



Mara Meru Cheetah Project

ANNUAL PROGRESS REPORT

2020

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INTRODUCTION

Since the beginning of 20th century cheetah population in the world reduced dramatically from over 100,000 to about 7,100 individuals (Durant *et al.* 2017) due to human activities on a global scale. Therefore understanding human-cheetah interface is essential in promoting the survival of this species on a long term. The Mara-Meru Cheetah Project (MMCP) operates in the Mara Ecosystem, mainly focusing on the territory of the Maasai Mara National Reserve, where tourism activity is high throughout a year.

The year 2020 differed from other years whereby for almost 5 months hardly there were any tourist cars in the reserve due to the lockdown. This period was characterized by long torrential rains posing a great challenge for data collection: fields were flooded with water, the main roads turned into impassable deep ruts full of mud, and the side roads were completely overgrown with tall grass. However, we managed to go to the field when the weather allowed and collected substantial data, constituted in this report.

Our project is closely working with the Narok County Government, Kenya Wildlife Service (KWS) officials and field officers and KWS Mara based Veterinary team, owners, managers and Wardens of several Mara conservancies and other local stakeholders. Since 2012, we involved over 150 guides from different Mara facilities and tour companies into cheetah monitoring. Guides provide us with vital information on cheetah health and sightings. With years, they became strong supporters of cheetah research and wildlife conservation. We regularly update them with important data on particular Mara cheetahs through workshops, meetings in the various tour facilities and in the field, share our findings and information which helps them to better understand behavior and ecology of animals and educate guests. We communicate with rangers of the Reserve and conservancies on the daily basis and assist each other with cheetah monitoring and anti-harassment activities.

Due to the lockdown and resultant adverse economic effects of the Covid-19 pandemic in the locality, we had to postpone our community education activities and focused on helping poor families from the nearby villages with donations of food (unga, wheat flour, rice etc).

In 2020, our two research teams spent 170 days (1,479 hours) and 125 days (1,219 hours) in the field and covered 8,075 km and 7,033 km respectively. We had the opportunity to observe the behavior of cheetahs during the lockdown period and as tourism slowly returned to the Mara. Field work included quantitative (scouting for cheetahs) and qualitative data collection (cheetah behavior observations). We collected behavioral data on 35 adult cheetahs (18 males and 17 females with and without cubs) in the Reserve and surrounding Conservancies. Below we provide data for 2020 and the impact of lockdown on the cheetah population in the Mara.

PROJECT TEAM

Project Founder and Principal Investigator – Dr. Elena Chelysheva is a biologist with over 35 years of experience of working with cheetahs and studying them in captivity and in the wild. In 2001-2002, Elena was working as an Assistant Researcher at the first governmental Cheetah Conservation Project in Kenya, initiated by the Kenya Wildlife Service (KWS) in the Maasai-Mara region. At that time, Elena developed original method of cheetah identification (published in 2004), which is widely used now by different researchers. In 2008, Elena defended her PhD in cheetah ecology and behavior. Dr. Elena Chelysheva is a member of the IUCN Conservation Planning Specialist Group. Since 2011, Dr. Elena is leading the Mara-Meru Cheetah Project (MMCP).





Senior Project Advisor – Salim Mandela Mandere graduated from the University of Nairobi with a Bachelor’s Degree in Wildlife Management and Conservation. Before joining the MMCP, Mandela completed several projects including assessment the contributions of private ranches in wildlife management and conservation; camera trapping and data analysis; game counts; community conservation education and conflict management. He joined the MMCP as a **Senior Research Assistant** in 2012 and took wide range of responsibilities including field data collection and analysis, community education programs development and implementation, conducting motivation talks to Kenyan students in different Universities and schools. Working in the Project, Mandela gained vast experience and skills, which allowed him to be chosen by the local community for the

position of the Manager of the newly formed Olerai Conservancy in the Mara. At the moment, Mandela is completing his Master’s thesis (based on the data collected while working at the MMCP) at the University of Nairobi and assists our team as the Senior Project Advisor and mentor of our new assistants.

Senior Research Assistant – Jackson Morara Otuke holds a bachelor’s degree in Environmental Planning and Management from Kenyatta University. His professional interests are GIS and Remote Sensing (competent in using different programs- Arcgis, Q-GIS, Snap, Open foris Collect Earth tool, Google Earth, Global mapper), spatial planning and environmental management for sustainable urban, rural and regional development while conducting research, designing and preparing development plans with environmental related programs/projects. In the MMCP, Jackson’s responsibilities include field data collection (wildlife behavior monitoring and recording), spatial analysis using GIS, developing and implementation of conservation outreach programs for the local community, rangers and local tour guides.



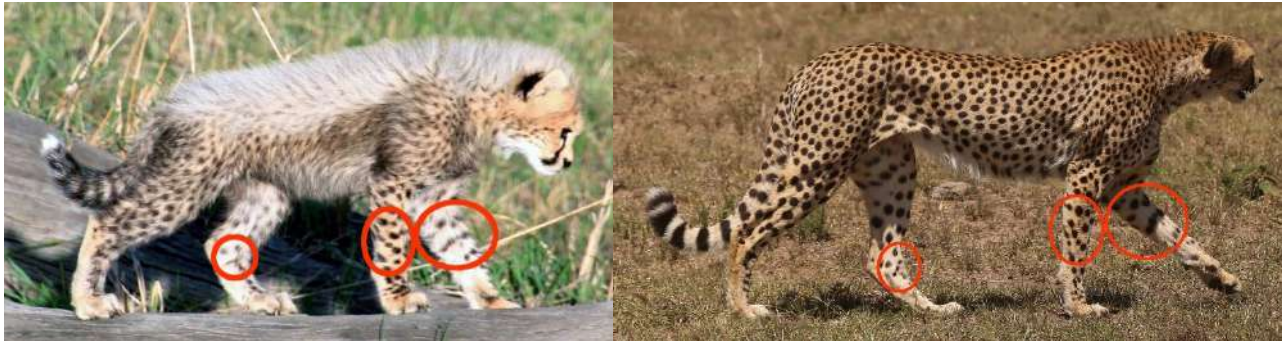
Research Assistant – Branson Togom Nalala graduated from the University of Nairobi in 2019 with a bachelor’s degree in the Wildlife Management and Conservation. Coming from a pastoral community, Branson chose to take a course in the University that will give him knowledge to help his community in solving daily conflicts that arise from the close interaction of people and the wildlife.

I. CHEETAH POPULATION

1.1. Database. The database has been built on the basis of individual identification by the original method of cheetah identification, developed by Dr. Elena Chelysheva in 2001 (*Chelysheva, 2004*). The method is based on the visual analysis of the unique spot patterns on front limbs (from toes to shoulder) and hind limbs (from toes to the hip), and spots and rings on the tail. It helps to identify individuals from the age of one month (Pic.1,2). In the example below, spot patterns (circled in red) of 1 month old cheetah cub match with those of an adult cheetah, revealing their phenotypical identity. Correct identification of cheetahs from collected photos enables building the Mara cheetah Pedigree (Pic. 5-7), where the year of birth and kinship among cheetahs (parents/grandparents/

littermates) has been revealed. To date, MMCP team processed over 75,000 photographs with dates and time taken, provided by researchers, who had been working in the area in the early 2000-s, professional photographers, guides who have been taking photos since 2000-s to date, and photos taken by Dr. Elena Chelysheva, who was working in the Maasai Mara Cheetah Conservation Project with the Kenya Wildlife Service in the period between 2001-2002.

Out of **211 adult** individuals identified from **2001-to date**, **kinship between 90%** adults revealed (For examples see Pic.6-8).



Pic.1-2. Original method developed by Dr. Elena Chelysheva enables to identify individual cheetahs from as early as from one month of age. Female Karemba at the age of 1,5 months (left) and two years (right)

1.2. Mara cheetah population trends. Our long-term data collection revealed that density fluctuated annually in the MMNR (Linden et al 2020). A comparison on density of cheetahs of the Mara Ecosystem, which comprises of the Maasai Mara National Reserve (1,510 km²) and of surrounding conservancies (1,500 km²) through 9 years, depicts a slight increment for the last two years (See Pic.3). The observed increment is attributed to the following factors:

1) Recruitment rate of adults exceeded the death rate. In 2020, zero deaths were recorded despite the mysterious disappearance of 3 males – members of different coalitions. In this reporting period, five females raised 14 (10 males and 4 females) cubs to independence.

2) Several adult individuals – 4 (2.2) appeared in the Mara after 1.5-2.5 years of absence.

Male M61 was last spotted in the Mara (Ol Chorro area) at the end of October 2017, only to re-appear after 2.5 years in late March 2020, in the neighboring area.

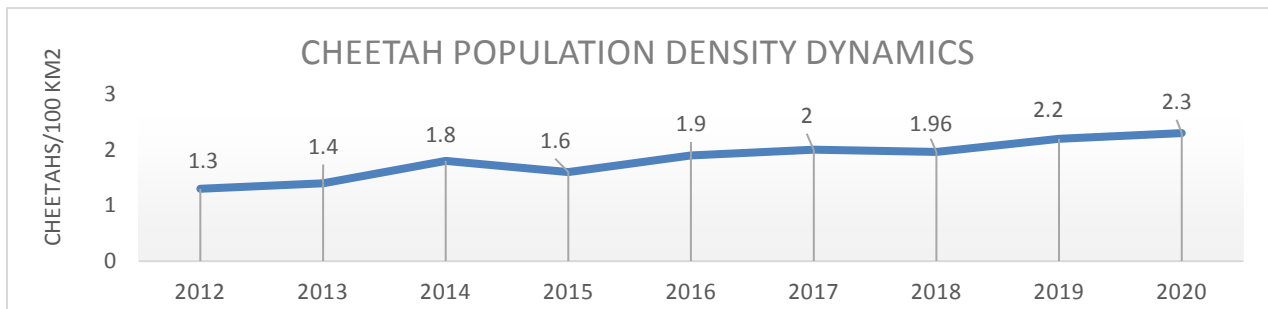
Male M50 was first observed in courtship with one of the females in the MMNR in July 2016, and re-captured three years later: in June 2019 in the middle of the MMNR, in August 2019 at the Mara-Serengeti border and towards the end of December 2020, M50 appeared in the MMNR.

Female Karemba (F55) was born in 2013 in the MMNR and raised in the northern conservancies by the mother Amani (F3) (See Pic.4). Soon after reaching independence, she moved to Serengeti. In February 2017, Karemba gave birth in the MMNR and moved to Serengeti after losing a litter. A year later, she appeared in the Mara Triangle for several days, disappeared for 5 months, and in the middle of August 2018, gave birth in the MMNR. Shortly after losing the litter, she disappeared for 2.5 years.

Female Maridadi (F61) was first spotted in mid-August 2016 as an adolescent in a perfect physical condition. In 1.5 years, she was observed afflicted by sarcoptic mange (5th stage) (See Pic. 78). She recovered fully and was spotted in December 2020 having two cubs.

It is noteworthy that since 2018, when the number of males and females in the Mara was equal (out of 64 adult cheetahs, 32 males and 32 females) and sex ratio was 1:1, in subsequent years, there was a shift towards an increase in the number of males. In 2019, out of 71 adult cheetahs there were 42 males and 29 females (1.45:1), while in 2020, out of 71 adult individuals, 40 were males and 31 females (1.3:1).

Despite the increase in population density, when assessing population success it is important to consider parameters such as the number of mature individuals participating in reproduction and their reproductive success.



Pic.3 Cheetah population dynamics

1.3.Lifespan of cheetahs. Female cheetahs in Mara Ecosystem live longer than males. Maximum documented age for males is 11 years while for females is 13 years. By March 2021, out of 29 females of reproductive age, 8 females, who had previously raised offspring, consider old: 2 females Miale (F7) and Rani (F8) were 13 years old, Amani (F3) was 12, Kakenya (F19) and Ropili (F52) were 11, and 3 females: Nora (F42), Imani (F50) and Kiraposhe (F56) were 9 years old. Seven females were 6 years old, and 9 females were 3 to 5 years old.

Young females usually lose their first, and very often several litters before gaining parental experience. For example, 4 females (F7, F8, F50, F51), raised their first litter after reaching 6 years of age, and it became the only one raised in their lifetime. Nine-year old Nora (F42) successfully raised one cub only when she was 4. She had been mating with different males since, and gave birth but was losing cubs within 3-5 months to predators.

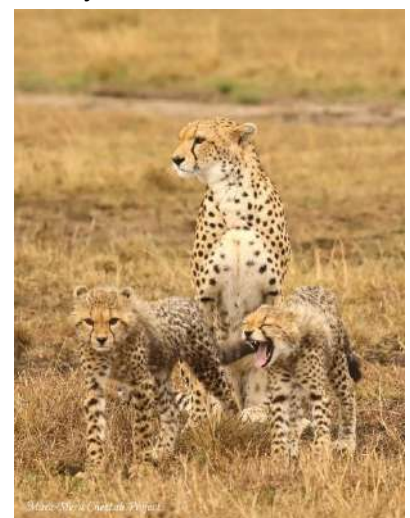
Old females (10-11 years) can conceive, but have no chances to raise litters to independence due to tremendous efforts dedicated to providing food and protection of the offspring in the areas inhabited by their resource competitors – lions, hyenas, leopards etc. Thus, a quarter (25%, n=8) of adult females are unable to contribute to the genetic diversity of the cheetah of the Mara Ecosystem. One of these females is 12-year old Amani (F3) – the most successful female in the Mara to date, who has successfully raised to independence 9 cubs – 6 females and 3 males. (Pic.6).

Some females managed to raise only male cubs, like Miale, Rahisi, Naretoi and Naserian, although there were female cubs in their litters. (Pic.7,8)

Below, are examples of Family Trees for different Mara cheetahs, where blue colour box – **males**, yellow – **females**, green – **cubs**. Cheetah name/ID number in black – alive by March 2021, red colour indicates individual dead/missing for over 2.5 years by March 2021.

Some mothers raised more males than females, like Rosetta and Malaika. (Pic.4,5). Probably, in the Mara, survival rate of female cubs might be lower, than of males. To continue the bloodline, females have to produce and successfully raise females in each generation. One of the good examples is Shakira's family tree: she raised 3 females in two litters, two of her daughters raised at least one daughter each, and each generation had at least one female. To date, we are observing 6th generation of Shakira's family.

One of Shakira's descendant is 5-year old female Nashipai (F69), whose case is very important for the continued pedigree. After the car accident in 2017 (when she crashed at full speed into a tourist car, which quickly drove off-road through the bushes), she recovered within a month, mated and conceived, but could not raise offspring due to absence of milk (For details see 2019 Progress Report).

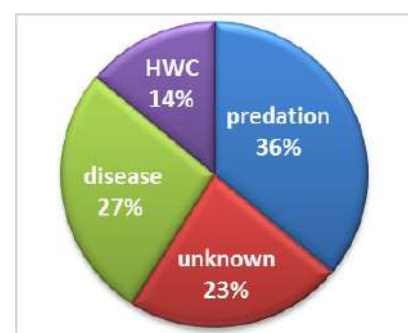


Pic.4 Nashipai with two cubs

There is a possibility that severe stress in a collision with a vehicle and a head (brain) injury caused disorders in the production of hormones that trigger milk production. After almost three years of continuous unsuccessful attempts, Nashipai finally was observed in the beginning of July 2020 breastfeeding two healthy 2.5 months old cubs (male and female) in the Reserve. By the beginning of February 2021, Nashipai with the cubs had already covered vast area of the Reserve and moved to the adjacent conservancies – OMC and later – to Naboisho. During lockdown she was in the Reserve (Pic. 4).

Although the predator impact on cheetah cubs survival was still significant, reduction in human disturbance during lockdown positively affected the number of cubs who had reached the end of the year. Such that by the end of 2019, 7 females were raising 25 (1 to 6) cubs, while by 31 December 2020, 12 females were raising 28 (1 to 4) cubs aged from 3 weeks to 12 months.

1.4. Causes of death. Since 2012 to date, 22 (11.11) adult cheetahs died of different causes, majorly of predation (See Table 1 for the details). No deaths recorded in 2020.

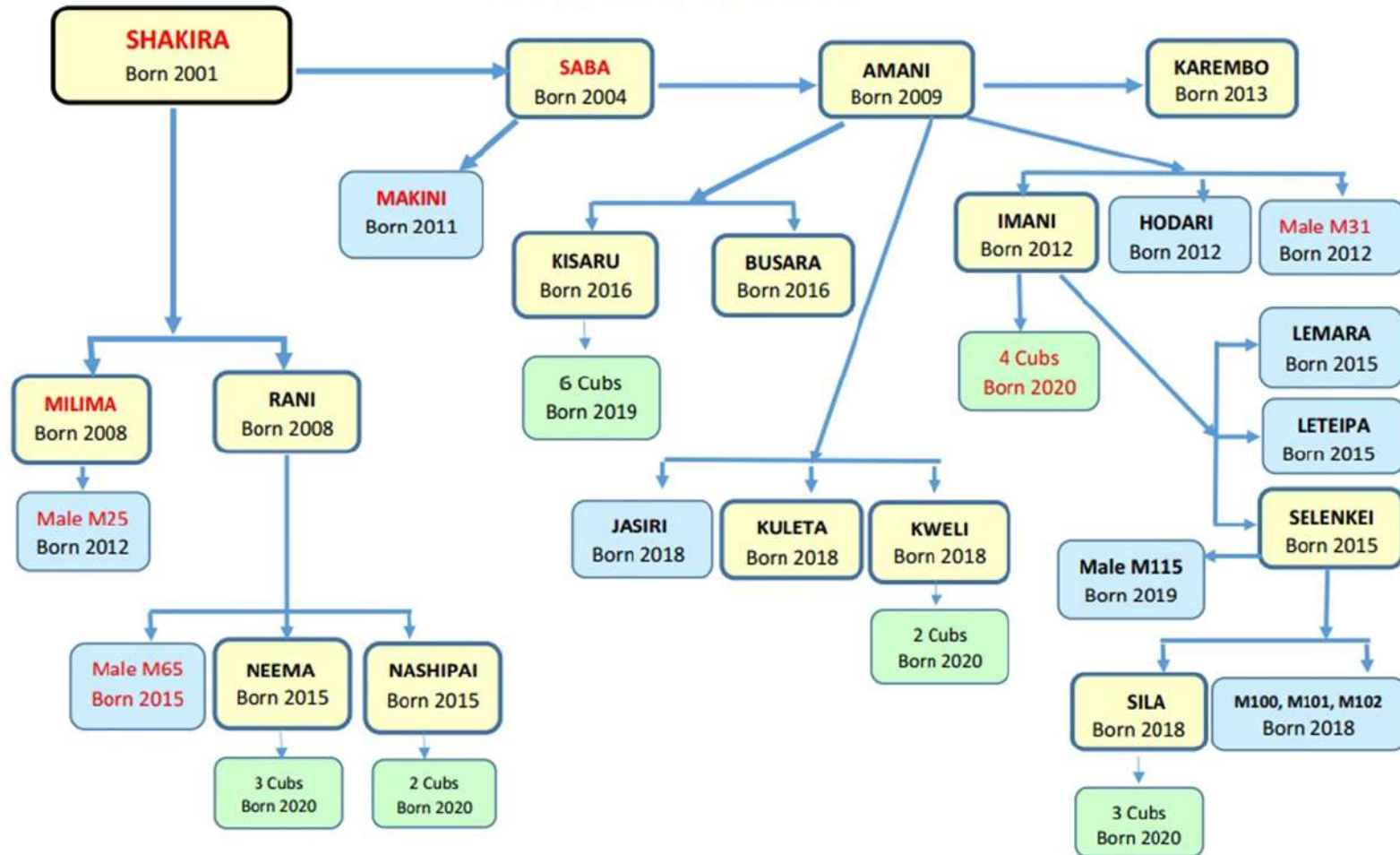


Pic 5. Proportion of causes of cheetah deaths

Table 1. Death cases documented from 2012 to date

Year	Total number	ID	Details	Age (years)	Cause of death
2012	1 (0.1)	F9 Resy	Single female	13	Unknown
2013	2 (1.1)	M1 Honey Boy	One male from a coalition of 2	7	Predation (lion)
		F2 Hanna	Female with cubs	5	Predation (lion)
2014	6 (4.2)	M26, M27 Kisiri's Sons	Two males in a coalition of 2	3	Infectious disease
		M4 Oloololo Brother	One male from a coalition of 2	5	Infectious disease
		M34	One male from a coalition of 2	3	Heart failure
		F4 Sidai	Single female	10	Predation (leopard)
		F5 Saba	Single female	10	Unknown
2015	1 (0.1)	F16 Narasha	Single female	12	Predation (lion)
2016	1 (0.1)	F39 Nabiki	Single female	6	Unknown
2017	2 (1.1)	M38 Chiko	Single male	4	Predation (lion)
		F57 Malkia	Last trimester of pregnancy	3	Disease
2018	5 (2.3)	M5 Martin (Oloololo Brother)	Single male (previously a member of a coalition of 2)	10	Predation
		M47	Single male	unk	Predation (lion)
		F64 Naretoi	Single female	4	Disease
		F13 Malaika	Single female	10,3	Possibly drowned
		F40 Kisiri	Single female	Appr.9	Unknown
2019	4 (3.1)	M16 Siriwua	Single male	11	Predation (lion)
		M68, F79	Littermates	2	HWC in Tanzania
		Cub of F85	Sub-adult cub male with the mother and littermates	1	HWC Road accident

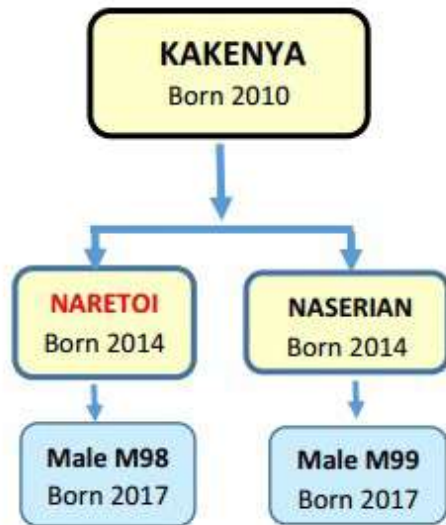
PEDIGREE SHAKIRA'S FAMILY TREE



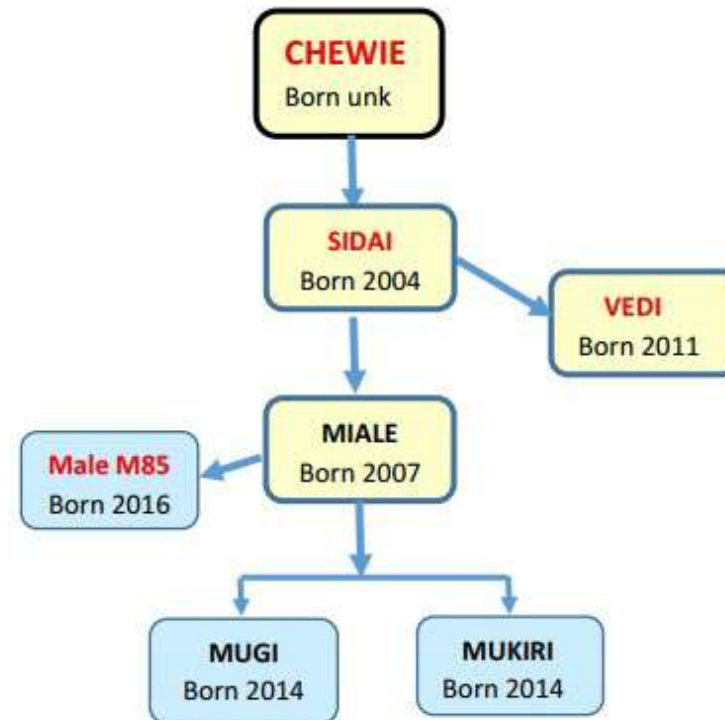
Pic. 6 Example of Pedigree of Shakira

PEDIGREE

KAKENYA'S FAMILY TREE



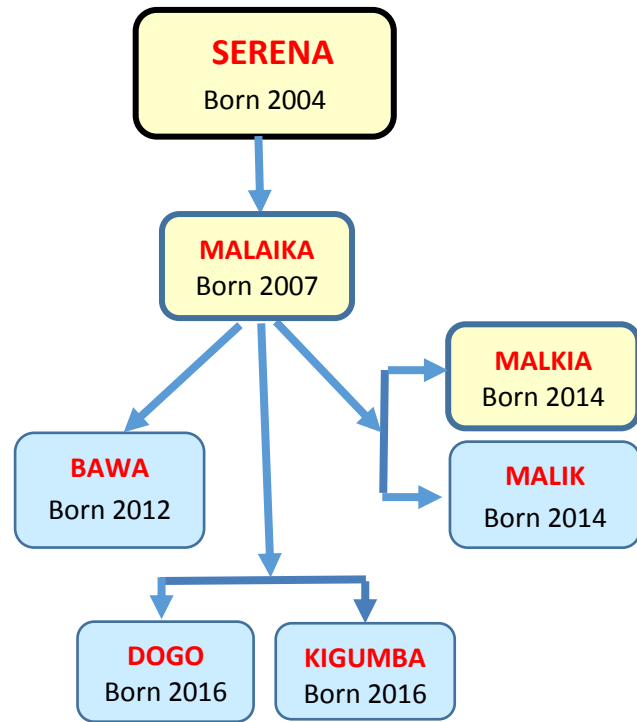
CHEWIE'S FAMILY TREE



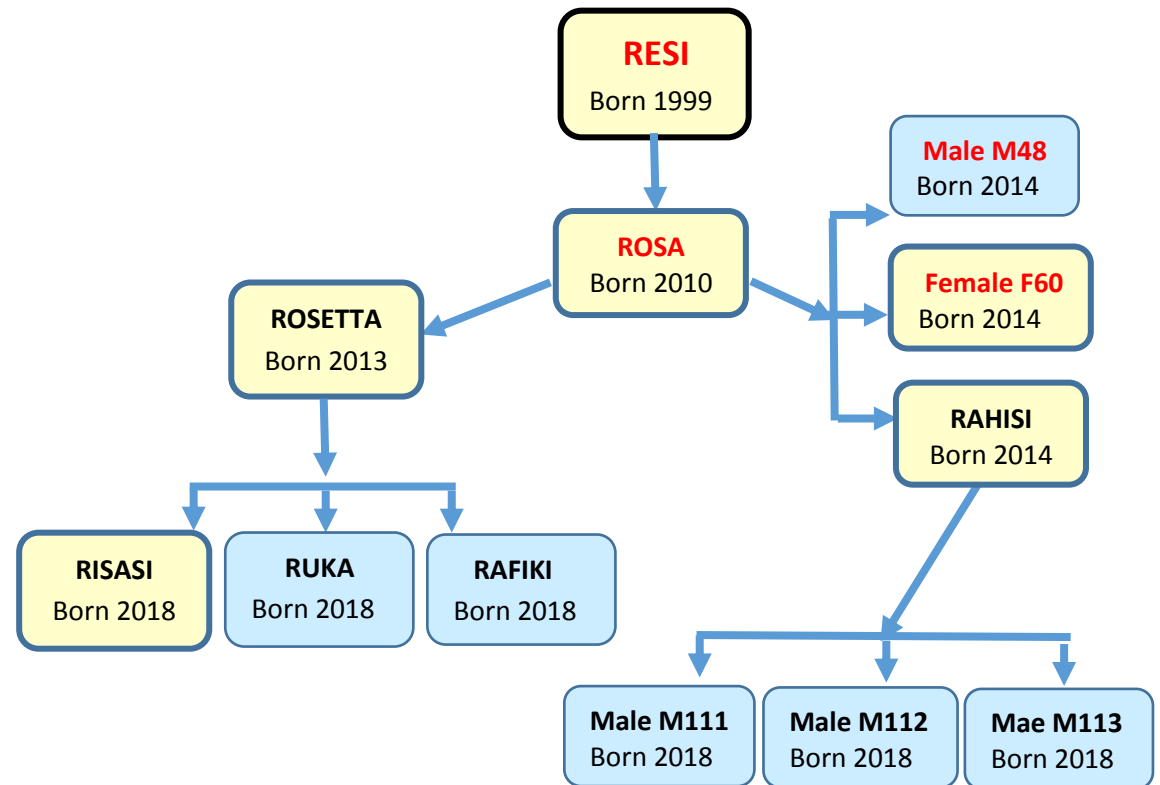
Pic.7. Example of Pedigree of two females: Kakenya and Cewie

PEDIGREE

SERENA'S FAMILY TREE



RESI'S FAMILY TREE

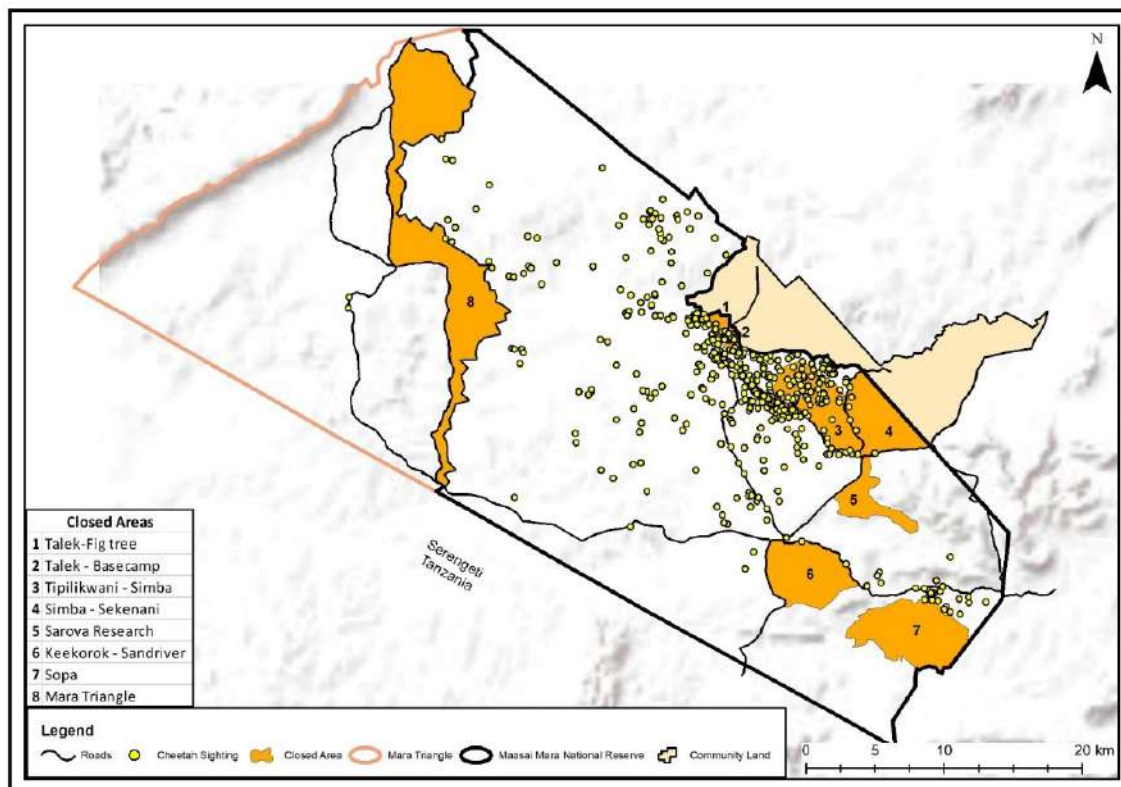


Pic.8. Example of Pedigree of two females: Serena and Resi

II. TERRITORY UTILIZATION

2.1. Territory utilization. From 2012 to date, out of 187 (117.70) identified adult individuals observed in the Mara Ecosystem, 73% utilized the territory of the Reserve and Triangle (1,510 km²), surrounding Conservancies (1,500 km²), and areas at the Tanzanian border, while 27% (n=50, out of which 24 males and 26 females) have not been spotted in the Reserve. It should be noted that, despite the different total number of cheetahs in the Mara in different years, this ratio remains stable and percentage of individuals who do not visit the Reserve maintains within 27-28% year to year.

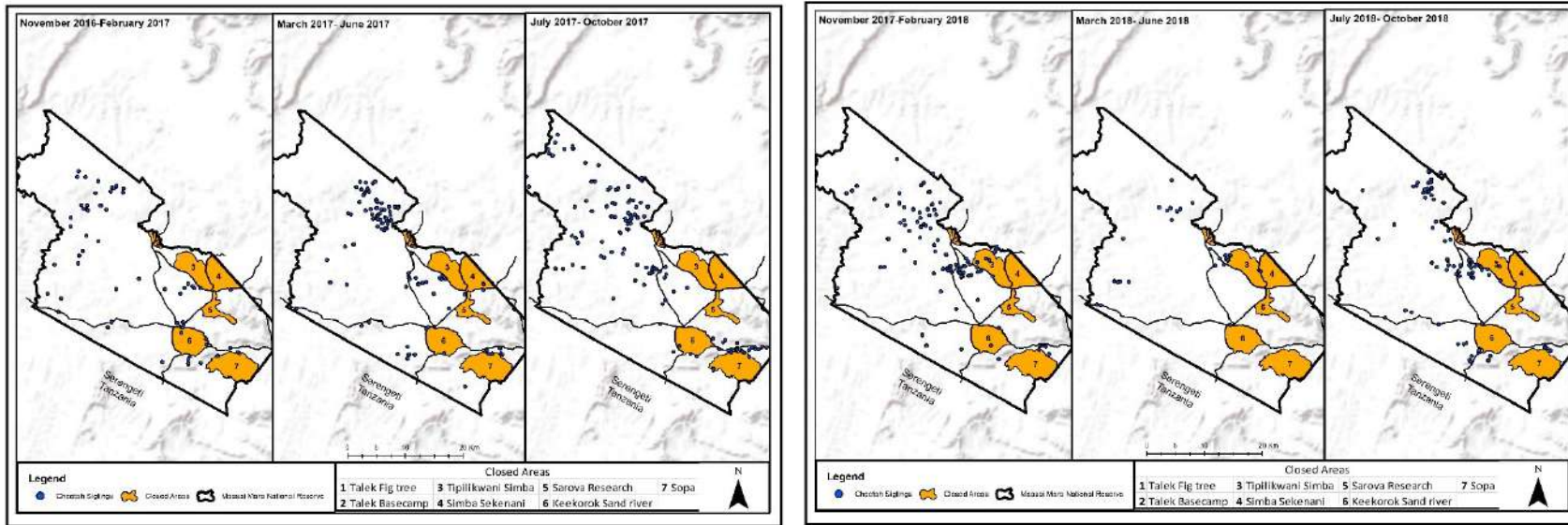
2.2. Cheetah distribution in the MMNR. Population monitoring is key to wildlife conservation and management. Our long-term observations (Linden et.al 2020) revealed a trend in the spatial distribution of cheetahs in the MMNR. In 2005 and since 2012 to date, Talek area (Zones 1,2,3) has been one of the most visited areas of the Reserve (Linden et al, 2020). The year 2020 has supported this trend (Pic.9-11)



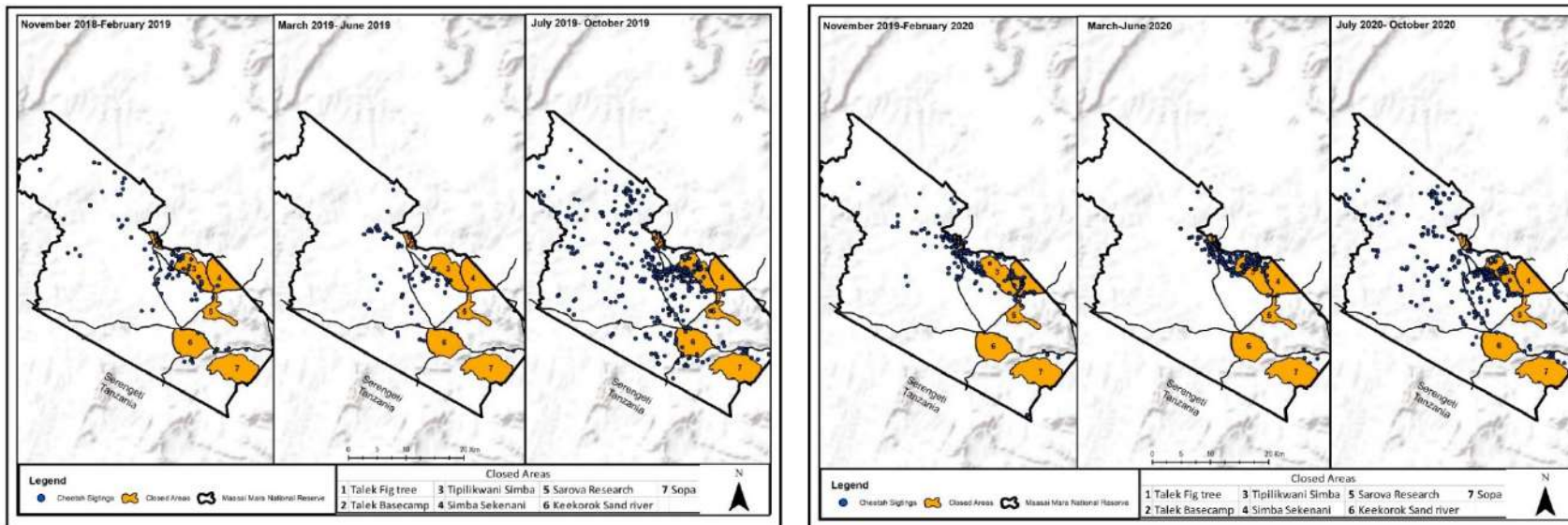
Pic..9
Cheetah
distribution
in MMNR
in 2020

2.3. Cheetahs' distribution in the Maasai Mara National Reserve. The following factors and their combinations contribute to cheetah movements, distribution and affect the size of their territories/home ranges:

- * Availability of suitable habitat (landscape; vegetation; rivers; roads)
- * Environmental conditions (weather; burning of the area etc.)
- * Availability of appropriate prey
- * Cheetah population density
- * Presence and activity of other predators and conspecifics
- * Social, health and reproductive status (single or in a group; lone after losing coalition-mate, mothers with cubs, couples/groups in courtship)
- * Age
- * Personal experience and success
- * Human activity in the area, the level of disturbance (tourists following animals during hunting or raising cubs etc.) and tolerance towards humans (tourists, and herders with livestock, locals on foot and on transport)
- * Conservation status of the area (protected/not protected).



Pic.10 Cheetah distribution in the MMNR during three periods in 2017 and 2018



Pic 11 Cheetah distribution in the MMNR during three periods in 2019 and 2020 (before lockdown, during and after lockdown)

Comparison of cheetah distribution in the MMNR for 4 years (2017-2020), shows that it is fluctuating within a year. Cheetahs utilize the whole territory of the Reserve from July through February. This trend documented over the years (See Pic.10,11). Cheetah space use in the Reserve for the years 2019 and 2020 was similar for two periods: July-October, when annual Wildebeest migration occurs and tourist visitation is the highest, and November-February. In 2019, cheetahs used closed zones during these periods more than during low tourist season (March-June). The difference between the two years was low utilization of closed zones during the long rainy season of March-June 2019, and high utilization during the lock-down in 2020 (Pic.11). From November 2019, cheetahs started intensively utilizing Talek area with maximum concentration from March through June 2020. This was most probably due to heavy rains from November 2019 throughout June 2020.

Cheetahs have been known to seek competition refuges within a landscape with low densities of lions and spotted hyenas. However, a combination of certain environmental factors can change things. Regular rains in the Mara since November 2019, and heavy downpours in February 2020, made many parts of the Mara inconvenient for various species of animals, including ungulates and predators, driving them to more suitable areas. Many areas were covered with tall grass while some became swampy. As a result, large herds of antelopes occupied fields of the Talek gate closed area of the Reserve, where the grass was short. It is likely that the abundance of prey reduced intraspecific and interspecific competition, whilst absence of human disturbance led many cheetahs to stay and regularly hunt in the Talek gate area. In general, by February 2020 and throughout lockdown, till the mid-July 2020, when resumption of tourism was slow, different cheetah individuals and male coalitions concentrated in the closed areas: Fig Tree-Talek-Basecamp-Tipilkwani (Zones №1,2,3) (Pic.11 left, middle).

During one week of February 2020, in the area of 9.5 sq. km of the Reserve, from Fig Tree camp towards Maji ya Fisi and to Ilkeliani camp, we observed five different cheetah females: Imani (F50), Miale (F7), Nora (F42), Rosetta (F51) with 3 cubs and Busara (F73) (whose territory covers Musiara area and the Mara Triangle). In a few occasions, females were 150 m apart and this did not seem to bother them. Next week, apart from a few females, we also found in the same area eight males: the five male coalition (Tano Bora, 5M), coalition of two males Mkali (M66) and Mwanga (M67) and a single male Olchorre (M81), who was usually roaming on the side of the Double Cross.



Pic. 12. Tano bora on 18 April 2020 in the wet area of the Reserve

In July-October 2020, grass became short throughout the reserve due to migrating wildebeest herds, actively eating grasses. This, in turn, influenced the movement and distribution of predators, including cheetahs, some of which followed their prey. Consequently, cheetahs started moving to different parts of the Reserve



(Pic. 7 right). During wildebeest migration period, abundance of prey most likely reduces interspecific competition, and cheetahs feel more relaxed in the presence of their major resource competitors – lions. (Pic.14)

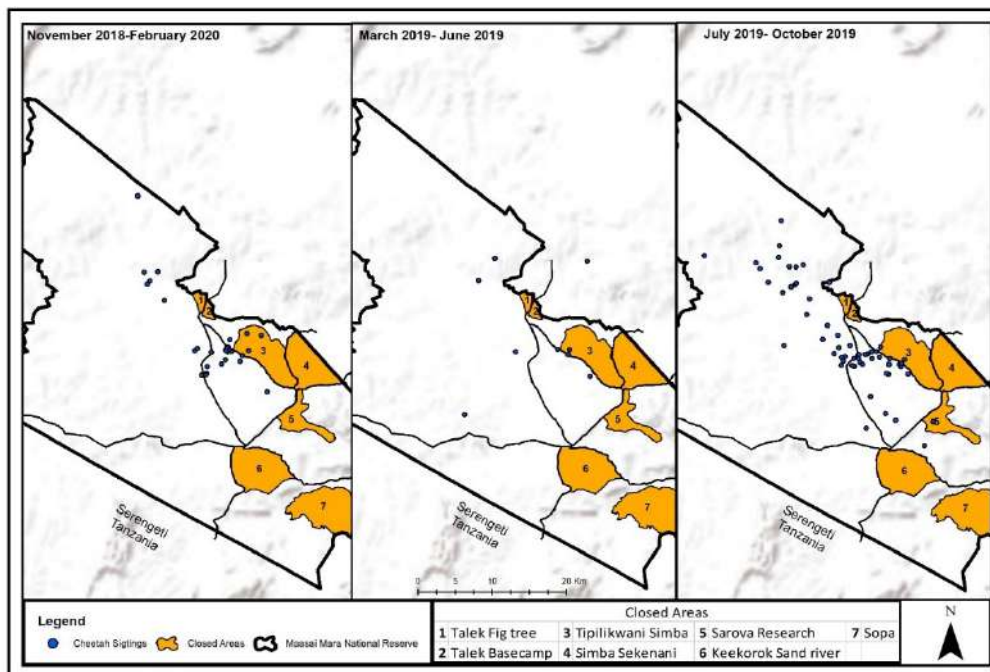
Pic.13. Tano Bora drinking



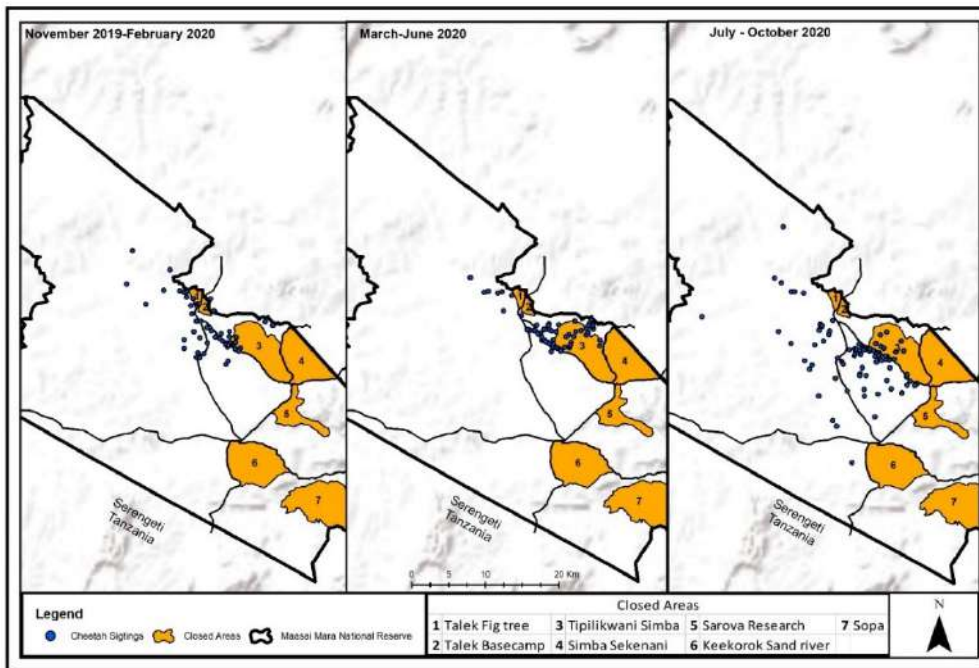
Pic. 14. Nashipai watching a lion at a kill. Her cubs are left in 60m behind hidden in the tall grass (08 October 2020).

During the lockdown period, 5 mothers split with their sub-adult cubs, who started exploring the territory of the Mara, including the Reserve. Consequently, 6 males and 3 females have been observed in the Zones 1,2,3 of the Reserve: 3 cubs of Rosetta (2.1), 3 cubs of Rahisi (3.0) and 3 cubs of Amani (1.2). Also, two males – Mkali (M66) and Mwanga (M67) were actively using these zones during February through September 2020.

2.4. Five male coalition Tano Bora (5M). In November 2020 - February 2021 period they mostly utilized closed zones 1 and 2, whereas in March through June mostly concentrated in zone 3. These areas were part of their territory, and also were rich in prey (Topi, gazelles, Impalas) due to presence of short grass. The other areas were covered with tall grass and were wet due to heavy rains. From July 2020, they expanded their movement range towards Keekorok area, following Wildebeest migration. (Pic.15, 16). During this period, 5 males mostly hunted Wildebeests and were looking for them in the wide areas of the reserve.



Pic.15 Cheetah male coalition Tano Bora (5M) distribution in the MMNR in 2019



Pic.16 Cheetah male coalition Tano Bora (5M) distribution in the MMNR in 2020 during three periods before, during and after lockdown

2.5. Cheetahs in closed areas. Closed areas of the Reserve are actively used by new sub-adults, who have been raised in the adjacent conservancies and explore new areas after separation from their mothers; by new shy adults, who came to the Mara from Tanzania; by females, who raise their cubs in the Reserve, and by all disturbed individuals.

Compared to 2019, in 2020 several “new” cheetahs were observed in the closed areas of MMNR (Pic.20,21) including: Rani (F8), Rosetta (F51), Nashipai (F69), Busara (F73), Risasi (F84), M104, Jasiri (M108) and three Rahisi’s sons (M111, M112, M113).

2-year old Entito’s son (M104) after separation from his mother in 2019 in adjacent Naboisho conservancy, was exploring the MMNR together with his littermates – brother and sister, travelling to the central part of the Reserve. By 13 March 2020, we observed this shy male in the Zones 2 and 3 alone, where he was roaming for several days and then left. (Pic.17) Most likely, he lost his brother. He was then was using Zone 3, although it is a part of Tano Bora (5M) territory.



Pic. 17 Entito's Son

Coalition of two males Mkali (M66) and Mwanga (M67) in 2019 used Zone 4, and in 2020 expanded their home range to the north-western part of the Reserve, where in 2020 they have been sharing the area with Rosetta’s sons Rafiki and Ruka (M109,M110). Being shy, males prefer areas far from the high tourism routes, staying at north-eastern part of the Reserve (Olkiombo side) and in Zone 2 or 3 at the border with Naboisho conservancy. In 2020, when there were 1-2 vehicles on the game drive, we have been observing males hunting in the open fields of the Reserve close to Talek gate. Since tourism resumed in the area, males moved to the hard-to-reach areas. Their home range overlaps with that of the Tano Bora (5M), and males are trying to stay away from the large coalition. To avoid detection, they do not mark the territory, while carefully examining trees and other objects with the marks left by other predators, but do not leave their own scent marks.

6-year old males Tano Bora (5M) – in 2019 were using certain parts of the Zones 1,3 and 5, while in 2020 they started utilizing the whole Zone 3, which became their preferable part of the Reserve and controlled territory. In 2020, in the Zone 3, they had several interactions with different

individuals: a male Jasiri (M108) and females (F7, F51, F69, F84). During the Wildebeest migration, they also moved randomly towards the Look-out and Sand River areas.

4-year old Busara's (F73) home range used to cover areas from the northern part of the Reserve towards the conservancies and the northern part of the Mara Triangle. In 2020, she was actively using the Zone 2, where she has been staying for a while before moving toward the Zone 3.

12-years old Rani (F8) also uses Zones 2 and 3, but her home range extended to almost the whole Reserve. Being born in the Mara Triangle, she visits it several times a year, although her main territory covers the western part of the Reserve close to the Mara Triangle.

7-years old Rosetta (F51) in 2019, when had small cubs (F84,M109,M110), was raising in Zones 3,4 and 5, where no vehicles could disturb them. In 2020, with the same grown-up cubs, she was staying in Zones 1, 2 and 3, and left them in March 2020 in Zone 4. After leaving the cubs, she was staying in Zones 3 and mostly 4.

Siliqi (F63), who was raising her 7 cubs in the Zones 3, 4 and 5 in 2019, by 24 December lost one cub and moved to the south towards Sopa. By 13 January 2020, she had 4, and 8 days later only 2 cubs. By mid-2020, she had been seen with only one cub at Sopa area, adjacent to Serengeti. In 2020, she was randomly spotted only there till she disappeared in Serengeti by October 2020.

5-years old Nashipai (F69) – in 2020 actively used Zone 3 for raising her litter of 2. She preferred to stay in that area for 2 weeks, sharing the area with Tano Bora (5M) coalition, with whom she met several times. Obviously, the benefits of being in this area outweighed the risk of meeting the group of males, since they never attempted to injure the female or kill the young. Her sister Neema (F68) in 2020, was roaming mostly in the MNC (where in the mid-March she had a litter in the hard-to-reach rocky area). By the beginning of August 2020, she came to the OMC, where a few days later at the border with the Reserve encountered male M99 – son of Naserian, who had raised him in Serengeti and the Mara Triangle. After exploring north-eastern area of the MMNR (Double Cross), by the mid-August she left to the OMC.

Sub-adult cheetahs, who had separated from their mothers, also have used the closed areas (Zone 1, 2, 3, 4, 5, and 6):

Rosetta cubs: In 2020, Risasi (F84), Rafiki (M109) and Ruka (M110) have used zone 1, 2 and 3 for the first few months after they had separated from their mother (Pic.17). They were familiar with those territories, because spent significant time there with their mother. The brothers then moved to the northern part of the Reserve (Rhino ridge area) and the sister was left behind moving between Zones 1, 2, 3 and 4. By the beginning of 2021, she settled in Zones 2 to 3.



Pic.18 Ruka and Rafiki (Rosetta's sons)

Rahisi's cubs (M111,M112,M113) have been raised in Tanzania and Southern part of the MMNR, including Zone 6. In November 2019 they have been roaming in Olderkesi conservancy in the south-eastern part of the Mara, next to the Cottar's camp together with their mother. After separation from the mother, 3 shy males have been spotted at the Olarro conservancy on 6 April 2020, and on 8 May 2020, appeared in the Reserve for a short time and only in Zone 4. After short visit to the MMNR, they started travelling across the Maasai Mara, and by early August 2020, came to the MNC, and later to Lemek conservancy.

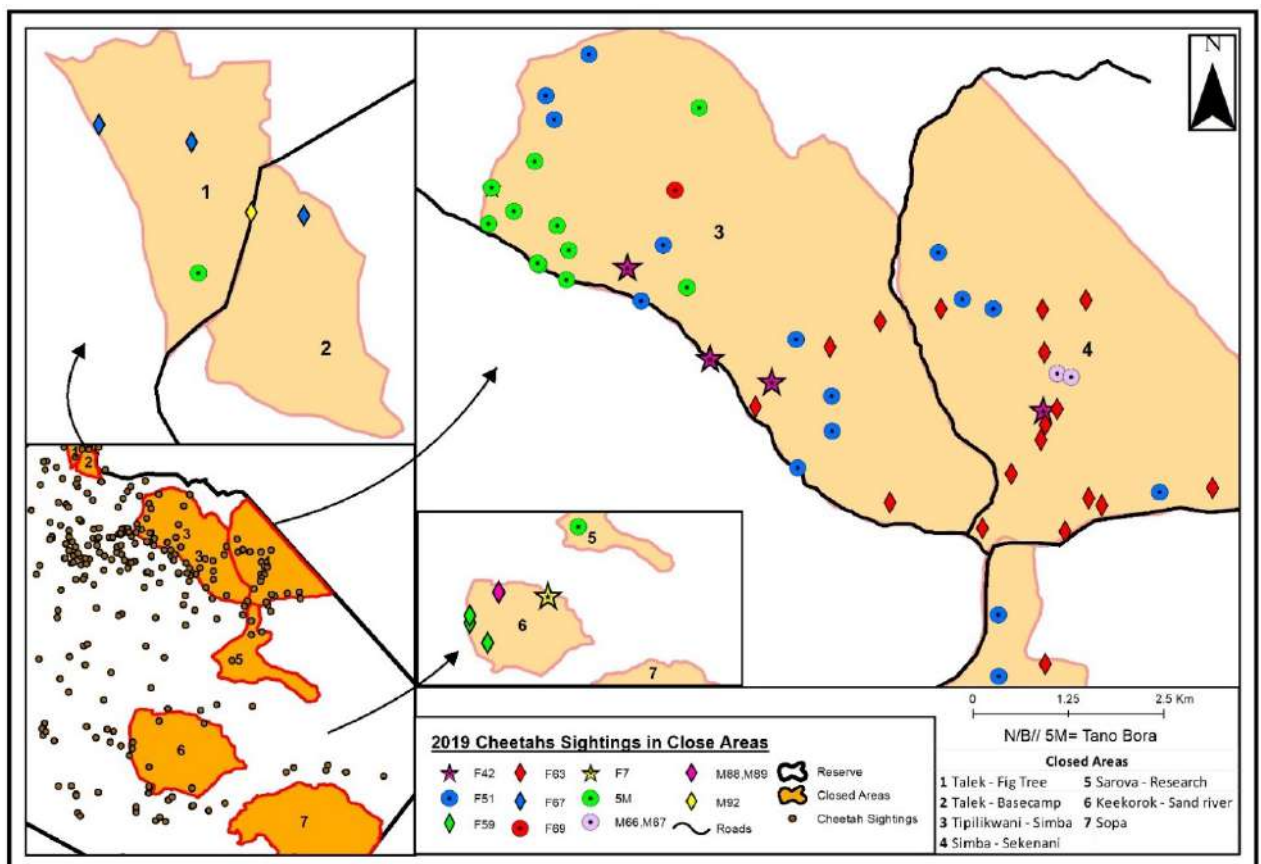
Amani's son Jasiri (M108) the son of Amani, who had already separated from his sisters Kuleta (F82) and Kweli (F83) by April 2020, came to the Zone 3 and was staying there for several days till Tano Bora (5M) came across him (Pic.66). He then moved to the south-eastern part of the Mara, and by early June 2020 was at Olarro conservancy, and in the end of September – at Siana conservancy. Been raised in the northern conservancies of the Mara, his sisters Kuleta (F82) and Kweli (F83) have been roaming through the Mara North, Olare-Motorogi and Naboisho

conservancies. Since they dispersed with the brother, Kuleta was seen mostly in the Naboisho conservancy, adjacent to the Reserve. Kweli came to the Reserve (part close to the OMC conservancy) in the end of August 2020 for two weeks with her two 2-months old cubs. She also preferred places with less tourist disturbance, but always was followed by vehicles, and in three days after losing one of the cubs (most probably to predators) in the beginning of September, moved to the OMC and further to MNC.

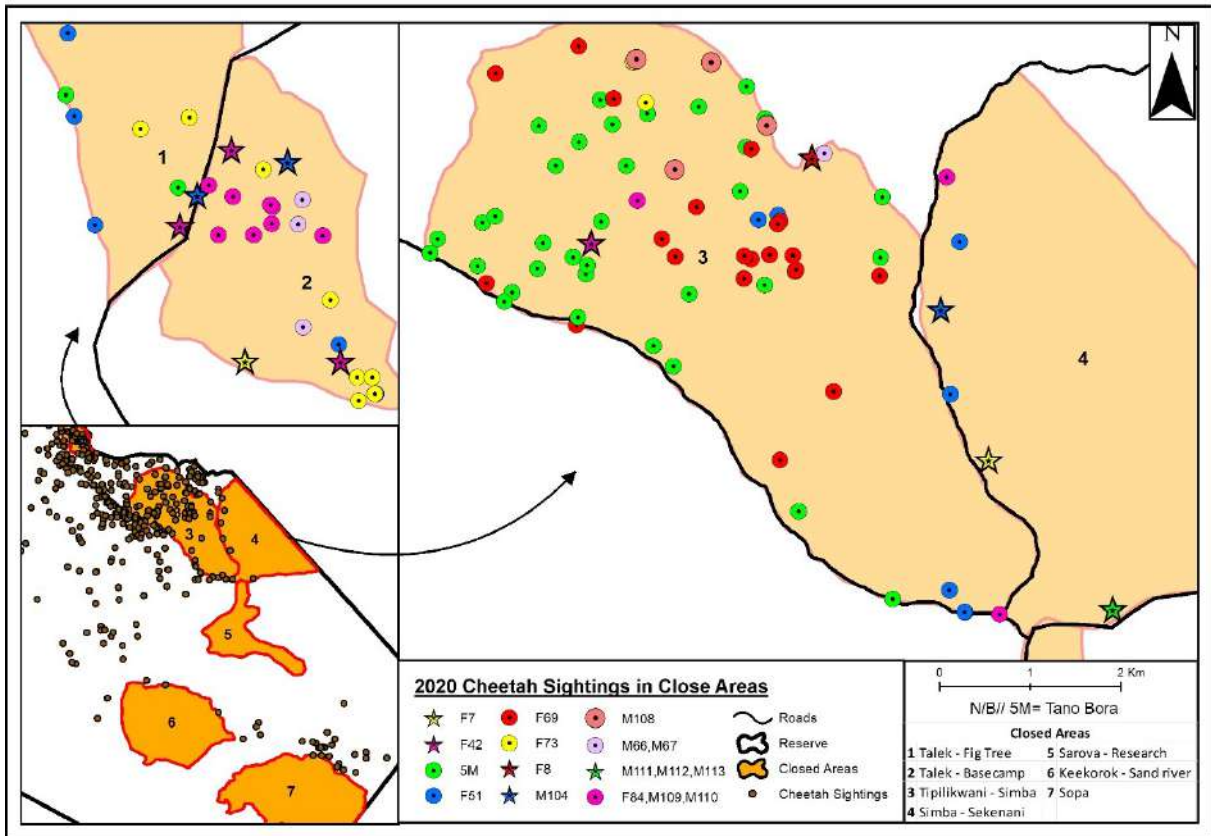
Closes areas play important role for all cheetahs in general. Since they are low use zones, there is minimal movement of cars there and hence no or minimal disturbance from visitors. Females with cubs use those areas to train their cubs to hunt e.g. Rosetta and Rahisi used to train their cubs how to hunt in zone 6. Sub-adults also go to the close areas after they separate from their mothers and stay there for some time. Absence of disturbance increases their hunting success. Success rate of cheetah hunts is high in the close areas. Most importantly, the close areas are refuge for shy cheetahs, they get a place to stay until they adapt to cars. After tourism resumed in the Mara in July 2020, cheetahs started using closed areas as refugee areas. For example, after 4 months of absence of vehicles following Tano Bora coalition, it took males time to get use to the cars again. In the beginning of July 2020, if males were resting and many cars were surrounding them at a close distance, males would get up and move to the closed area to sleep there to avoid disturbance. After tourism resumed, Nashipai preferred to stay with cubs in the Zone 3.



Pic.19 A male in the wet area



Pic. 20 Cheetahs in the closed areas of the MMNR in 2019



Pic. 21 Cheetahs in the closed areas of the MMNR in 2020

2.6. Cheetahs of the Mara Triangle. In 2020, 8(6.2) cheetahs were spotted in the Triangle. Out of two females, one was 12-year old **Rani** (F8), who had been born in the Mara Triangle. The other female – **Kalenya** (F19) spent significant time in Tanzania. Out of 6 males one was approximately 7-years old **M59**, who has been roaming in the Mara Triangle since 2016 with rare visits to the Reserve. The other single male was 3-years old **M99** son of Naserian. In 2020 he started exploring the Greater Mara.



Pic.22 Sons of Rosetta – Ruka and Rafiki

In the beginning of August 2020, M99 was seen at the border of the Reserve and OMC following Neema (F68), and in the beginning of September – at the Rhino Ridge of the Reserve following Imani (F50). (Pic.23)



Pic.23 Son of Naserian (right) in courtship with Imani (left)

There were two male coalitions spotted in the Mara Triangle in 2020. Two 2-year old sons of Rosetta (**M109, M110**) (Pic.22), who have separated with their sister by July 2020 in the Reserve and started exploring the Mara before set up by the middle of 2020 at the Rhino Ridge area of the Reserve.

The other coalition consisted of two Lemai Boys (M91 Mwenzi and M90 Mgeni). They were last spotted together on 23 March 2020, although there were sightings of lonely Mgeni (M90) at the

Tanzanian border in the Mara Triangle in December 2019, when coalition-mates could have temporarily split for courtship.

III. CHEETAH BEHAVIOR

3.1. Hunting and feeding behavior.

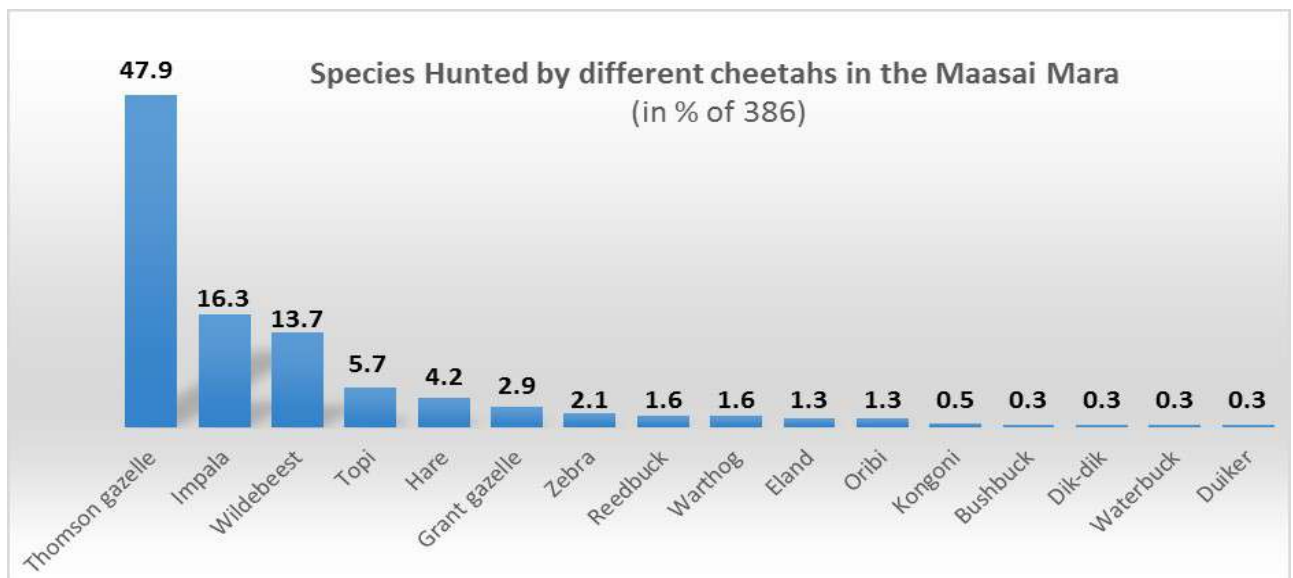
Data on hunting and feeding behavior of 68 different adult cheetahs (37 males and 31 females) was collected from 2013 to date. For the analysis, cheetahs were divided into four categories: Single male, single female, coalition and female with cubs.

We recorded 386 hunting events, out of which Single males – 35 events, Single females – 61, Coalitions – 104, and Females with cubs – 186 events.

Hunted animals were divided into three categories: Small prey (Hare, Dik-dik, Warthog piglet, fawns of Impala, Reedbuck, Grant's and Thomson's gazelles), Medium size prey (adult Impala, Grant's and Thomson's gazelles, Reedbuck, Oribi, Bushbuck, Duiker, calves of Wildebeest, Zebra, Eland, Waterbuck, Topi, Kongoni) and Large prey (adult and sub-adult Wildebeest, Topi, Kongoni, Waterbuck, Zebra, Eland). Hunting event is a successful hunt in which a cheetah alone caught and killed prey on his own. For calculating of feeding, the time from the start of eating the carcass to the moment when the cheetah stopped eating was taken into account. Cases when the cheetah was found already eating or was driven away from the carcass by competitors were excluded from the analysis. We observed 386 successful hunts on 16 different species, out of which Thompson's gazelle was hunted mostly by all four categories of cheetahs.

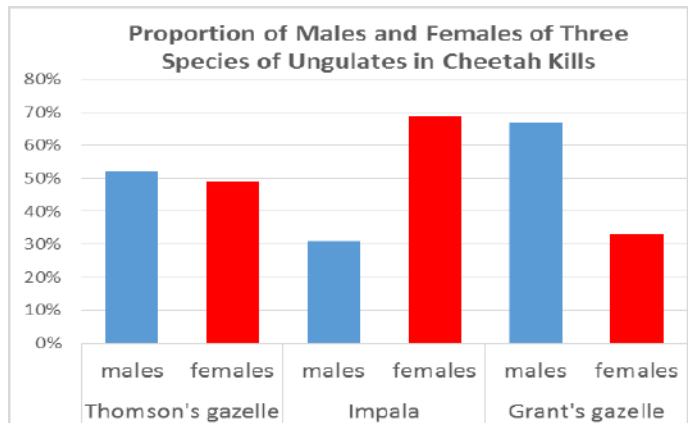


Pic.24 Tano Bora male hunting Wildebeest



Pic.25 Species hunted by Cheetahs in the Maasai Mara

Proportion of Thomson’s gazelle males and females in total intake is almost equal, while in Impalas, females hunted in 38% more cases than males, and in Grant’s gazelle proportion there was reverse ratio – males taken in 34% more than females. In most of the cases, when cheetahs were hunting Thomson’s gazelles male, it was a single individual roaming in the area, in some cases – male from the family (male, female, fawn), while females were hunted in herds and in families (male, female, fawn). Impala males were single individuals grazing next to the Thomson’s gazelle herds, or in a bachelor herds. Grant’s gazelles were least hunted – single males roaming alone or next To the mixed herd of Thomson’s gazelles and Impalas.



Pic. 26. Proportion of males and females Thomson’s gazelle, Impala and Grant’s gazelles hunted by cheetahs in the Mara

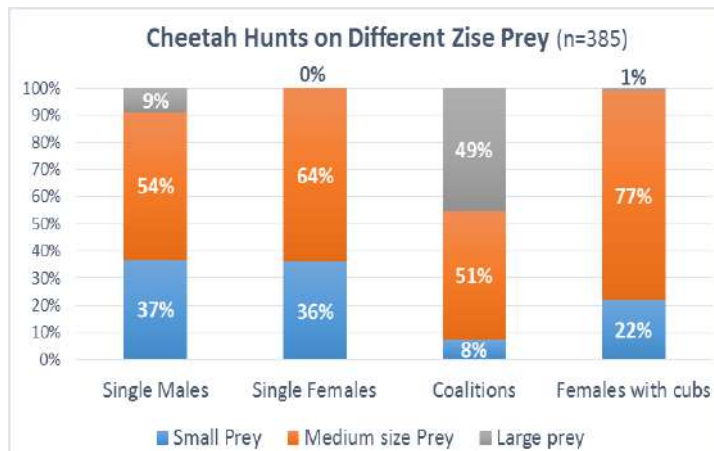
Cheetahs occasionally take domestic stock – sheep and goats. This happens to:

- * sub-adults when they explore new species to hunt or hone their hunting skills
- * females with cubs in the areas where wild prey is temporarily absent
- * sick, injured and old cheetahs unable to run with full speed

However, we found out that such cheetahs survive for a long time on small prey – hares and fawns of small and medium size antelopes. In search for food, they check all bushes, shrubs and a bunch of tall grass in the fields (Pic.32). Strong adults when injured can hunt adult medium-sized ungulates if environment allows. For example, in July 2015 in the Mara Triangle, we observed an adult cheetah male (M42) limping on the back limb, who successfully hunted an adult Impala. Noticing an Impala in a field with tall grass, the cheetah crawled crouching over 60 meters towards the prey, periodically checking the position of the antelope, and attacked the Impala from a distance of 3 meters. For such behavior, he was named by the Triangle rangers Leomom, which means Lucky in Maa language.

3.2. Size of prey.

Large size prey was hunted mostly by males in coalitions (Pic.27). Living in a group requires more food, and male coalitions have more chances to bring down large ungulates by joint efforts and shared duties during and after the hunt when they suffocate the prey. Rare recorded cases of single males taking down a sub-adult wildebeest refer to the male Martin (M5) from the coalition called



Pic 27. Proportion of small, medium and large sized prey hunted by cheetahs in the Mara in 2013-2020

Olololo Brothers, who had lost his partner and hunted alone. After Martin’s coalition-mate died on 1 October 2015, we recorded two cases when Martin successfully hunted large prey – sub-adult Wildebeests – on 7 October 2015 and 4 August 2017. Life in a group is useful in that the skills acquired in joint hunting help the male, who has lost partners, to survive later. The only one case of female with cubs taking large prey was on 13 October 2018, when Naserian (F65) with 2 sub-adult male cubs killed sub-adult Wildebeest.

Proportion of medium-sized prey is the highest out of three prey size categories successfully hunted by all categories of cheetahs. This is most probably due to variety of prey species and abundance of ungulates in the Maasai Mara Ecosystem. For females with cubs, medium-sized prey is the major source of food, as it requires adequate hunting efforts and is able for a short time to feed a family of 7 cheetahs - female and 6 adolescents, at least for one day.

Small-sized prey equally taken by single cheetahs of both sexes, and least taken by males in coalitions. For single males and females, most often it serves as the source of the only available prey in the area, if the cheetah young (began an independent life after separation from the mother), adult but not skilled hunter, weakened or wounded.

Additionally, for single females, small prey becomes the major food for females in the last trimester of pregnancy. A cheetah with a full belly, it is difficult to determine whether the animal has a hearty meal or is pregnant. Our long-term field observations revealed, that hunting (especially small prey) by a female with full belly is reliable indicator of pregnancy. An additional indicator is if the large size of the female's abdomen remains unchanged for several days – if the same cheetah can be found for a few consecutive days.

Females with cubs use small prey – majorly hares and fawns of Thomson gazelles and Impalas for teaching cubs hunting.



Pic.28 Tano Bora taking down adult Wildebeest

3.3. Gazelles and Impalas kills. Of all the medium-sized ungulates that cheetahs prey on, three species – Thomson's and Grant's gazelles and Impala's males armed with long horns that can be dangerous for the hunter. Of the 195 cases of hunting medium-sized ungulates, all cheetahs hunted more often Thomson's gazelles, than Impalas, and the proportion of Grant's gazelles was the lowest. (Pic.26).



Pic.29 Cheetah suffocates Thomson's gazelle male

Single cheetah males hunted equally males and females of Thomson's gazelles. We have not recorded cases of cheetah males hunting male Impalas and female Grant's gazelles, although one male from a coalition could initiate a hunt by chasing a male Impala, but taking down and suffocating would be done by 3-4 coalition-mates (Pic.30). Therefore we counted such events as coalition hunts rather than single cheetah male hunts. However, singletons successfully were taking down Grant's gazelles males.

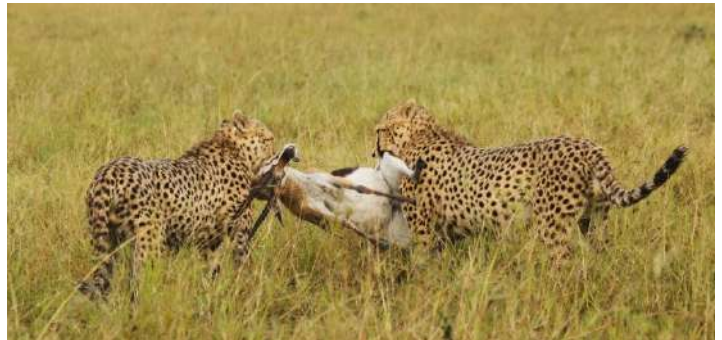


Pic.30 Two males of Tano Bora (5M) suffocating Impala male

Single cheetah females were hunting more females than males of Thomson’s gazelles and Impalas, but more males than females of Grant’s gazelles. Out of all cheetah categories, females had the highest proportion of hunts for Thomson’s gazelle females.

Cheetah male coalitions hunted more males than females of all three species of ungulates, with no cases recorded of them taking down Grant’s gazelle females.

Of all cheetah categories, only cheetah females with cubs hunted both sexes of all three species of ungulates, with the higher proportion of male than female Thomson’s gazelles (2% difference). They were killing half less Impala females than males. The proportion of males and females Grant’s gazelles kills was equal, but the lowest among three ungulate species taken by females with cubs. This could be due to the fact that having dependent members of the family, females have to consider any ungulate that falls within the weight and size range of typical cheetah prey.

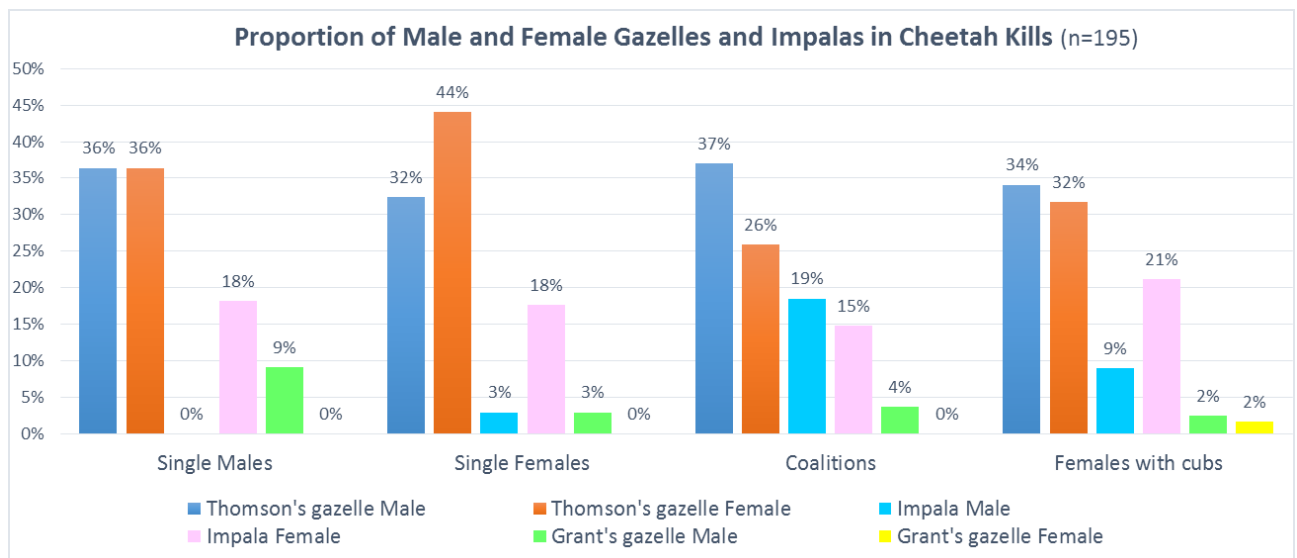


Pic. 31 Two males of Tano Bora carrying the kill – a male Thomson’s gazelle



Although we have not recorded cases of single cheetah females, lonely males and coalitions taking Grant’s gazelle females, they cannot be excluded from the list of cheetah prey because they are in the range of sizes and weights of ungulates that cheetahs prey on.

Pic.32 Young cheetah is examining the bush looking for hares



Pic. 33 Proportion of male and female of three ungulate species in cheetah kills

3.4. Hunting strategies. During our long-hour behavioral observations, we recorded variety of hunting strategies which cheetahs use depending on:

- * Cheetah’s age, skills, experience, group composition, health status
- * Type and size of prey, its number and distance
- * Environmental conditions (terrain, vegetation, weather etc.)
- * Presence of tourist vehicles and their movements

Single hunter uses following strategies**I. Direct chase:**

1) In the open field with medium size grass or with mosaic bush/shrub vegetation, cheetah stalks the distant prey (250-300 m), slowly approaches, periodically freezes and again crouches towards the prey, keeping an eye on the selected hunting object, hiding behind bushes and start full-speed chase from 60-15 meters.

2) In the tall grass field, cheetah walks crouching towards the prey and ambushes from the short distance 10-5 meters. In both cases cheetah is hiding in a tall grass or behind bushes or tall trees.

We observed multiple time (especially during Wildebeest migration) Tano Bora (5M) coalition lying down on the road in between or under tall trees, thereby getting the opportunity to inspect the fields on both sides of the road in anticipation of a convenient moment for hunting, when the herd will get closer or will cross the road to the other side.

II. Confusing run:

1) Cheetah walks across the field towards or in between ungulates in the herd with no visible intention for hunt. In most cases, antelopes start following the cheetah at a distance, making distant alert calls. If the fawn of the antelope starts running towards the mother, cheetah starts running same direction, so that the fawn crosses the path in front of a cheetah, which catches it.

2) In front of the line of bushes (along the river/ravine) cheetah hides behind the bush opposite the vegetation line, waiting for the antelope to approach and once it stops/walks right in front, cheetah runs forward, but not directly at the antelope, but away from it. At some point antelope changes direction and for a few seconds runs "after" the predator. In this way, the predator shortens the distance, cutting the path of the antelope (Pic.34)

Group of cheetahs use the following strategies:

1) **Direct chase**, which can be performed by one member of the group (male coalition or female with sub-adult cubs) with others joining the hunt immediately or with a few seconds delay. We observed it in all coalitions and cheetah families.

2) Prey confusing hunt:

One member of the group exposes himself by sitting or standing, thereby attracting attention of the prey while other members start approaching, go around the prey from the other side and stalk. Once chase started, exposed cheetah joins the others in hunt, so that the whole group chases and kills the prey. Sometimes, 4 members of a coalition were exposing themselves and one was stalking, but eventually all members participated in the hunt. This strategy we often observed in cheetahs hunting antelopes in herds: Tano Bora (5M) coalition hunting Topi, a group of two adolescent sisters Busara (F73) and Kisaru (F74) hunting gazelles and Impalas. Interestingly, this strategy was used by two sisters for several months, which they spent together after separating from their mother. Later, Kisaru used this strategy with her own sub-adult cubs.

3) Making two kills simultaneously:

In the areas with high chance of hyena presence at the cheetah hunting site, cheetahs in the group make two kills at a time. This strategy helps to save one kill if the other one was taken by hyenas. We observed it many times in different cheetah male coalitions including Mkali and Mwanga (M66,M67), who hunted Thomson's gazelles; Tano Bora (5M), when they hunted Wildebeests and Elands, and in the female group of Busara and Kisaru, who hunted gazelles and Impalas.

3.5. Challenges of hunting.

Cheetahs encounter different challenges when hunt:

- * environmental, such as terrain, soil, vegetation, weather;
- * presence and behavior of territory competitors, including predators (lion, hyena, leopard), primates (baboons);
- * animals that interfere with hunting by alerts or direct intervention (elephants, antelopes, zebras:
- * humans (tourists, herders with livestock etc.)

Hunting in the open field might be challenging due to the wet soil or rocky ground, which prevent high-speed chase, causing cheetah abort a chase. However, cheetahs hunt in rocky terrains successfully. Although there are documented cases of cheetahs breaking legs while hunting in rocky areas (Durant et al. 2004), they are known to live and successfully hunt in rocky upland terrains and mountains of Ethiopia (Jackson & Nowell, 1996).

Hunting in a group requires cooperation of efforts right from stalking to suffocation of a kill. Disturbance at any stage may cause abandoning of a hunt. For example, we observed multiple times how tourists' behavior affected hunts of the Tano Bora (5M) coalition. When they were sitting in a field ready to hunt and looking at one direction towards the herd of Topi/Wildebeest in over 200m, all cars were on the road in over 50 m from cheetahs. Once males started stalking, if the car/cars move around and behind the prey, they stopped, turn around and look opposite direction. The same scenario repeated 3 times, and eventually, when all vehicles concentrated at one side, males started the hunt, which ended successfully. Since the coalition had been formed in the end of 2016, this situation was observed multiple times whereby 5-30 cars interfered with hunts. During lockdown months, all 22 observed hunts of Tano Bora were successful first attempts.

Hyenas often follow cheetah singletons, coalitions and mothers with cubs, periodically approaching and checking for prey. Cheetahs abort a hunt if they detect baboons or any large predator – hyena, lion or leopard.

Cheetah (or a group) passing by a herd of antelopes piques their interest. As a result, ungulates follow a predator for 100-300 meters with alert signals and run away for a short distance if the predator changes direction towards them. In 2020, we observed several cases when ungulates of one species interfered with cheetah's hunts on other species. For example, when Tano Bora coalition was trying to hunt Wildebeests in a herd, a group of adult Elands started following cheetahs at a distance, and once cheetahs started stalking, Elands ran down the field towards Wildebeests and scattered them over the field. On 5 October 2020, a buffalo chased a small group of Topi, who ran away, and Tano Bora stopped hunting. On 19 January 2021, when Sila with 4 cubs after midday rest started walking in the field, a herd of Wildebeests ran following her towards the herd of Thomson's gazelles and scared them away.

During 4 months period covering lockdown (March-June), we observed 40 hunts of 7 females, including 2 with cubs, and 13 males: 2 singletons and 4 coalitions (2-5 males), and apart from 5 cases when cheetahs missed a prey, all hunts were successful, which was 87.5% success.

3.6. Duration of the chase. Out of 36 recorded chases, the shortest took 6 sec and the longest – 55 sec. Shortest chases (6-7 sec) were recorded for females F13 and F74 when each had 6 cubs, and mostly hunted adult Thomson's gazelles and Impalas of both sexes. The mean chase duration for all prey categories was 21 sec. (Table 2).

Table 2. Duration of the chase (sec)

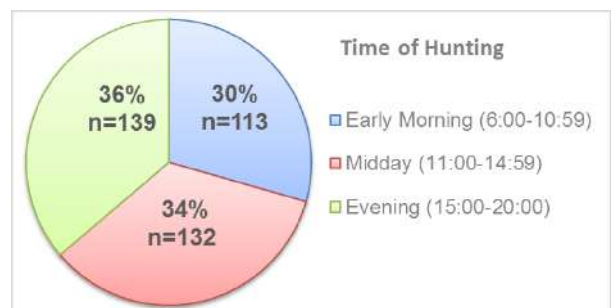
Prey category	Number of hunts	Shortest Chase(Sec)	Longest Chase(sec)	Mean Chase(sec)
Small Prey	8	0	36	21
Mid-sized Prey	24	6	55	21
Large Prey	4	0	45	21

The shortest interval between chases we recorded was 9 min 42 sec. On 4 December 2018, we observed Amani (F3) with 3 cubs. She chased at full speed adult Thomson's gazelle in a herd for 6 sec (11:57:17-11:57:23) but missed it; she stopped and walked in opposite direction. At 12:07:05 she ran at full speed and in 10 sec caught Thomson's gazelle pregnant female. It was the shortest interval between chases we have recorded since 2012 to date. Although, it is known that after the full speed chase cheetah needs a rest, and new hunt takes place in 30 or more minutes.



Pic. 34 (1-8) Prey confusing run: Female Nashipai (F69) hunting Thomson's gazelle male in front of the bush line, changing direction from running away from the gazelle to following it

3.7. Time of the day cheetahs hunt. Although it is known that cheetahs mostly hunt during early morning and late afternoon hours, cheetahs in the Mara hunt throughout the day with more kills made during the hottest hours (11:00-15:00) than during early morning hours (Pic. 35). The reason for such behavior is that cheetahs are opportunistic hunters and use every opportunity to get food, whenever prey is available, other predators are not visible and



Pic. 35 Time of the day cheetah hunt in the Maasai Mara

the level of disturbance is getting lower. In the Reserve, shy individuals, mothers with cubs and male coalitions often wait for tourists to leave for lunch and then start hunting. However, during lockdown, with no cars in the area, all 20 (13.7) cheetahs we observed hunted at any time of the day when the opportunity allowed, including the hottest hours. However, in each year overall annual proportion of 3 hunting periods and proportion of these hunting periods for 5 months (March-July) differs (Pic.36,37)

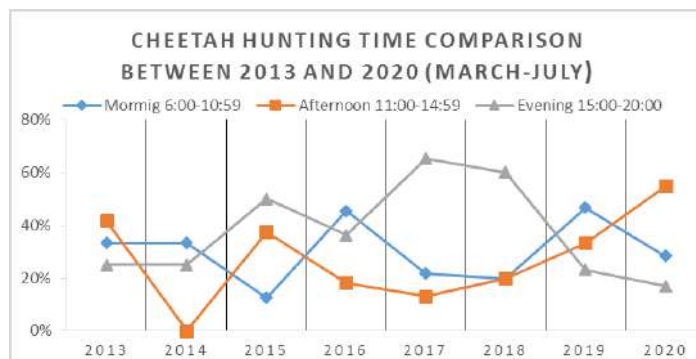
During 5-months period (March-July) cheetahs hunted more during the afternoon hours in 2013 and 2020, while in 12-month period – in 2013, 2018 and 2020. In 2014 5-months period hunting during afternoon hours was the lowest, while in 12-month its proportion was nearly equal to the evening period. This was due to lack of data on the 5 months period in 2014.

In 2015, 2017 and 2018 during a 5-months period cheetahs hunted mostly during evening hours. However in 12-month evening hunts prevailed in 2015, 2016, 2017 and 2019. Early morning hunts prevalence recorded in 2014, 2016 and 2019, but never during 12-month periods.

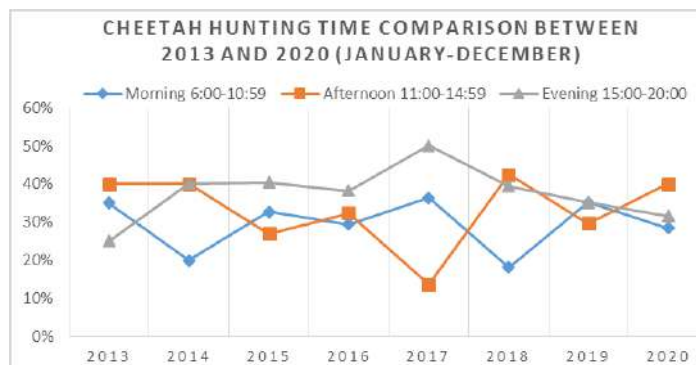
Our long-term observations give reason to conclude that cheetahs in the Maasai Mara hunt mainly during the day and evening. Cheetah food competitors, for example hyenas, are more active in the evening, and cheetahs use different adaptations:

- * do not hunt if spotted a hyena
- * make two kills at a time
- * hide kill in the bush, bunch of tall grass, between rocks and in a hall covered with grass
- * wait for hours before open a kill (morning and early afternoon kills only)
- * start eating right after killing, especially evening kills, eats fast,
- * start eating with muscular meat on the hind legs and open up the belly last
- * rake up grass over the kill with and eat in phases for long hours
- * share a kill with a hyena

3.8. Interval between hunting and feeding. In some cases, cheetahs start feeding immediately after suffocating their prey, in most cases – within 10-30 minutes. However, in some cases they wait for several hours before opening the kill.



Pic. 36 Hunting time comparison in different years during March-July months



Pic. 37 Hunting time comparison in different years during January-December

They wait for several hours before opening the kill. The reasons for such delay in feeding could be different – tiredness after fast chase or long distance to the place where cheetah had to drag its kill, hot weather and absence of shelter, very rare – disorientation (see example below), and often – presence of other predators (lion, hyena, leopard etc.).

The longest time between the end of the hunt and beginning of feeding we recorded on 13 August 2015, when 3-year old Nora (F42) killed an adult Thomson gazelle female at 11.08 and started eating in 4 hours 22 minutes. Nora spotted a hyena and was patiently waiting for the predator to leave the area. She was then feeding on a kill for 2 hours 28 minutes and left it.

In another case 21 November 2013, when Amani with 3 cubs killed an adult male Thomson's gazelle at 13.00, dragged it

into a bush and waited for 2 hours 34 min before starting to eat with cubs – she detected a hyena and was waiting for it to leave the area. In one case female started eating in 1 hour 26 minutes because she lost the spot where she had left a kill. On 7 August 2016, Malaika (F13) left her 2 small cubs in the bush and went hunting in the open field 250m away. After killing an adult female Thomson's gazelle at 13.02, she left it in the tall grass field and went for the cubs. When she led cubs to the field, she could not detect the spot with the kill, and it took the family more than an hour to locate it.

3.9. Feeding time.

The average duration of eating one kill depends on the size of the carcass, cheetah category (Table 3) and the level of comfort of the cheetah, and for all kills sizes is always lower in male coalitions and higher in females with cubs. For small-sized prey mean time varies from 24 min in male coalitions to 62 min in females with cubs. For medium-sized prey – from 98 min in coalitions to 173 min in females with cubs. For large prey – from 145 min in coalitions to 279 min in females with cubs.

The shortest feeding time – 6 min we recorded on 18 December 2017, when Nora (F42) consumed an adult hare in 6 minutes. The longest feeding we recorded – 543 min was on 4 May 2018, when Imani with 1 cub were eating adult Impala female for over 9 hours with several breaks.

The longest time of the cheetah staying at a kill and feeding from it, was 1,095 min. On 10 and 11 March 2013, when M3 killed an adult Thomson's gazelle male at 14:07:55, started eating at 14:20, finished at 18:43:04, but did not leave the carcass. Next morning we found him at the same spot feeding on the same carcass till 8:35:12, at which time he stopped eating and left. So he spent 18 hours and 15 minutes at a kill from the first to the last bite. When cheetah started eating, heavy rain began and lasted for several hours, which the male kept eating. Most probably, the weather condition became important factor allowing cheetah eating without interference – hyenas could not detect a kill because heavy downpour prevented dispersing of the smell of prey.

Single males can finish a kill within 10 minutes (warthog piglet) or eat for more than 6 hours (adult Impala female). The latter was a new shy male (M114), who made a kill in the dense forest on 1 September 2020 and dragged it to the small gap in between two Croton bushes. He ate little by little for 368 min with breaks.

Single females can finish an adult hare within 6 minutes, or eat for 8 hours: on 20 November 2018, Naretoi (F64) was eating Thomson's gazelle male for 485 min.

Coalitions eat an adult hare within 11 min, as we recorded in Mkali and Mwanga (M66,M67). The max time spent eating a kill we recorded on 2 August 2019 in Tano bora (5M) feeding on adult Wildebeest for 6 hours 25 min.

Table 3. Duration of feeding on a prey of different size (min)

Cheetah category	Small Prey				Mid-Sized Prey				Large Prey			
	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
Single Males	10	160	45	42	29	368	148	105	61	220	164	89
Single Females	6	102	47	21	51	485	154	96	-	-	-	-
Coalitions	11	34	24	8	15	311	98	68	45	375	145	86
Females with cubs	10	372	62	76	35	543	173	105	279	279	279	-

3.10. Time (min to max) cheetahs spend eating different prey:

Hare – from 6 to 45 min

Thomson's gazelle – from 15 (coalition), 68 min (single male) to 485 min (single male)

Impala – from 105 (female with cubs) to 368 min (single male)

Wildebeest – from 60 (single male) to 375 min (coalition)

Topi – from 45 (coalition of 5) to 158 min (coalition of 5)

Eland calf – from 29 min to 132 min (coalition of 5)

Zebra – from to 137 min to 340 mi (coalition of 5)

3.11. Measures to save a kill. If the kill was made in an open area, single cheetahs and females with cubs usually drag it into the nearest bush (Pic.38), shrub or hide it in a bunch of tall grass, and open abdomen after most of the muscle meat is eaten, most probably avoiding spread of a strong odor from the stomach and intestine, which can attract other predators. In areas with short grass, female drags the kill underneath her belly and during a short rest, sits over the carcass covering it with her body (Pic. 41).



Pic. 38 Nashipai drags a kill to her small cubs



Pic.39 Kisaru is carrying a kill to the secure place



Pic. 40 Kisaru is carrying a kill (left)



Pic.41 Kisaru is covering a kill during short break



If there is no shade nearby, cheetahs rake up grass, covering a kill. The carcass becomes withered in the sun, preserving it for hours, and cheetah resting next to the kill repeatedly returns to the carcass for eating. Thus, some cheetahs spend many hours at the carcass.



Pic.41 Nashipai feeding with cubs in the open field (left upper photo)
Pic.42 Feeding in tall grass (left down photo)



Pic.43 Carcass covered with grass by Female, who rests nearby



Pic. 44, 45 Carcass covered with grass, left by a cheetah

3.12. Kills lost to food competitors.

Although cheetahs take measures to keep their food safe, in some cases they lose it. Out of 386 kills, cheetahs lost their kills to kleptoparasites in 5.4% (n=21). Most of them were females with cubs – 48% and male coalitions – 33% out of total 21 cases. Whereas in all cases females with cubs lost Medium sized prey (the most hunted), and coalition of males – Large and Medium sized prey. (See Table 4) Cheetahs were losing mostly large prey (10% of 48 kills) and medium sized prey (6% of 255 kills), while small prey was lost once in 1% of 83 kills.

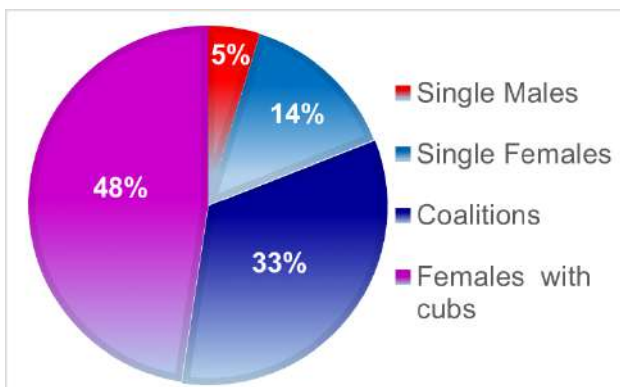


Pic. 46 Hyena took a kil from Kisarul

Table 4. Prey losses to kleptoparasites by cheetahs

	Kills taken by predators				
	Small size	Middle size	Large	Total	%
Single Males	1	0	0	1	5%
Single Females	0	3	0	3	14%
Male Coalitions	0	2	5	7	33%
Female with cubs	0	10	0	10	48%
Total	1	15	5	21	

Male coalitions lose kills to kleptoparasites because unlike single cheetahs and females with cubs, they do not drag kills to the secure places (bushes etc.) and by eating at the spot, attract attention of other animals, or example ungulates (who make alarm and other calls), raptors (circling over the spot) etc., which in turn attracts kleptoparasites (jackals, lions, hyenas, etc).



Pic. 47 Proportion of kills lost by different categories of cheetahs

Females with cubs lose prey mostly when they call cubs to a kill made at far distance from the place cubs have been left hidden. Also, sometimes hyenas accidentally come across females with a kill. To protect their cubs, females start growling but keep eating. Cubs usually run away for up to 200 m, while the mother draws attention of the predator to a kill. Once the predator approaches, cheetah displays defending behavior by slapping on the ground, and leaves following her cubs. At the safe distance, female starts calling her cubs and leads them away.

Cheetahs lose kills also to baboons and Warthogs, who drive single cheetah from a kill and eat meat and skin. For example, on 1 December 2018, adult Warthog female chased Nora (F42) from her kill (adult Thomson's gazelle) far to the bushes, returned to the carcass and ate for some time alongside two jackals (Pic.48).



Pic. 48 Warthogs is chasing Nora from a kill (1,2) and eating the meat (3,4)

3.13. Hunting and feeding behavior of females with cubs.

To make sure cubs will not interfere with the hunt cheetah mothers leave them behind. If cubs are small and cannot follow their mother and prey is not available in that area, females walk for over 3 km to find appropriate place to hunt. Before leaving, mother nourishes cubs with milk and leaves them for 1-7 hours. After successful hunt, female comes back to the den by a different route. Even when cubs begin eating solid food, mothers still prefer to leave cubs behind and hunt available prey in a few hundred meters from them. In all cases, mothers have to feel secure while hunting, expecting that nobody will wake up their offspring.

In areas with intensive tourism, females with small cubs leave them in a bush far from the roads before going for hunting. On the way back, females use another route to the den to reduce risk of her litter being detected by any possible follower. With age, cubs start following the mother, hiding behind her while she is stalking and chasing a prey. Once it is suffocated, mother calls cubs. Continuous presence of tourists following females with cubs, forced females to lead their young to an appropriate hunting location. As a result, cubs often interfered and spoiled hunts or get separated from the mother by vehicles, were getting lost and stressed while looking for their mother.

Mother only calls cubs to a kill after she suffocated the prey and the cubs will join the mother shortly if there is no one between them and the mother. If there are vehicles between her and the offspring, it becomes challenging for the cubs to find their mother. We observed numerous cases with different cheetah families, when cars surrounded a female with a kill, blocking her view so that cubs could not see her and moreover could not hear mother's calls due to working engines and radio. In such cases, we asked guides to switch off engines and radios and clear the view for the family members. As a result, cubs were able to join their mothers in 1-3 minutes depending on the distance between them. If cubs are small, female has to deliver the food for them or bring it closer to the den/hide. In order to provide shade and security to the kill, she drags it under the closest bush or bunch of tall grass in the field far from the roads. If there are vehicles on her way in the field, female can drag the kill under one of them and call cubs. We advise guides not to encourage such behavior and give female space to pass by and take the kill to the natural shade/shelter.



Pic. 49 Nashipai is leaving cubs in the field far from the roads in the closed area (1) and goes for hunting, leaving cubs in the grass (2,3)





Pic. 50 Cubs hidden in the grass in the open field while mother is hunting

During lockdown, when no vehicles were in the Reserve, females would leave cubs in an open field in tall grass if there were no antelopes around (Pic.49,50). In a few occasions mothers were leaving cubs for 4-6 hours in search of prey. Such behaviour was observed for the first time. After tourism resumed in the Mara, females started leaving cubs in small bushes where they were more secure, as before lockdown.

Nashipai started raising her two cubs during lockdown, when there were no vehicles. She would leave cubs at any place including open fields for 5-6 hours, and cubs remained quiet despite changing postures or fiddling with each other (Pic. 50). When by the mid-July 2020, tourist cars appeared in the Reserve, Nashipai started leaving cubs only in the bush before hunting.

The size of a cheetah is largely determined by the quality of its nutrition during infancy. The more food the cubs get, the faster they gain weight and strength. For females desire to feed the litter is a priority and a powerful motivation to the hunt. Having caught prey, female gives her offspring the opportunity to get enough and only then begins to feed. If the prey is small, female eats a little in order to maintain interest in hunting again. Milk production in females also depends on the quality of her nutrition.

To stimulate appetite of the cubs, female leaves the prey unopened for a while - sometimes for an hour, and lays down nearby. While playing on the carcass, the cubs try to open it, and when the female eventually opens the carcass, they begin to eat with appetite. (Pic.51).



Pic.51 Kisaru cubs playing with a kill

One of the factors contributing to a successful hunt is lack of disturbance. Cubs, following their mother during stalking, often interfere with a hunt. Therefore, it is beneficial for a female to leave them behind. After completing a hunt, the female calls cubs, and at this moment, it is important that there are no cars on their way, and if there are any, it is important that engines and radio are turned off so that mother and cubs can hear each other and reunite as soon as possible.

Lack of nutrition leads to a halt in the production of milk in a female, and then she begins to drive away cubs from the nipples, rolling over to the other side and snarling at her cubs. In the beginning of October 2020, Nashipai was continuously followed with many cars, interfering with her hunts. For 4 days, Nashipai tried to hunt, making more than 10 attempts in the same area. One ended successfully, but hyena took the prey. As the result, on 8 October, she did not let cubs suckling, displaying discomfort every time cubs tried to touch her nipples.

For cubs, sucking mother's milk has not only a physiological (nutritional) function, but, importantly, also a psychological function of social cohesion, safety and comfort. Being in a state of distress for several days from hunger, forced to follow the mother for long distances, Nashipai's cubs periodically tried to suckle, invariably causing mother's aggressive reaction. Eventually, on 9 October 2020, Nashipai left the area, within 11 hours the family covered 12 kilometers and in the evening, Nashipai hunted successfully next to the closed zone 3 (Pic. 34)

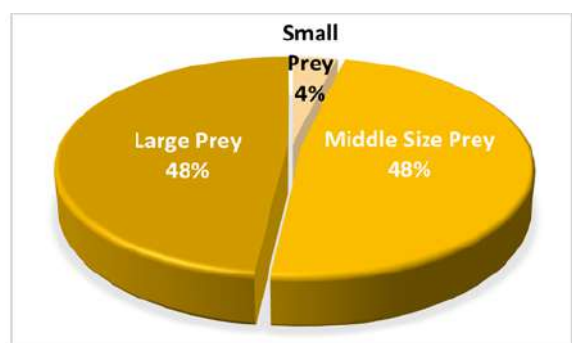
During COVID lockdown, Nashipai used to leave cubs for 3-6 hours in open fields or small bush, with no disturbance, and cubs kept quiet until mother appeared on the spot. After lock-down, Nashipai followed the same strategy and once she caught prey, she would call cubs to the kill.

Females with small cubs, who completely depend on milk, eat the kill fast and as much as possible, although they can stay at a kill for several hours – if cubs are far from the spot. Losing cubs to kleptoparasites is a higher risk than losing a kill. When cubs start eating meat, mother lets cubs get enough before start eating and ends feeding not being full. By that, maintains the need for further hunting. The more cubs depend on solid food, the more female eats with them thereby teaching them how to defend a kill by pulling the piece, growing at cubs and sometimes slightly biting a cub.

To maintain effective vigilance during feeding with sub-adult cubs, especially in open areas, females apply a feeding rotation strategy. For example, Kuahidi (F76) took turns eating an adult Impala with her 12-months old son for 4 hours 40 minutes. Each of them was feeding for 2-10 minutes and then resting close to a kill while the other one was taking turn for the next several minutes.

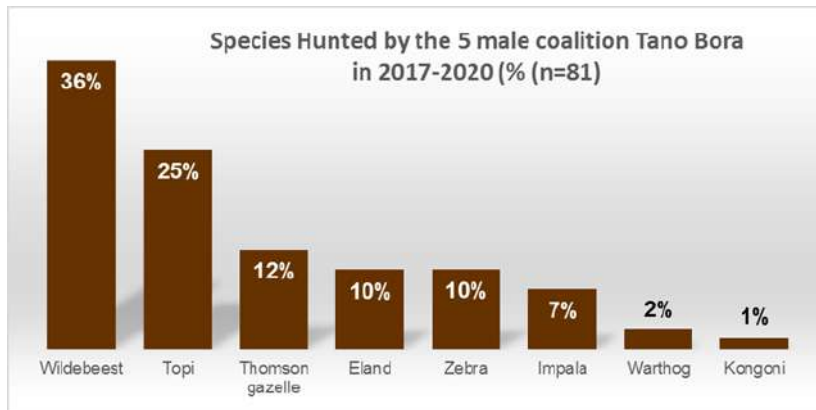
3.14. Hunting and feeding behavior of a coalition of 5 males – Tano Bora.

Large groups of predators require more food and each member must contribute to the hunt. It took five males of the coalition called Tano Bora, over a year and a half to learn the necessary strategies for cooperative hunting. Initially all members would chase different animals in a herd but, with time, developed an effective style of hunting where four would expose themselves to grazing antelopes and the fifth would slowly stalk the prey.



Pic.52 Proportion of large, middle and small sized animals in Tano Bora kills

Group hunting of males in a cheetah coalition has typically been associated with enhancing confidence among members. This we observed during the long rainy season of 2019-2020, when one male would confidently chase and tackle a bigger prey thrice its weight such as topi or even wildebeest (six times the weight of an individual cheetah) Other will join the hunter when the prey is captured. Single cheetahs hardly ever hunt such big prey, unless they have recently lost coalition-mates.



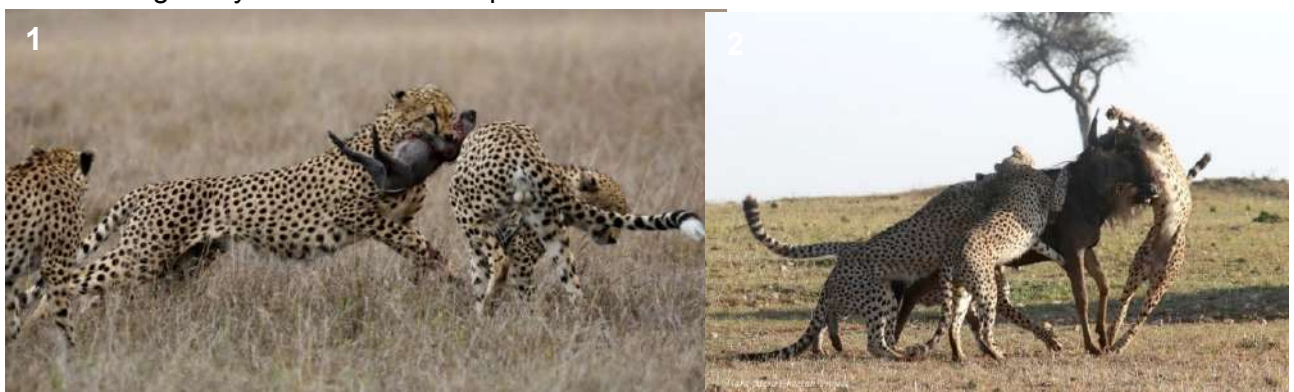
When taking down large antelope, all five divide duties and act quickly and efficiently in order to feed as much as possible before the arrival of kleptoparasites. When hunting adult Wildebeest or Topi males, one of the Tano Bora males bites testicles of the antelope (Pic. 999), causing bleeding, which hastens its death (Pic.54).

Pic. 53 Animals hunted by Tano Bora coalition



Pic.54 Olpadan is eating testicles (1-March 2021, 2- July 2020) while his coalition-mates taking down Topi

Out of 81 observed successful hunts in 2017-2020, in 35,8% Tano Bora killed Wildebeest, and in 64,2% - 7 other species. Majority of kills were of large and middle size (48% equally), while small prey was killed only in 4%. In all cases, one of the males accidentally found small antelope fawn or hare and ate it alone. For Warthog piglets, out of 5 males, two or three were hunting and after successful kill made by one male (or two if 2 piglets were killed, other coalition-mates were trying to snatch it. As hares were killed and eaten by only one member of a coalition, hares were excluded from feeding analysis and the list of species coalition hunted.



Pic.55 Tano bora males hunting Warthog piglets (1) and Wildebeest (2)

3.15. Feeding time of Tano Bora (5M) coalition

In general, 5 males spent more time eating large prey than middle size and small prey (Pic.56).

Duration of feeding on different prey was following:

Warthog piglet – 25-30 min

Thomson’s gazelle – from 15 to 30 min

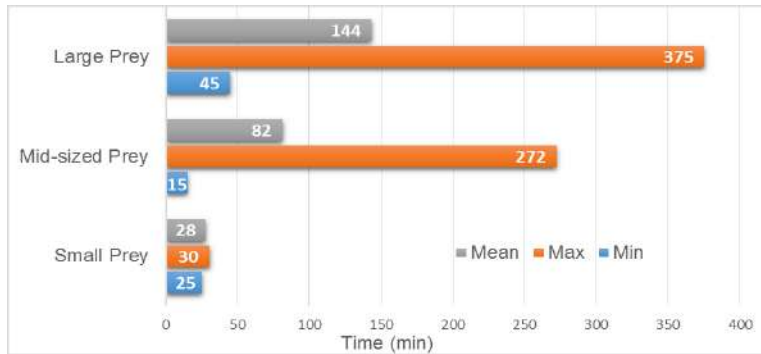
Impala – from 38 to 112 min

Wildebeest – from 107 to 375 min (calf – 52 min)

Topi – from 45 to 158 min

Eland calf – from 29 to 132 min

Zebra – from to 137 to 340 min



Pic. 56 Proportion of large, middle and small sized animals hunted by Tano Bora



Pic.57 Tano Bora feeding

Tano Bora mainly made kills in the open fields with no shade, and after feeding for some time, walked towards tour vehicle and lay down in its shade. After feeding in the sun, males walk to the nearest shade, where they sleep for the next 7-11.5 hours. We observed multiple times 5 males sleeping in a shade in absence of vehicles, but when 7-15 cars gather at the spot for the evening game drive (around 16:00), they start performing different activities – stretching, grooming each other and one by one come from the grass to the road and lie down next to the vehicles for 10-15 minutes and then walk back to the same place in the thick grass. Usually after that, most of the cars leave the spot. Perhaps, by that, cheetahs reduce the level of disturbance.



Pic. 58 Tano Bora taking down Impala male



Pic. 59 Single hyena takes a kill from Tano Bora males

In 2020, we observed the same behavior in females with cubs in the Reserve (Imani with 3 cubs, Nashipai with 2 cubs) and in the conservancies (Kisaruu with 6 cubs), who have been exposing their cubs twice a day – in the early morning and late afternoon at different times and after four cars gathered at the spot. After 30-45 minutes, females were leading cubs into the bush or tall grass far from the roads.

Cheetahs often lose their prey to larger predators – sometimes to lions and, more regularly, to hyenas. Out of 81 kills, males lost only 7% to hyenas and lions.

On several occasions, they have chosen not to fight with a hyena but to share a kill with it. In both cases we observed in 2020, cheetahs had made large kills (an adult Topi and Wildebeest) and in both instances, Olpadan (M58) refused to feed alongside the hyena. In the first instance, all the other males fed on the opposite side of the carcass from hyena, while Olpadan watched from a distance, and in the second instance, Olarishani and later Olonyok (M73) fed fearlessly next to a hyena while three males waited next to the kill (Pic.60-62).



Pic.60 (1,2). Tano Bora coalition eating with hyena (18 March 2020)





Pic. 61 (1,2) Tano Bora sharing a kill with a hyena (6 June 2020)

Pic. 61 (3) Olonyok is sharing a kill with hyena



Such events are rare and to date, have been recorded in the Mara only three times. The first one was witnessed on 16 January 2016 by the Mara guide Vincent Lenkoko. Martin (M5) was feeding together with a hyena on a Wildebeest carcass. Three and a half months earlier, on 1 October 2015, 6.5 years-old Martin lost his brother, who died of a viral respiratory infection. As a member of the coalition, Martin used to hunt large prey and share kills. After losing his partner, Martin continued to hunt successfully sub-adult wildebeests from time to time, and as his kill was enough for two predators, he apparently did not feel uncomfortable to share it. It is possible also, that hyenas who eagerly share kills with cheetahs, are low-rank individuals and therefore less confident during interspecific interactions. In case of Martin, dark time also contributed to the peaceful co-feeding, which for the cheetah was one of the surviving strategies – instead of fighting or leaving a kill, he preferred sharing his meal.



Pic.62 Martin is sharing a kill with hyena in 3.5 months after losing his coalition-mate

4. Social behavior.

4.1. Social interactions within male coalitions during lockdown.

In most cases, the dominance hierarchy is relatively stable, and members usually step aside when confronted by the leader. However, if the leader is weakened by injury, disease, or senility, the shift in ranking may occur and the individual with the highest rank will move downward to the lowest position. During intraspecific fights, cheetah males target ano-genital area of rivals and there have even been cases where males have bitten and cut off the testicles of intruders. That what happened to Olpadan. His dominant status began to waver around the beginning of 2019, when two members of the coalition, Winda and Leboo, began to attack him on a regular basis. In two cases, the fight happened during the courtship with different females. One fight in mid-March 2019 resulted in a serious injury to one of Olpadan's testicles. Since that time, leadership has been shared mostly by Olarishani, Winda and Olonyok. Being the lowest-ranking male in the group, Olpadan often follows the group at the end of the chain and the last to start eating. Interestingly, Olonyok, whom Olpadan had attacked before, demonstrating reverse aggression, is now the one who allows Olpadan to eat next to him and who is engaged with ex-leader in mutual grooming after eating.

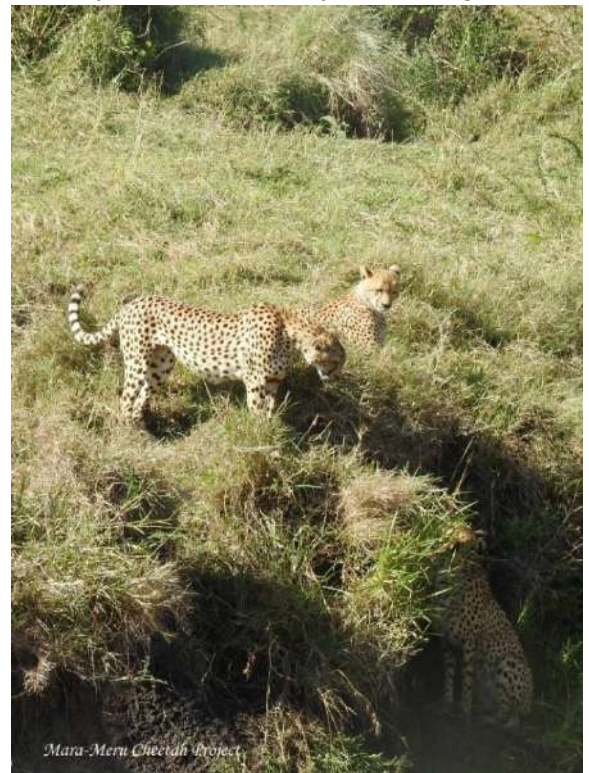
During lockdown period when no cars were around, the level of aggressive interactions between members dropped significantly. Although males displayed aggression towards each other during feeding, we have not observed any reverse aggression. Moreover, males often were playing "tag of war", running around different objects (termite mounds, single bushes etc.). This playful behaviour we have been observing for 3 months, but after tourism resumed in the Reserve, it stopped.

4.2. Social interactions of different males. While wandering through the ecosystem, male cheetahs encounter single males and coalitions, and display more or less peaceful or aggressive behavior. In the wild, there are known cases of coalition-mates killing and feeding on the carcass of the intruder, as, for example, in Phinda Resource Reserve in South Africa. For 9 years of observation in the Mara, we have witnessed numerous cases of collisions of different males (in groups or loners), which lasted from several hours to two days, and fortunately, not a single male



Pic.63 Chai Boys

was injured. In September 2020, we observed the interaction of a cheetah coalition of two males with a male from the three-member coalition known as the Chai Boys. Both coalitions of young males emerged in the past year: two (Mkali and Mwanga) appeared initially in the Triangle in June, and three Chai Boys in the reserve in October. In December 2019, both coalitions were spotted in the reserve, and in early 2020, the Chai Boys moved to the conservancies



Pic.64 Chai Boy (below) trapped by Mkali and Mwanga (over)

(Naboisho, OMC and OI Kinyei), while Mkali and Mwanga preferred the territory of the reserve, although they also used territories of the neighboring Naboisho and OMC. At the end of September 2020, one of the Chai Boys appeared without his coalition-mates in the Reserve, where he encountered a pair of males. It is obvious that the scenario of a meeting of two complete coalitions - a pair and a triplet - would be different. However, in this case, the couple trapped the lonely male, and for many hours until darkness was not giving him the opportunity to get out of the ravine. It remains unclear what had happened to the other two Chai Boys, but it was clear from the behavior of all three males that the couple was not ready to accept a new member, and the one was not ready to join the pair.



Pic.65 Chai Boy (left) displaying self-defense to Mkali and Mwanga

Singletons find it more difficult to compete for resources with coalitions, especially those as large as Tano Bora, so they either have to travel far to avoid colliding with coalitions, or forge their alliances with unrelated males to survive and succeed. On 13 April 2020, Tano Bora spotted young male Jasiri (M108) who had recently dispersed from his two sisters and started exploring the Mara. Jasiri was hiding in the thick bush, and 5 males surrounded him. After several attempts to attack him for 20 minutes, they let him walk away, and went opposite direction for hunting. (Pic.66)



Pic.66 Tano Bora males approaching Jasiri (1) and fighting with him in the bush (2)

4.3. Social interactions of males and females

In the wild, cheetahs of both sexes not only recognize each other, but quite possibly prefer well-known mating partners. For example, Tano Bora implemented useful tactics – once the male found the scent mark of the familiar receptive female or spotted known female from a distance, he separates from a group looking and calling for her.



The male leave a group for a day or two, following and mating with a female and then re-joins his coalition-mates. Interestingly, each member of the Tano Bora coalition have been repeatedly mating with different females: Olpadan with Rani, Olarishani with Nora, Leboo with Miale, Olonyok with Nashipai.

Pic. 67 Two of the Tano Bora males approaching Nashipai.

In many occasions males come across non-receptive female cheetah females are induced ovulators, that is, in order to come into oestrus, they need external stimuli. Encounter with males is one such incentive. When Tano Bora coalition meets non-receptive females, some of them stay with a female for hours or days, and eventually leave the female in order to hunt jointly with the coalition-mates.

Within 10 days of May 2020, the Tano Bora male coalition met Nora several times, but only three males initially lingered in hope of mating - Olarishani (who had previously mated with her), Olpadan and Leboo. However, the more often they intersected, the less interest this female aroused in males. For example, on 16 May, they all ignored her when spotted in 50 meters. The males were more interested in gazelles. Interestingly, on 7 May 2020, there were 3 different females - Nora, Miale and Nashipai in close proximity to each other (100-250m). When the two males left Nora, they met with Nashipai, who was also not ready for mating. (Pic.69)

Pic.68 Nashipai (left) with two males of Tano Bora

Pic.68 (2,3)Olarishani is following Nashipai



On 7 May 2020, two out of five Tano Bora males – Leboo and Olarishani, who had temporary split with other 3 males, spotted Nashipai walking on the main road (Pic.68) To investigate her reproductive status, they ran towards her, and female lay down, huddled to the ground. Nashipai had full belly and exposed nipples, which was a sign of nursing cubs. She was trying to escape from the males, heading to the bushes. When she escaped in the bush near the main road, Leboo left her. After following her for some time, Olarishani eventually left her and went in search for his coalition-mates. Nashipai showed up in Reserve with two healthy cubs – a male and a female in the beginning of July 2020 (Pic.4).

In 2020, we observed three more courtship encounters of Tano Bora males with 8 year-old Nora and 12-year old Miale. Both females were not in estrus and after spending several hours with females, males were leaving them.

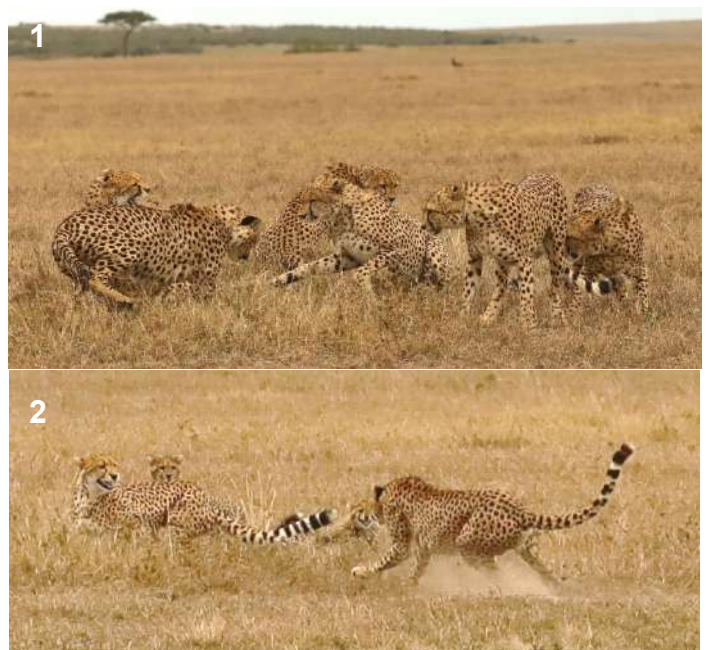


Pic. 69 Nora surrounded by Tano Bora males on 12.05.2020



Pic 70. Leboo (left) and Miale (right) on 14.02.2020 (1) Miale and Leboo 21.09.2020 (2)

4.4. Social interactions of males with females with cubs. Every day cheetah cubs encounter with many inhabitants of the savanna and learn survival strategies by watching their mother's behavior. Encounter with conspecifics can be life-threatening, as it has been recorded in Serengeti, where male cheetahs killed cubs (Caro 1994). In the Mara, the Tano Bora coalition periodically met different females as their home ranges overlapped. Within 3.5 months of 2020, Nashipai faced this coalition three times, and each time not all males were friendly, although they fought mostly among themselves. In August 2018 we observed Olonyok successfully mating with Nashipai, and in 3 months she gave birth. Since then, we have spotted them in courtship several times. On 28 July 2020, all five males came across Nashipai with her two 2.5-months old cubs.



Pic. 71 Nashipai with 2 cubs surrounded by Tano Bora (1) and Winda approaching Nasiai with two cubs (2)

Of all five males, Olonyok was the most persistent and interested in the female. He did not give up and returned to the female twice even after all the other males had left the spot.

Interestingly, during their encounter on 20 October, 2020, the former leader of the coalition Olpadan several times showed aggression towards Nashipai, while two males – Olonyok (repeatedly mated with Nashipai) and Olarishani (the “peacemaker”) stood up for her. Males showed curiosity about cubs. Every time scenario of the encounter was the same: after realizing that female was not receptive, males were losing interest in her and leaving. However, once the female was trying to escape, they were coming back surrounding her. Typically, for the third time, the males left the female completely and went far.



Pic. 72 Nashipai with 2 cubs encounter Tano Bora coalition



Pic. 73 Nashipai (right) is displaying protective behaviour towards approaching male, cubs (right) are watching



Pic. 74 Nashipai is leading her cubs away from the spot after Tano Bora had left for hunting

Mara-Meru Cheetah Project

5. Cheetah families

5.1. Females with cubs in the Reserve

Before delivery, cheetah females are looking for secure place. In the Reserve, females often choose closed areas, or rocky or bushy hard-to-reach places. However, within first 3 month they often lose litters mostly due to other predators. In 2020, three females gave birth and were raising cubs in the Reserve:

In August 2020, 7-year old **Rosetta** gave birth to 5 cubs in the closed area of the Reserve, but lost them by 13 September. To date, Rosetta successfully raised one litter of 2 males and one female in 2020.

In October 2020, 8-years old **Imani** gave birth to 4 cubs in the field in 300m from highly used road. Rangers closed the area with road signs we provided for such cases (“Restricted area. Do not drive beyond this point”, “Area closed” and “Track closed”). We were assisting the rangers in monitoring the area. When female started moving with cubs to another areas of the Reserve, the signs have been removed. Imani lost her cubs in March 2021 (one to a lion). To date, Imani successfully raised one litter of 2 males and one female in 2016.

In April 2020, 5-year old **Nashipai** gave birth to two cubs in the closed area of the Reserve and by March 2021, was raising them, travelling intensively through the Reserve and to the adjacent conservancies. It was the first time when she was spotted raising cubs.

In November 2020, 5-year old Neema, sister of Nashipai, gave birth to three cubs in OMC and in the end of February appeared in the Reserve.

In June 2020, 2 years two months old **Kweli** (daughter of Amani) gave birth in OMC to two cubs, and in the end of August brought them to the Reserve. In 10 days she lost one cub most likely to predators. Kweli was the youngest female who was recorded having cubs, although she lost the remaining cub by 20 January 2021.

In the beginning of September 2020, 4-year old **Kisaruru** was in courtship with the male Olchorre at Lemek conservancy, and in the beginning of December gave birth to 3 cubs at Enonkishu conservancy, but lost all of them within a month. To date, Kisaruru successfully raised 3 cubs to independence, and left them in the end of October 2020 most probably being pregnant.

5.2. Maternity Behavior

Females raised in the conservancies take their offspring at certain time to the Reserve if it was a part of their mothers’ home range. Raising to independence large litter (5-6 cubs) is challenging and very rare event. It was only in 2011, when female Shingo successfully raised a litter of 4 males and 2 females. However, she left them at the age of 12 months, and due to limited time spent with the mother, only one female (Mama Kali, F23) was spotted later raising her own cubs while other 5 cubs have not been seen ever after. Lack of knowledge gained from the mother through observing her behavior in different situations, and insufficient personal experience negatively affect the survival of cubs and their success. In general the success is ability to successfully hunt, socialize with conspecifics and reproduce. The success of individual animals: for females – reproduction of the first generation; for males – successful breeding of a male or his coalition, or the male's ability to establish and maintain the territory for one and a half years (Johnson et al. 2010). However, it is extremely difficult to witness the process of mating of cheetahs in the wild, which makes determination the degree of success of males (both individually and as a coalition) not always possible. Thus, at the individual level, the success of males can be assessed by the fact that males have retained the territory for 1.5 years.



Pic.75 Kisaruru with 6 cubs

Personal cheetah success depends on a number of factors, including mother's parental experience, high level of hunting and survival skills, and number of cubs in the litter. Our long-term observations revealed that cheetah female can successfully raise 3 to 4 cubs to the age of 14-20 months. For example, Amani (F3) – the most successful female in the Mara (Pic.6) spent with her litters of 2-3 cubs 14 to 18 months, and raised confident offspring. However, her single cub from the second litter – Karemba (F55) raised in 2015, spent 15 months with the mother, but to date, has not been successful in raising offspring. It could be due to absence of littermates and joint learning of survival strategies.

Our long-term observations allow us to conclude that females identify if one of the 6 or 4 small cubs gets missing, and start intensively looking for it, calling periodically. We observed such cases with Miale (F7) and her four 2-month old cubs (6 January 2015), when cubs were chased by a troop of baboons, and with Malaika (F13) with six 1.5-months old cubs (20 August 2014). In both cases females left cubs in the bushes and went hunting. Miale spotted baboons and started calling cubs, but only 3 out of four appeared. In a few minutes, when they started suckling, she got up and started calling for a missing cub. She found him 400 m away. Makaika made a kill and left it in the field in 300 m, from the bush where she had left 6 cubs. When she led them to the kill half way and they started eating, she started calling intensively looking around. In 10 min she ran towards the ravine at the opposite side of the field over 400 m and came back carrying the missing cub.

For overnight, females in the Reserve lead cubs to the field and settles far from roads in a bunch of grass. If there is no human and predator disturbance in the area, the family stays at the same spot until early morning. In many occasions, in the evening we have observed from large distance (200-300 m) hyena walking in the field without noticing hidden cheetahs in a bunch of grass. However, if there was any vehicle in the field in 20-30m from the cheetahs, hyena often came close to the car examining the area around it. It is very likely that for years observing visitors in the reserve, hyenas have learnt that four vehicles stop at a certain spot because of some attraction. By that, hyena may discover the cheetah. In such cases, mother chases hyena away, while cubs run opposite direction. It takes 10 to 25 minutes for the family to reunite. In 2020, we observed such a scenario with Kweli (F83) and 2 cubs in August 2020, and with Nashipai (F69) with 2 cubs in October. It is therefore important not to follow females to the spot where the family settled.

5.3. Adoption of Cubs

In 2018, we documented a case of adoption of a 15 months old male cub of Naretoi (F64) by her sister Naserian (F65). Naserian successfully raised both males, although they have been spotted separately. Whichever reason for separation was (for example, female in estrus chased males), time spent with Naserian's family provided Naretoi's son with necessary resources and was definitely beneficial for the young male. Adopted cub (M98) was spotted in the Serengeti on 23rd of July 2019. At that time he was 25 months old. Naserian's son (M99) was spotted first on 5 August 2020 at the border OMC and Reserve with Neema (F68), and later – on 11 September 2020 at the Rhino ridge area of the Reserve, in courtship with Imani (F50). Both males – M98 and M99 were in the very good physical condition. To date, it was the first documented case of cheetah adoption in the Mara.

In 2020, we recorded one more case of cheetah cub adoption after a case of 2018. In November 2020, 3-year old female Sila with 3 half-year old cubs accepted a 15-months old male (who had been recently left by his mother Selenkei, who is also the mother of Sila. The adoptee was sharing



Pic. 76 Sila (middle) with her litter and adopted cub (left)

duties with his adoptive mother: hunting with her, chasing kleptoparasites from the kill while the family was feeding, he keeps vigilant taking turns with Sila while her three cubs were sleeping. Interestingly, in documented cases in Serengeti (Caro 1994), Adoptees were also males aging from 6 months to over 12.5 months. By joining families, cubs who lost their family/mothers, increase their chances for survival by getting an access to food and possibly protection.

High level of sociality and strong maternity instinct altogether allow cheetah females adopt cubs of different ages. In captivity, cheetah females accept small cubs (from 1 day old) and allow them nursing together with biological cubs, when the cub/cubs are put in a den with cubs in the absence of their mother. Such event is man-initiated. In case of a female “coalition”, where both females have cubs, they raise all cubs together, voluntary nursing them and sharing meals with them (Chelysheva 2006).

In the wild, adoption of cheetah cubs documented in the Serengeti where the youngest adoptee was 4 months old. (Caro 1994). In 9 recorder cases, mothers had 2-4 own cubs aging from 4 to 12.5 months. Out of 9 cases, in 6 cases adoptees were males aging from 6 months to over 12.5 months, who were staying with the family from 3 days to over 11 months. Interestingly, that males adoptee were staying significantly longer with the family which contained at least one male, and the longest time spent was 337 days. (Caro 1994). By joining families, cubs who lost



Pic. 77 Social grooming – Sila with adopted male

their family/mothers, increase their chances for survival by getting an access to food and possibly protection. These cases show that wild female cheetahs are capable of adopting unrelated cubs. Consideration should be given to transferring abandoned cubs (if the mother is confirmed to have died) to another female raising cubs of a similar age.

5.4. Lifespan of the cheetah families. In the Masai Mara, mothers spend from 12 to 23 months with their litters. The average age of independence the Mara is 16.9 months, n=33 litters (See Table 5), which is similar to Serengeti, where it is 17.1 months (Kelly et al., 1998). Mothers stayed longer (23-18 months) with litters with at least one female cub. If the female gets pregnant, she leaves her sub-adult cubs from the previous litter one month before delivery. Littermates stay together for up to six months perfecting their hunting skills. When females reach sexual maturity at approximately two years of age, they leave their brothers and start solitary life. Males-littermates remain together for the rest of their lives in groups called “coalitions”, which may consist of up to 5 individuals. Male cubs move from the mother’s territory while cubs females usually establish territories (home ranges) within their mother’s home range. If females (sisters) raise cubs in the same area, one of them can adopt sister’s cub/cubs (see Chapter 5.3).

Table 5. Lifespan of cheetah families

Nº	Lifespan of a Family (months)	Nº of Cubs	Sex of Cubs	Cheetah Female ID
1	23	2	1.1	F13
2	23	3	0.3	F74
3	21	2	0.2	F9
4	21	2	2.0	F13
5	20	2	1.1	F16
6	19	1	0.1	F4
7	19	5	1.4	F19
8	19	3	1.2	F3
9	18	3	1.2	F26
10	18	3	1.2	F8
11	18	1	1.0	F7
12	18	3	1.2	F51
13	18	3	1.2	F3
14	17	2	0.2	F3
15	17	3	3.0	F59
16	17	3	2.1	F78
17	17	3	2.1	F53
18	17	2	2.0	F7
19	16	3	2.1	F50
20	16	1	1.0	F13
21	16	4	3.1	F67
22	15	1	1.0	F42
23	15	1	1.0	F67
24	15	1	1.0	F5
25	15	2	2.0	F40
26	15	1	0.1	F3
27	14	1	1.0	F24
28	14	3	2.1	F56
29	14	1	1.0	F1
30	14	3	2.1	F3
31	14	1	1.0	F76
32	13	1	0.1	F26
33	12	6	4.2	F6

IV. HEALTH MONITORING

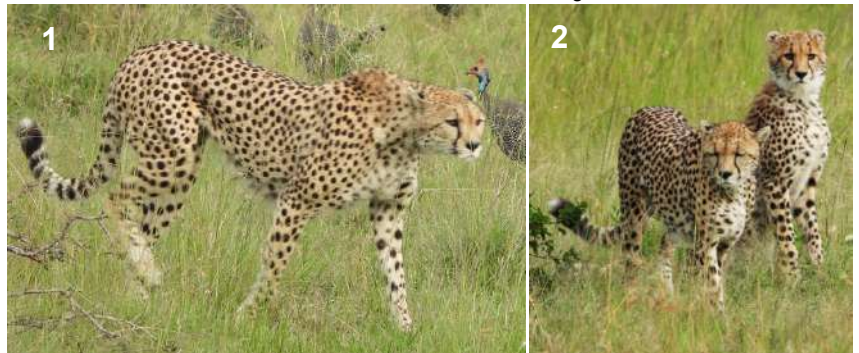
Following one of the Project objectives (i.e. *Identification of major threats to the cheetah population including health problems*) the research team performs cheetah health monitoring by direct observations and collecting photographic materials from the rangers and guides. In case of any health issues observed, we report to Reserve/conservancies authorities and local KWS veterinary unit and assist them in locating these individuals who required treatment.

Sarcoptic mange. Sarcoptic mange is a highly contagious mite infection caused by *Sarcoptes scabiei* burrowing under the skin of domestic and wild mammals. It has been reported from 10 orders, 27 families and 104 species of domestic, free-ranging and wild mammals, including cheetahs. Cheetahs acquire it via direct contact with infected prey species or conspecifics. Clinical symptoms of mange depend on the immune status of the respective host. At the latest stages, the skin becomes extensively thickened, greyish in colour, there is a marked eosinophilia throughout the epidermis and dermis (the skin becomes red in colour) and often almost complete alopecia. The skin cracks, dries and exfoliates exposing the unprotected tissues. Treatment of infected individuals in the field has been successful.



Pic. 78 Maridadi with mange, Dec 2018

From 2012-to date, 29 (14.13.2) cheetahs were spotted with different stages of mange, of which 9 (4.3.2) were treated by the Veterinary Units, and 5 (1.4) recovered on their own. We documented two sources of mange in cheetahs: prey (feeding on infected Thompson's gazelle) and another cheetah (contact with infected individual during courtship).



Pic. 79 Maridadi with one of her cubs fully recovered from mange (February 2021)
(Photos by Vicky Rose)

In general, there is positive dynamics in the cheetah health:

In 2012, 22 (10.10.2) cheetahs (**29%**) were spotted with different stages of mange, of which 8 (3.3.2) were treated by the Veterinary Units, and 3 (1.2) recovered on their own.

In 2014-2015 there were 10(3.6) adult cheetahs spotted with mange, or **13%** of the Mara cheetah population;

In 2016, 5(3.2), which was **8.5%**,

In 2017, 4 (2.2) with mange, i.e. **5.4%**,

In 2018, 2(1.1) -**3.5%**, both spent most time in Serengeti;

In 2019 – 5(3.2) or **7%** adult cheetahs, out of which 2 males spent most time in Serengeti. In 2019, two young cheetahs (1.1) have been treated by the KWS Vet Unit and one female recovered on her own. **In 2020**, no cheetahs were spotted with mange.

Maridadi (F61), who had been suffering from mange in the end of 2018, was spotted in the Mara in February 2020 after 2.5 years of absence in the perfect physical shape, fully recovered from mange and raising two cubs (Pic.79).

OUR PUBLICATIONS

Linden DW, Green DS, Chelysheva EV, Mandere SM, Dloniak SM. 2020. Challenges and opportunities in population monitoring of cheetahs. *Population Ecology*. 2020; 1–12. <https://doi.org/10.1002/1438-390X.12052>

Chelysheva EV and Jeffrey Wu. The Power of Unity. A Story of Coexistence, Tolerance, Dominance and Consequences. *Africa Geographic* 22 October 2020.

BBC documentary. In 2020, our Project team took part in the documentary produced by BBC Studios Natural History Unit “*The Year Earth Changed*”, narrated by David Attenborough. The documentary took a new approach to affect to the global lockdown on wildlife across the globe, including effects on cheetahs in Maasai Mara. Dr. Elena Chelysheva (Project founder) became a consultant to the documentary during 2-weeks shooting and subsequent work on the materials; Otuke J.M. (Research assistant) was a spotter for the filming crew, and S.Mandela was filmed commenting some of our project finding.

BIBLIOGRAPHY

Caro, T.M. 1994. Cheetahs of the Serengeti Plains: Group living in an asocial species. – Chicago: University of Chicago Press, 1994. – Pp. 89-92

Chelysheva, 2004. New Approach to Cheetah Identification.// CAT NEWS, 2004. № 41. P.27-29.

Chelysheva E.V. 2006. Specifics of Social Behavior of the Cheetahs (*Acinonyx jubatus*) in the Wild and in Captivity: on the Issue of the Optimization of Keeping Conditions. // *CARNIVORES AND MARINE MAMMALS IN CAPTIVITY – Eurasian Regional Association of Zoos and Aquariums*. 2006: 32-62 (*in Russian*).

Chelysheva E.V. 2011. Cheetah (*Acinonyx jubatus*) Reintroduction – 46 years of Translocations // *Scientific Research at Zoological Parks*. Moscow 2011 (27): 135-179

Durant S.M., Kelly M., Caro T.M. 2004. Factors affecting life and death in Serengeti cheetahs: Environment, age and sociality// *Behavioral Ecology*. – 2004. – No 15(1). – P. 11-22.

Jackson P., Nowell K (Editors) 1996. Wild Cats: Status Survey And Conservation Action Plan (Iucn/Ssc Action Plans for the Conservation of Biological Division.

Johnson S, Mengersen K, de Waal A, Marnewick K, Cilliers D, Houser AM, Boast LK. 2010. Modelling cheetah relocation success in southern Africa using an Iterative Bayesian Network Development Cycle. *Ecological Modeling* 221:641-651

Kelly M.J., Laurenson M.K., Fitzgibbon C.D., Collins D.A., Durant S.M., Frame G.W., Bertram B.C.R., Caro T.M. 1998. Demography of the Serengeti cheetah (*Acinonyx jubatus*) population: the first 25 years. *J. Zool. London*. 244:473-488.

Linden DW, Green DS, Chelysheva EV, Mandere SM, Dloniak SM. 2020. Challenges and opportunities in population monitoring of cheetahs. *Population Ecology*. 2020; 1–12. <https://doi.org/10.1002/1438-390X.12052>

Durant et al. 2017. The global decline of cheetah and what it means for conservation. *Proc. Natl. Acad. Sci. USA* 114, 528–533.

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