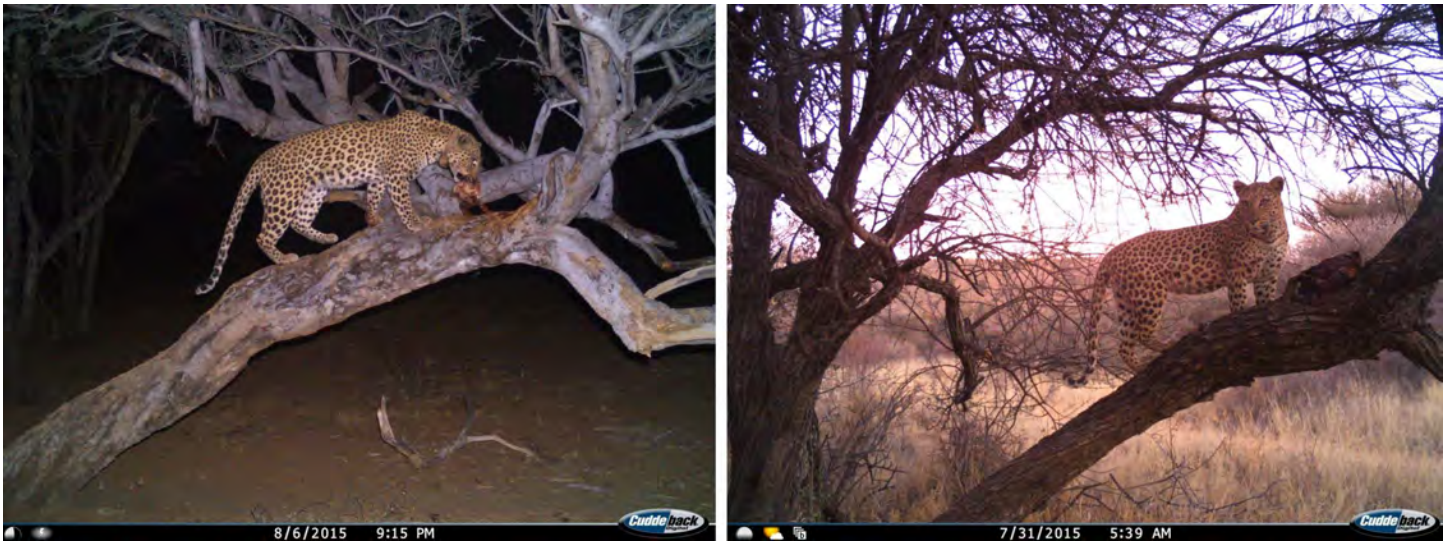


Fig. 3: Captures of female leopard Ishara (Pp1) during two different trap occasions at two different camera stations.

Fig. 4: Captures of two different individuals (left: un-collared male Pp5; right: collared female Pp10) at the same camera station.

Fig. 5: Captures of collared female during one trapping occasion at the same camera station. A bait that is fastened in the tree ensures that the animal spends significantly more time in front of the camera increasing the chances of individual identification.

Tab. 1: Summary statistics for photographic capture-recapture data on leopards in **Combretum - Okonjima Dam Block (1)**

Size	3 816
Number of camera trap stations	20
Survey period	24 July - 11 September 2015
Sampling occasions (12 pm – 12 am)	50
Sampling effort (trap nights)	966
Total number of individuals caught	15 (six females, seven males, two juveniles)
Total number of captures	87
Number of individual animals caught once	3
Number of individuals animals caught more than once	12

13 individual adult leopards (six females and seven males) and two dependent juvenile leopards were photographed during 50 trapping occasions and were captured a total of 87 times. Capture frequencies ranged from 1 – 28 captures per individual (6.21 ± 7.36) (Fig. 6). Leopards were photographed at 19 out of 20 camera stations. The leopard activity index (frequency of leopards caught per 100 trap nights) was 0.42 ± 0.25 but differed significantly between camera stations (Fig.7).

Nine out of the 13 adult leopards that were caught during the survey period were collared individuals. While only two out of six males were collared individuals, all captured females were equipped with a radio collar. Female capture frequencies were significantly higher (9 ± 10.60) compared to male capture frequencies (2.42 ± 1.13), but showed more variations (1 - 28 captures) within their demographic class.

Density was 3.9 leopards per 10 km^2 within the first sampling block.

Spatial distribution patterns of radio-collared individuals as displayed by the movement between the camera stations will be compared to the movement patterns established via the use of VHF-telemetry after completion of the entire study period of 250 days. Spatial distribution patterns within this block are only displayed for female leopards due to a higher capture frequency compared to those of male leopards (Fig. 8).

The two juvenile leopards that were recorded during the sampling period were of approximately 6 months (Pp14) and 12 months (Pp15) of age, respectively (Fig. 10). Both cubs' origin could be allocated to two collared females (Pp1 and Pp5). The capture frequency of the older cub (Pp15) without its mother was found to be significantly higher than the capture frequency of Pp14 (Fig. 9).

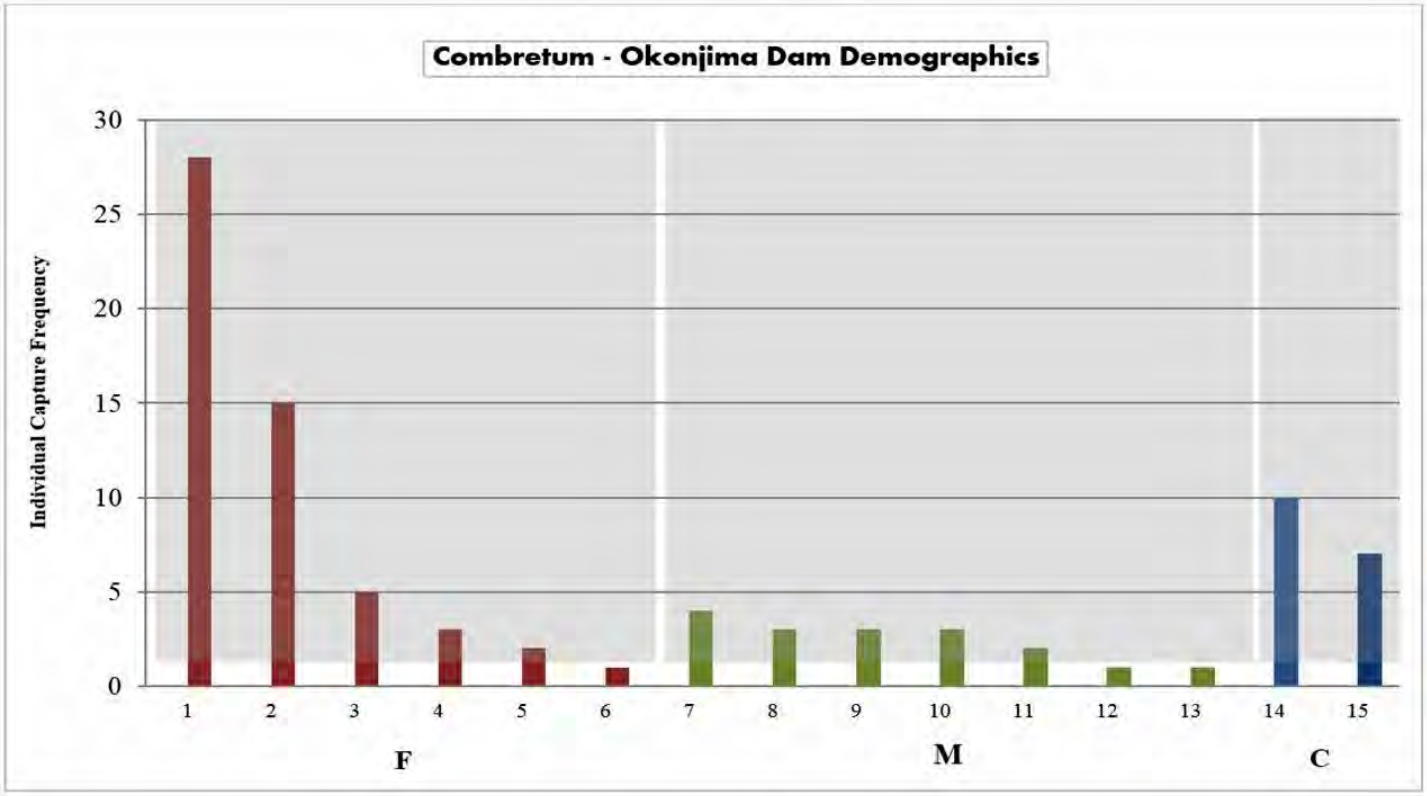


Fig. 6: Capture success of leopard demographics within the first sampling block. Each number on the x-axis refers to a positively identified leopard within the corresponding demographic class: F = female, M = male, C = cub. Data are ordered by the number of captures within the demographic class.

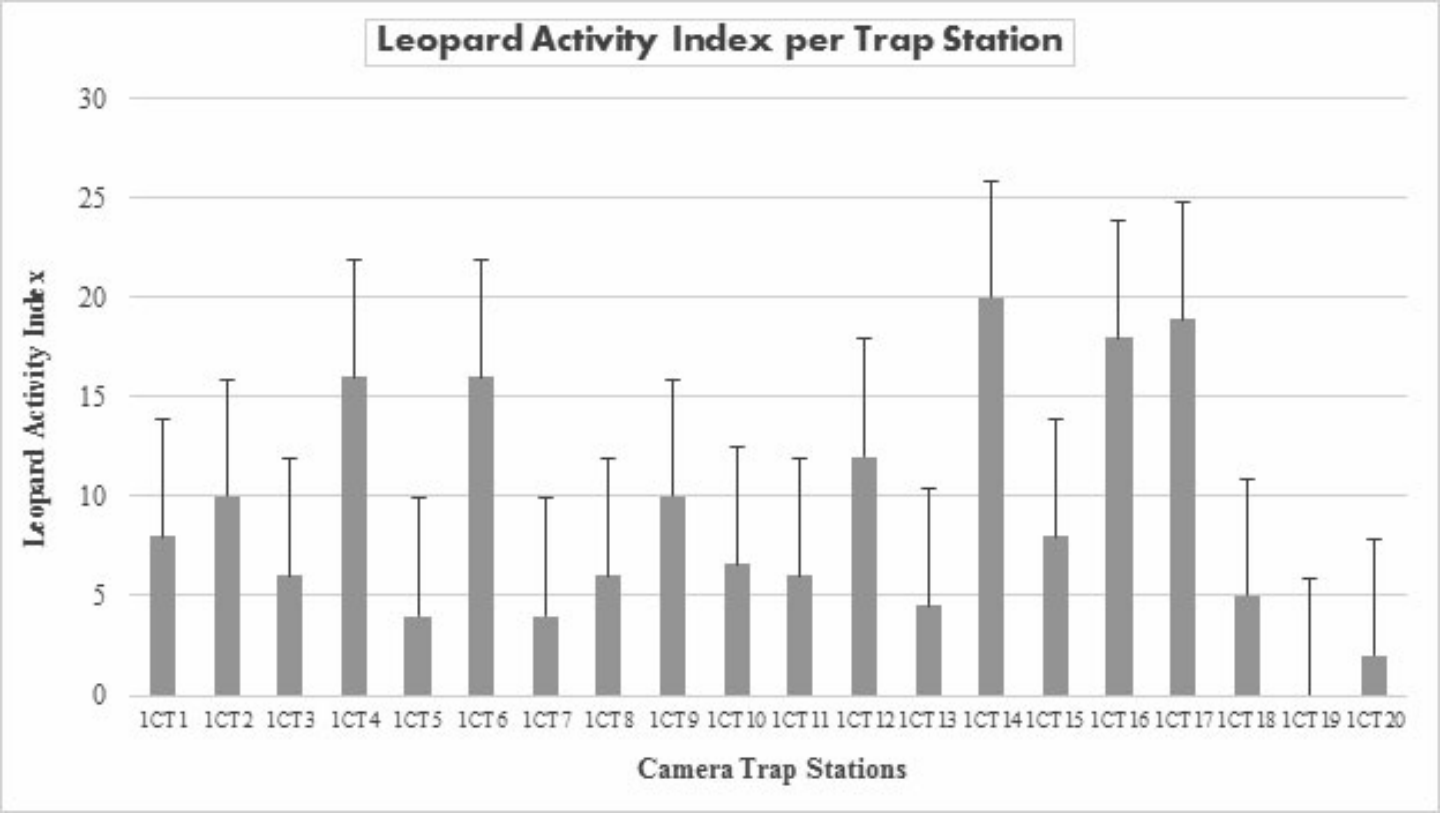


Fig. 7: Leopard activity index (trap events/trap nights * 100) calculated for 20 camera station distributed throughout the first study block. The leopard activity index expresses the trap success per 100 trap nights

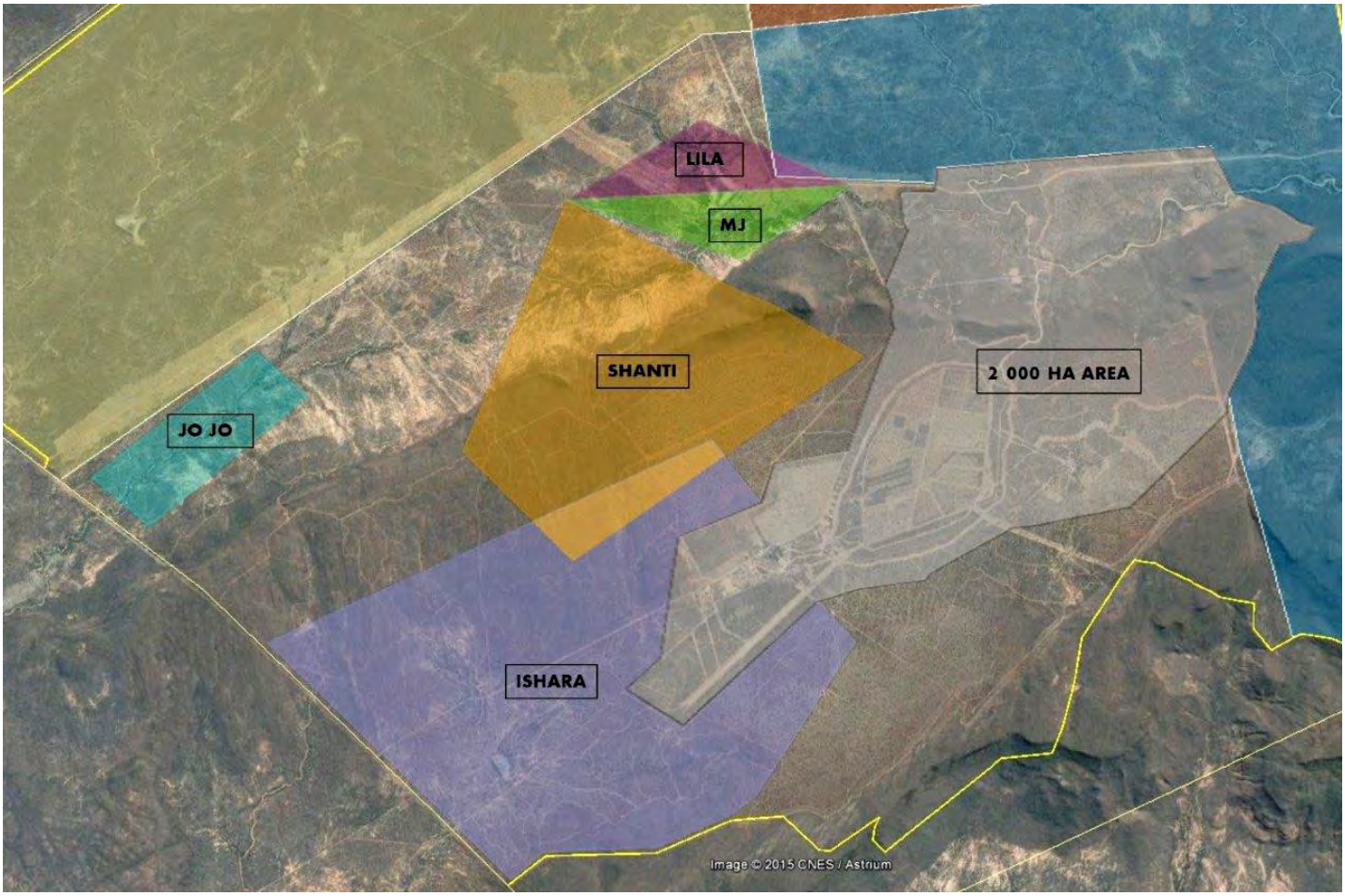


Fig. 8: Movement patterns 24th July – 11th September 2015 between camera stations of five of the captures female leopards. Male movements are not displayed due to low capture frequencies and limited movement between trapping stations.

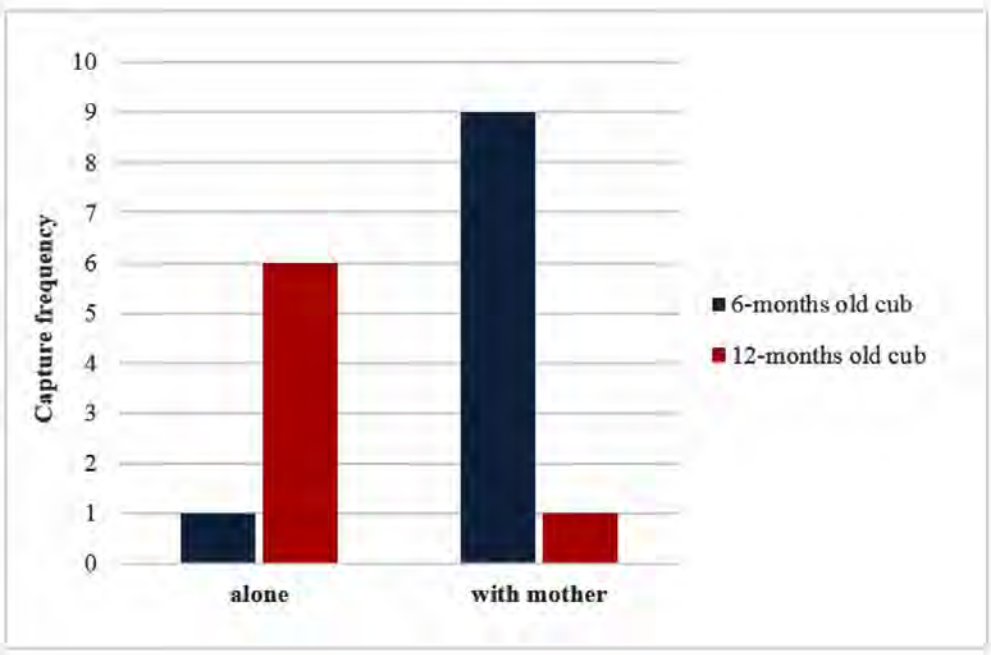


Fig. 9: Capture frequencies of dependent juvenile leopards with and without mother during trap events.

Fig. 10: Juvenile leopards recorded within the first sampling block during the survey period from the 24 Jul - 11 Sep 2015 (left: Pp14; right: Pp15).

Appendix

Tab. 2: Positively identified individuals within the first sampling block.

Identification number	**Individual**
Pp 1	Ishara
Pp 2	Shanti
Pp 3	MJ
Pp 4	Lila
Pp 5	Jo Jo
Pp 6	Lundu
Pp 7	Un-collared male
Pp 8	Bwana
Pp 9	Mafana
Pp 10	Un-collared male
Pp 11	Un-collared male
Pp 12	Un-collared male
Pp 13	Nkozi
Pp 14	Ishara's cub
Pp 15	Jo Jo's cub