FACTORS THAT DETERMINE VIGILANCE BEHAVIOUR AND REPRODUCTIVE SUCCESS OF CHEETAH MOTHERS: A CASE STUDY OF MAASAI MARA NATIONAL RESERVE, KENYA

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DECLARATION

I hereby declare that this research project is my own original work and has not been presented for examination at any other university or institution.

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ABSTRACT

There is a drastic decline in cheetah (*Acinonyx jubatus*) population globally with human activities being among the major causes of this reduction. Visitation to areas of wilderness by tourists has been implicated for poor success in reproduction in wild cheetahs due to unchecked pressures associated with wildlife viewing activities such as commotion from overcrowding tourist vehicles and noise. These disrupt cheetah hunts, obscure cheetah view essential in scanning the environment for potential danger and prompt avoidance behaviors which increase their chances of being detected by potential predators. All these indirectly hinder success in cheetah cub recruitment due to malnutrition and aggravated predation related mortalities. Tourism a sector experiencing exponential growth throughout the world for its benefits to governments also plays a critical funding role in the conservation of species such as cheetahs. Therefore I conducted this research with an aim of assessing the impact of wildlife tourism on cheetah mothers focusing on vigilance as an anti-predation behavior, influence of vegetation cover on vigilance of cheetah mothers and cub recruitment success among cheetahs of Maasai Mara National Reserve. A generalized linear mixed effects model using lme4 in R was used to test hypotheses of the study. Results indicate that the probability of a cheetah mother being actively vigilant increased with increasing number of tourist vehicles at a sighting, cheetah mothers exhibited increased active vigilance with increasing vegetation cover, and cheetahs of Maasai Mara exhibit a very low reproductive success of 30%. However there was no enough evidence to correlate the low cub recruitment with elevated levels of vigilance among cheetah mothers. Based on these results I recommend creation of awareness addressing the low reproductive success among cheetahs of Maasai Mara, creation of policies to reduce the number of tour vehicles at wildlife sightings, further research to be conducted on direct causes of cheetah mortalities as well as nocturnal tendencies of cheetahs be investigated.

ACRONYMS

ANIMAL.ID	Animal Identification
CCF	Cheetah Conservation Fund
CITES	Convention on International Trade in Endangered Species
FEMALE.VIG	Female Vigilance
GoK	Government of Kenya
GPS	Global Positioning System
IUCN	International Union of Conservation of Nature
KWS	Kenya Wildlife Service
MMNR	Maasai Mara National Reserve
NGO	Non-Governmental Organization
NOT.ACTIVE.VIG	Non active scans
PAs	Protected Areas
RS	Reproductive Success
SDGs	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
SSC	Species Survival Commission
TOT.VIG	Total Vigilance
UNWTO	United Nations World Tourism Organization
VEG3	Refactoring of vegetation types into three groups
VEHICLE.RATE	A rate indicating the total number of vehicles per length of observation session
WT	Wildlife-based Tourism

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CHAPTER ONE: INTRODUCTION

1.0 Background

Tourism has a global recognition for being among the most expansive economic sectors experiencing an exponential growth (Creaco and Querini, 2003). The significance of this sector lies in its merits usually occurring in the form of revenue to governments through taxes, expansion of income generating activities and foreign exchange (Valle and Yobesia, 2009). Due to such significance many developing countries have made their tourism sectors vibrant resulting in growing their economies with increased economic participation (Meyer and Meyer, 2015). Therefore having been proven to be a viable regional development tool that promotes creation of new local economic activities, many countries especially those classified as developing including Kenya have turned to tourism as a viable alternative to achieving their sustainable development goals (SDGs) including poverty alleviation (Goal No 1) (Akama, 2000).

Considering the competitive advantage of Kenya with reference to having the a suitable environment for conducting nature based tourism, the Government of Kenya (GoK) acknowledges tourism together with manufacturing and trade as key drivers of the economy (GoK, 2002). This has prompted continued diversification and expansion of this sector aiming to create the much-needed employment opportunities and increase foreign direct investment through the development of tourist facilities. Most of the expansion and diversification is taking place in key tourist destinations of the country comprising of the coast and national parks. These areas present a wide variety of tourism products ranging from safari to beach holidays (Ondicho, 2000). Out of these wildlife safari dominates the sector thereby explaining the high number of tourists witnessed visiting national parks and reserves with animals of high interest being the black Rhinoceros *Rhinoceros unicornis*, Giraffe *Giraffa camelopardalis*,Cheetah *Acinonyx jubatus*, Leopard *Panthera pardus*, Lion *Panthera leo* and African Elephant *Loxodonta africana*, (Valle and Yobesia, 2009).

Cheetah which is the animal of interest in this study is the fastest terrestrial mammal and the most endangered of the big cats in Africa (https://cheetah.org/about-the-cheetah/ accessed on September 2018). This carnivore is distinctively known for its solid black spots which form patterns that are fingerprint unique for every individual and dark facial tear marks (Chelysheva, 2004). The cheetah has its scientific name derived from its semi-retractable claws making it unique among cats and

the mantle like mane in cubs (Furstenburg, 2011). The fingerprint uniqueness of cheetah spot patterns is of great significance to any study conducted on the species because this aids in perfect identification of individuals which is an important aspect in conducting population counts by facilitating capture and re-capture method of data collection without causing confusion.

Despite surviving a population bottleneck (O'Brien *et al*., 1987) there has been a significant reduction in the global population of cheetahs from approximately 15,000 individuals towards the end of the 20th century (Myers, 1975) to approximately 7,100 individuals (Durant *et al*., 2017). This sharp decline has been attributed to reduction in home ranges for this species from their historical range of 2,709,054 km^2 which stretched across Africa and Asia to 25,344,648 km^2 (International Union of Classification of Nature [IUCN], 2015). In this regard the Asian sub-species of the cheetah has become extinct in most of its geographical range (Marker *et al*., 2005). In the African continent the cheetah strongholds occur in Southern and Eastern parts namely: South Africa, Botswana, Zimbabwe, Namibia Kenya and Tanzania (Johnson *et al*., 2010). These strongholds account for 10% of the historic range for the species in Africa (IUCN Species Survival Commission [SSC], 2008). Moreover cheetah population declines have been aggravated by diseases, loss of habitat, illegal trade, high cub and adult mortalities associated with attacks by other carnivores such as lions, spotted hyenas *Crocuta crocuta* as well as small predators like jackals *Canis aureus* and honey badgers *Mellivora capensis* (Mills *et al*., 2014; Walsh, 2015). Poor cub recruitment success associated with anthropogenic factors such as human access to protected areas (PAs) and persecution outside PAs greatly affects population growth rates and persistence (Durant, 2000; Kerley *et al*., 2002; Durant *et al.*, 2017; Broekhuis, 2018). Owing to this decline and continued reduction in the home range the IUCN has classified cheetahs as "vulnerable" leading to enlistment of this species in the Convention on International Trade in Endangered Species [CITES] under Appendix I (Ghimirey, 2006). This enlistment places cheetahs among species prioritized for conservation initiatives.

Kenya which is part of the Eastern Africa stronghold for wild cheetahs harbors the Maasai Mara National Reserve (MMNR) a world over renowned tourist destination famous for its big five species namely lion, leopard, elephant, rhinoceros and buffalo *Syncerus caffer* and the spectacular wildebeest migration. The MMNR supports 30 adult cheetahs that are ranging freely in the area. This low number is attributed to low reproductive success rates as a result of reduced cub recruitment thus hindering population growth, an essential aspect of population demographics for

persistence of a population (Broekhuis, 2018). In order to survive predation risks associated with human access to PAs cheetahs rely on their powerful binocular vision to monitor their environment (Durant, 2000).

Vigilance referred to as the act of monitoring one's environment for any danger that could be lurking is an anti-predation behavior that determines the chances of detecting an approaching danger (Treves, 2000). The likelihood of detection is dependent on how big the group is and how far is a cover that is likely to conceal a predator. An increase in these two parameters increases the likelihood of detection (Watson *et al*., 2007). The notion that vigilance is only exhibited by prey animals has prompted most vigilance-oriented studies to concentrate on species occupying the low trophic level especially herbivores, rodents and passerine birds (Ebensperger *et al*., 2006). While majority of investigations on individuals at the top of the food chain concentrate on the significance of vigilance in predatory success overlooking its significance in predation avoidance (Cooper *et al*., 2007). However, carnivores too suffer competition from other predators resulting in high mortality due to intra-specific and inter-specific conflict (Mills and Mills, 2014).

1.1 Problem statement

PAs such as MMNR play an integral role in the survival of cheetahs especially in this era where those individuals occurring outside PAs face persecution suppressing population growth rates (Durant *et al.,* 2017). Despite such areas being choreographed as safe havens for wildlife heightened direct interventions such as prompt response to disease cases and injuries are witnessed in PAs. Unfortunately, even with such interventions aimed at promoting the wellbeing of a species cheetahs of MMNR continue to exist in a small population of 30 individuals (Broekhuis, 2018). This is because despite tourism in MMNR continues to be celebrated for being extremely successful in economic terms of all PAs including inland and marine national parks, reserves as well as conservancies the booming tourism comes with a greater impact on the Reserve (Bhandari, 2014). This impact is due to unchecked pressures from human activities that end up predisposing wildlife to dire consequences such as reduced reproductive success (Gittleman *et al*., 2001; Caro, 2005; Ciuti *et al.,* 2012). For instance abundance of tourists disrupt cheetah hunts leading to unsuccessful chases or abandonment of the kill consequently having indirect negative impact on offspring especially recruitment of cubs (Burney, 1980; Laurenson, 1994; Frid and Dill, 2002; Kerley *et al*., 2002; Broekhuis, 2018; Broekhuis *et al*., 2018).

Cheetahs are low ranking in the carnivore guild and as a result experience high cub and adult mortalities due to intra-guild hostilities from larger carnivores thereby continuously aggravating population declines in cheetahs. Because of their low-ranking cheetahs hardly stage successful confrontational attacks against other large carnivores making this species protection reliant (Broekhuis, 2108). Recruitment of cubs known as a reproductive success of cheetah mothers is of great significance in promoting the persistence of cheetahs as a species (Durant, 2000; Broekhuis, 2018). Other than existing levels of predation (Mills *et al*., 2014, Broekhuis, 2018), incidences of disease, availability of food and anthropogenic factors such as human access to PAs usually in the form of tourism equally affect recruitment success of cheetah cubs (Kerley *et al*., 2002). In this regard abundance of tourists disrupt cheetah hunts leading to unsuccessful chases (Burney, 1980) or abandonment of the kill (Broekhuis *et al*., 2018) thereby having indirect negative impact on offspring especially the recruitment of cubs (Laurenson, 1994; Frid and Dill, 2002; Broekhuis, 2018).

In order to survive predation risks associated with human access to PAs cheetahs rely on their powerful vision (Montgomery, 2014). These enhance their detectability of prey and predation risk factors (Watson *et al*., 2006). Despite this knowhow little has been done in assessing how the much celebrated tourist abundance influences vigilance behavior of cheetahs which is an important behavioral adaptation for the survival of this species on the verge of extinction.

1.2 Research questions

The following questions were integral to this investigation:

- Is there a relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant?
- Is there a variation in active vigilance among cheetah mothers?
- Does active vigilance among cheetah mothers differ by vegetation type?
- Is there a relationship between time spent being actively vigilant by cheetah mothers and survivorship of cubs?

1.3 Research objectives

General objective

Generally this investigation is set to determine whether presence of tourists and type of vegetation impacts the survivorship of cheetah cubs.

Specific objectives

1. To determine whether there is a relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant.
2. To assess existence of variation in active vigilance among cheetah mothers.
3. To investigate the effect of vegetation type on vigilance behavior of cheetah mothers in MMNR.
4. To determine whether there is a relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs.

1.4 Hypotheses

The following hypotheses were tested for the study:

H_o: There is no relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant.
H_1: There is a relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant.

H_o: There is no variation in active vigilance among cheetah mothers.
H_1: There is a variation in active vigilance among cheetah mothers.

H_o: Active vigilance among cheetah mothers does not differ by vegetation type.
H_1: Active vigilance among cheetah mothers differs by vegetation type.

H_0: There is no relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs.

H_1: There is a relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs

1.5 Justification of the study

Vigilance is often assumed only to be exhibited by prey animals to detect predators (Dunbar and Dunbar, 1980). However, carnivores too suffer competition from other predators resulting in high mortality due to intra-specific and inter-specific conflict (Mills and Mej, 2014). As a threat sensitive behavior, vigilance increases fitness of an individual by influencing foraging and time budgets as well as improving predator detection thus enhancing predator avoidance and as a result increasing the reproductive success of an individual thereby promoting population growth rates (Durant, 2000). Being low ranking in the carnivore guild cheetahs hardly stage successful confrontational attacks against other large carnivores making this species protection reliant (Broekhuis, 2018). Despite their low ranking in the carnivore guild cheetahs have continued to utilize areas occupied by other large carnivores where they manage to hunt, reproduce, raise cubs and somehow evade confrontation with other large carnivores. The continued survival of cheetahs in such areas where carnivore ranges overlap has been possible mostly due to early detection of eminent danger and adoption of confrontation avoidance behaviors such as temporal partitioning of activity patterns. In spite of this the population of cheetahs in MMNR is declining due to increased adult and cub mortalities associated with aggravated attacks by other predators especially lions leading to low cub recruitment rates.

MMNR was deemed fit for the study not only because the reserve is known to harbor one of the highest number of wild cheetahs in Africa but also due to the high visitation of tourists in the area, an important anthropogenic focus point for the study. The exponential growth of tourism witnessed in MMNR prompted the need to conduct an assessment on whether tourist activity influenced the vigilance behavior of cheetah mothers. The results were then used to determine whether a relationship existed between vigilance and reproductive success among cheetah mothers. The idea to conduct this study was further enhanced by existing literature indicating that unchecked pressures from human activities end up predisposing wildlife to dire consequences such as

extinction (Soofi *et al*., 2018). Thorough investigation on effects of anthropogenic activities on carnivores is elemental in aiding their proper conservation (Berger, 2000; Gittleman *et al*., 2001).

Results from this study will aid in policy formulation aimed at enhancing the experience of wildlife tourism while at the same time eliminating the elements of tourists' behavior that have a negative impact on the recruitment success of cubs with an aim of promoting growth of cheetah populations.

1.6 Scope of study

This study revolves around how vigilance impacts a cryptic animal such as the cheetah (Broekhuis, 2018). The guiding principle is that as the animal is busy keeping vigil, exposure time increases thereby increasing chances of detectability by potential danger hence experiencing reduced reproductive success and fitness (Watson *et al*., 2007). The crowding effect of uncontrolled wildlife viewing by tourists introduces another aspect of habitat characteristics as an indicator of the effectiveness of vigilance as a predation avoidance behavior. Studies have determined that vigilance increases in a more obscure environment (Whittingham *et al*., 2004).

1.7 Operational definitions

Cub independence: This is a time from which cubs commence a life of their own away from their mother usually as a sibling group, male coalition or solitary life in the case of a litter comprising of only one cub.

Reproductive success: This is the number of cubs a female cheetah raises to independence.

Tourist abundance: This is the number of tour vehicles recorded at a particular cheetah sighting.

Vigilance: This is referred to as the state of monitoring one's environment for any danger that could be lurking.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This section tackles both theoretical and empirical studies useful as a baseline for assessing the impact of tourists on vigilance behavior of cheetah mothers and how the type of vigilance exhibited by these mothers influences their success in raising cubs. The theoretical aspect will encompass the global cheetah population status, distribution, ecology and factors influencing the survival of cubs, a detailed description on tourism and its detrimental aspects on wildlife especially cheetahs as well as a discussion of the theoretical framework on how human disturbance influences wildlife behavior. The empirical section reviews research work conducted on the subject area.

2.1 Description and brief history of wildlife tourism

Tourism dates back to the Babylonians era a time when travelling was for necessity mostly in search of food or escape from danger. However other people travelled for religious pilgrimages. It was not until the establishment of the Roman Empire that travelling for leisure became more popular. At the peak of its rule the Roman Empire provided people with more money and built roads as well as places where people could rest. All these facilitated the development of tourism as an industry back then. In the middle ages a network of roads, taverns and inns were built along pilgrimage routes to accommodate pilgrims visiting sites of religious significance in France, Spain and Italy. Adventures of pilgrimage can be found at the Geoffrey Chaucer's Canterbury of Tales (Shackley, 2007).

In the 1600s recreational tourism became popular where people would visit spas or other countries to learn their arts and cultures. For instance, young aristocrats from England often traveled to Italy and France visiting ancient ruins and renaissance churches as well as cultural sites so as to appreciate their arts (Aramberi, 2010).

In the 1800s came the industrial revolution which increased the level of affluence among the middle class thereby eliminating the notion that travel for leisure was only for the wealthy upper class. In this era the invention of the train which happened in 1841 followed by further advancements in modes of travel with the invention of steam engines, power sailing ships and later on the car made travel easier unlike before when old methods of travel were time consuming. Despite the changes

in age and technological advancements the reasons for travel and activities have not changed greatly over the centuries (Westcott, 2015). As indicated in Armitage's book the behavior of most tourists irrespective of the date or nature of participation, was summed up as to gape or marvel. This is because all travelers not taking into consideration areas visited and activities indulged humans have travelled far and wide for the same reason, to embrace the marvels of the world. Similarly, a great number of travelers of this age are wowed by the stunning states of areas visited whether archeological sites or areas of wilderness. Moreover, travelers of these days purchase souvenirs for the same reason old age travelers bought mementos, as proof of travel or place visited (Armitage, 1997).

In the beginning of the 20th Century tourism became more popular especially after the two world wars. The use of planes became affordable among the growing middle class contributing to a boom in the tourism industry leading to an increase in the number of accommodation facilities (Westcott, 2015). In this century tourism has expanded incorporating nature-based activities such as mountain climbing and wilderness safari. This was non-existent during the Roman Empire era because areas of wilderness were considered dangerous thus undesirable to visit. However the Roman poets aided the acknowledgement of mountains and wilderness areas leading to a growing appeal towards mountains and delineation of wilderness areas into national parks in Canada, New Zealand and United States, with Rockies and Southern Alps becoming major tourist attractions (Debarbieux *et al*., 2014). Other than just being viewing sites mountains were later on popularized for climbing, walking and setting of winter games (Rio-Rama *et al*, 2019). On top of that perceived health values associated with holidays in mountainous regions have been embraced all together changing the previously regarded useless lands into popular tourist destinations. There have been other few innovations in tourism an example being the cruise tourism bringing back the once disappearing luxury ships that were previously used by the elites for travel to and from destinations. Despite not being an invention exploration has been made much easier, safer and more comfortable but with a concept of tourism attached to it (Armitage, 1997).

Current places of technological and architectural marvel as displayed in Dubai are modern-day versions of pre-historical ingeniousness witnessed in the hanging gardens of Babylon, the Xanadu domes as well as the pavilion of Brighton. The idea of Las Vegas which was choreographed as a major gambling center of the world truly affirms that man-made tourist attractions keep changing

as time goes and whatever is made today for tourism shall be overtaken by a new invention as long as it will be extreme, rare and unique (Butler, 2015).

Wildlife tourism involves observing wildlife in their natural areas or captive settings (Higginbottom, 2004). Nature based tourism which involves expeditions to National parks and wilderness areas has become popular especially to areas that still harbor vast wilderness such as developing countries where biodiversity occur in large numbers (Christ, 2003). Most vacations involving urban dwellers are usually themed in a manner that brings them closer to nature. This is because urban settings are known to disconnect urban dwellers from nature. Moreover, for many people this a chance to escape from their normal bustles and hustles while for others it is an opportunity to explore the world.

However based on the concerns surrounding the degrading effects associated with tourism and related activities the concept of sustainable tourism arouse aimed at addressing these concerns and has been universally accepted as the best approach to development of tourism (Yazdi, 2012). Majority of scientists define sustainable tourism development as the incorporation of the economic, social and environmental aspects of tourism with an ultimate goal of improving experience of tourists (Shen *et al*., 2020). In this perspective the target is to create an equilibrium between protecting the environment, preserving cultural integrity, creating an enabling environment for social justice to prevail through servicing the needs of the current population thereby refining their standards of living both in the short term and future thus attaining both intra-generational and inter-generational equity as embedded in the concept of sustainable development (Bhandari, 2014).

Tourism is an expanding sector experiencing uninterrupted growth with an observed emergence of new destinations and growing markets as a result of emerging economies of the world (United Nations World Tourism Organization, 2013). Despite the portrayal that tourism is purely an ideology of the west the tourism landscape is greatly shifting attributed to the growing middle classes from China, India, South America and Africa who are seeking to enjoy the freedom and consumption privileges enjoyed by previous economies (Burns and Bibbings, 2009). A significant aspect of this growing industry is the non-consumptive utilization of wildlife by viewing wildlife in their natural habitats (Newsome and Rodger, 2013). Averagely India recorded a 15% annual growth rate of tourists in the period stretching from 2002 to 2008 with domestic tourism mostly by the middle class of India accounting for most of this growth (Karanth *et al*., 2012). On the other

hand, in spite of the expansion of the tourism industry global concerns of climate change, unpredictable political environment, uncontrolled human population growth rates, fragmentation and declining habitats as well as species pose a great threat to the industry.

Back in 1963 the main source of foreign exchange for Kenya was majorly through exportation of agricultural produce especially tea and coffee. A decline in prices of these commodities in the world market, prompted Kenya to capitalize on tourism as the best economic alternative thereby contributing to the observed growth of the sector in Kenya and becoming among the drivers of socioeconomic development just like in other developing countries (Valle and Yobesia, 2009). Kenya is among the revered safari destinations of the world as a result of its wildlife diversity, pristine beaches, scenic landscape, unique indigenous cultural heritage and ideal weather conditions (Odunga and Folmer, 2004). Since the colonial era Europeans have continuously visited Kenya and embracing the abundant wildlife and beauty that comes with every species encountered. In early days of colonization most tourist activities were dominated by hunting safaris which was later on banned as early as 1977. Currently itinerary of tourists in the country mainly comprise of safari and holidays at the beach. These have a spatial restriction to a few strategic tourist destinations in the coastal areas as well as in major wilderness areas especially Maasai Mara, Amboseli National Park and Tsavo National Parks (Ondicho, 2000).

The view that Wildlife based Tourism (WT) is a way of combating destruction of wildlife habitats and of immense value in promoting conservation has contributed to an increase in the number of countries and Non-Governmental Organizations implementing the idea of WT is their areas of jurisdiction. However, the high number of stake holders in the tourism sector coupled with insufficient knowledge on how WT affects various ecosystem components continues to pose a great challenge hindering implementation of successful WT (Berger, 2000; Higginbottom *et al*., 2004). In addition, increasing human population, ease of movement across continents and increased preference to travel among humans continue to exert pressure on the meagre resources on the land and water in almost every corner of the universe. These not only destabilizes natural systems but also the quality of recreation (Bhandari, 2014). For example, the high flow of tourists into MMNR is of concern in spite of the economic benefit accruing from tourism.

2.2 Effects of humans on wildlife behavior

Disturbance arising from human activities has a likelihood of influencing the behavior of wildlife and consequently affecting populations. When in an area experiencing disturbance as a result of human presence or activities wildlife tend to pay more attention to their environment by staying actively vigilant with a resultant effect of reduced feeding and consequently recording poor rates in reproduction success(Ciuti *et al.,* 2012). In response to increasing activity of humans carnivores exhibit avoidance behaviors in both space and time because human activities have been associated with excretion of stress hormones in high concentrations, a reduction in foraging episodes and more time keeping vigil for quite a number of carnivores (Pangle and Holekamp, 2010). Therefore, proper carnivore conservation requires an in depth understanding on effects of human disturbance whether lethal or not (Gittleman *et al*., 2001).

Behaviors such as vigilance which are oriented in determination of threats are significant in the conservation of carnivores because they are likely to influence feeding and time budgets (Caro, 1999) with a tangible effect on growth rates among populations (Dobson and Poole, 1998). Currently majority of mammalian investigations focus on the role of carnivores as predators omitting the fact that carnivores too get preyed on (Cooper *et al*., 2007). Such an omission results in poor understanding of how carnivores cope with danger.

Tolerance to tourists exhibited by cheetahs of the MMNR was more less a learned behavior attributed to long hours of exposure of cheetahs to tourist activity. However, cheetahs in the Mara tend to move about and fend for themselves regardless of the presence or absence of tourists with most hunts occurring in early and late hours of the day (Chelysheva and Kuznetcov, 2008). This pattern had numerous exceptions however nearly one quarter of the total hunting was recorded in the hottest hours of the midday period when virtually all the tourists were back in the facilities having lunch and rest. This clearly suggests that tourist activities have an influence on cheetah behavior.

2.3 Background information on cheetahs (*Acinonyx jubatus*)

Cheetahs are classified as “Vulnerable” (this classification implies that cheetahs are vulnerable to becoming extinct as a result of continued reduction in their numbers globally) by the IUCN and

are listed in the CITES Appendix I (Nowell and Jackson, 1996). Historically cheetahs were widely distributed across Africa and Asia. However, their current historic range has significantly reduced from 2,709,054 km^2 to 25,344,648 km^2 (IUCN, 2015). This reduction in range is mostly attributed to loss of habitat and fragmentation, retaliatory killings and capture of cheetahs for attacks on livestock and, reduction to total loss of species the cheetahs prey on (IUCN SSC, 2012). In areas such as the horn of Africa, sale of cheetahs through the black market is purported to be a major cause of decline (Tricorache *et al*., 2018). In Asia they have become extinct in most of their geographical ranges (Marker *et al*., 2005). However,r cheetahs occupy 10% of their previous range in the African continent (IUCN SSC, 2008).

The global population of known cheetahs is estimated at 7,100 adults and adolescent individuals. Out of this, Eastern Africa has the second largest cheetah population after Southern Africa with 1,960 individuals. These are known to utilize not more than 6% of their pre-historic range that covers an area of 310,586 km^2. Despite the consequential range loss and persecution these two are the species strongholds for the last remaining wild cheetahs (IUCN/SSC, 2008).

The area connecting Northern Tanzania and Southern Kenya is an important range for cheetahs. Resident Cheetahs occur in the whole of Ethiopia's Southern corridor connecting South Sudan with a probable extension of this resident population into the northern areas of Kenya. Other parts of Kenya, northern parts of Uganda, Tanzania, Ethiopia and South Sudan harbor cheetah sub-populations that are fragmented throughout these regions. Unfortunately the status of cheetahs in Sudan, Somalia, Eritrea and Djibouti is not known (IUCN, 2015).

Cheetahs exhibit both anatomical and behavioral differences to other big cats. Distinctive to a cheetah are the long black lines that are tear shaped running down from the inner corner of each eye along both sides of the nose to the mouth. The coat of a cheetah is tan-yellow in color with both small and large solid black spots and a white belly. Spots on the tail fuse forming dark rings with the tip of the tail often being fluffy white or with a black tuft. Cheetahs do not exhibit sexual dimorphism such that one cannot tell males from females by appearance. Cubs are usually born with mane like fur on their back and harbor small spots on their coat which become distinct as the cub grows.

Being the fastest terrestrial mammal cheetah has a large and strong heart, gigantic liver and arteries that are characteristically large and strong. Its narrow body with slender long legs and specialized must act simultaneously to provide the much needed acceleration during high speed chase hunts. The tail of a cheetah acts as a stabilizer preventing rolling over when negotiating bends while at full flight. Cheetah is also known for its semi retractable claws a feature unique to it among the cats. These semi retractable claws aid in gripping the ground thus enhancing traction.

Cheetah was initially classified under *Felis jubatus* but was later reclassified into the monospecific *Acinonyx brooks* with *jubatus* as the only species. The translation of the genus and species name of cheetah *Acinonyx jubatus* is in reference to its semi retractable claws and mane like mantle on cubs respectively. As far as classification is concerned there are five recognized subspecies of cheetahs. These include*Acinonyx jubatus venaticus, Acinonyx jubatus hecki, Acinonyx jubatus soemmeringii, Acinonyx jubatus raineyii and Acinonyx jubatus raddei* (Farhadinia *et al*., 2016).

2.4 Cheetah habitat and ecology

Cheetahs like any other animal require a habitat that gives them the opportunity to reproduce safely, meet their nutritional requirement and provide shade for temperature regulation during warm seasons and hot climatic conditions. On a continental level, cheetahs are found in Iran, parts of Asia and Africa. African cheetahs exhibit diverse habitat utilization and eco-regions including mountainous regions of Ethiopia, woody forests, scrubland, grassland and areas with desert-like conditions such as Sahara and Namibia (Durant *et al*., 2014). With regards to climate and elevation cheetahs predominantly occupy habitats experiencing dry climatic conditions which are often associated with low level vegetation. Despite there being no reports of cheetahs in the tropics and montane forests cheetahs have been sighted in Mount Kenya at an altitude of 4,000m (Mwebi *et al*., 2019). Desert vegetation is known to provide adequate protection to cheetahs seeking for lairs and shade while at the same time the open vast land enables cheetahs to locate prey with ease and ensures successful hunts due to little or no inhabitance to high speed chase by cheetahs. Cheetahs are not obligate drinkers thus highly adapted to living in arid areas. For instance, in the Kalahari Desert cheetahs approximately walk up to 82 km between drinks of water. Desert inhabiting cheetahs consume tsama melons or urine and blood of their victims as a way of quenching their thirst (Woosnam, 1913).

In choosing a location to establish a lair, cheetahs look for a habitat that will allow them take cover in. Lairs are very important to cheetah mothers as well as for raising cubs. Most lairs are in gullies, areas with dense vegetation and marshes. All these must be near a water source since pregnant mothers or nursing offspring drink water frequently (Durant *et al*., 2010).

Male cheetahs are known to exhibit high social behavior compared to females which is depicted as soon as cubs begin an independent life away from their mother. Independence life of cubs begins when a mother separates herself from her sub adult cubs. Immediately cubs form a temporary sibling group which lasts for approximately seven months a period during which cubs sharpen their survival skills especially food acquisition. After which the sibling group breaks where male cubs form a life-long unit called a coalition whereas female cubs begin their solitary life.

2.5 Activity patterns of cheetahs

Night-time activity of cheetahs has been associated with the cycles of the moon (Broekhuis *et al*., 2014). Such an association supports the hypothesis that vision is integral in shaping day time behavior useful in avoiding competition. In the contrary cheetahs have been observed to exhibit high nocturnal activity in areas where they experience little competition such as in Sahara and farmlands of Southern Africa (Belbachir *et al*., 2015). However, it is quite difficult to determine whether such a behavior is as a result of competition reduction or elevated day time activity of humans in the area. There are reports that tie crepuscular behavior among carnivores to increased success in hunting (Hayward and Slotow, 2009). But there has been no support for the hypothesis that predators would be active at the same time as their main prey species. Moreover, predators that limit their activity to night-time exhibit a decrease in activity during the darkest hours of night due to limited vision during such moments.

All members of a guild are bound to suffer some level of predation but only the low-ranking individuals exhibit avoidance in an attempt to minimize interactions with other members especially the high-ranking ones. According to Hayward and Slotow (2009) low ranking predators (wild dogs and cheetahs) frequently lost their kills to high ranking predators thereby minimizing their activity in a time when high ranking predators exhibited heightened activity (lions and spotted hyenas). High ranking predators have an extensive diet which overlaps with that of low-ranking ones but still do not exhibit reduced activity that would otherwise lower food competition in a guild. Thus,

ideal patterns of activity evolved in a manner that complements the existing differences among species. Hayward and Slotow (2009) concluded that the need to avoid competition is a major factor influencing the time when an animal is to be active and when to halt activity. They also added that carnivores in Africa have evolved morphological adaptations that correspond to their patterns of activity whilst indicating the duration they have occupied in the same ecosystem.

Lack of homogeneity in dominance behavior is a characteristic of large carnivore guilds but in spite of the asymmetry subordinate species can co-exist with their dominant counterparts by altering the time they utilize habitats and when they search for food (Cozzi *et al*., 2012). When considering a guild in Africa cheetah and the African wild dogs are often described as crepuscular animals whose activities are limited to day-time. The notion is that these patterns of activity are as a result of wanting to avoid crossing paths with lions and spotted hyenas who are known to be stronger. However, the perception that activity patterns of carnivores are influenced by the risk of predation and need to avoid competition has been challenged with existence of new recorded observations.

Analysis of a radio collaring study conducted on the Okavango delta involving cheetahs, spotted hyenas, wild dogs and lions revealed existence of higher levels of overlap in activity patterns among these carnivores over a 24-hour cycle (Cozzi *et al*., 2012). According to this study the results were contradicting previous notions due to lack of extensive investigations on night-time activity of cheetahs and wild dogs. Results of this study also indicated that night-time activity of cheetahs fluctuated with the cycle of the moon which accounted for 40% of most of the recorded night-time activity. Availability of moonlight was concluded to be a hindrance to night-time activity of these carnivores. Contrary to nocturnal patterns of activity in cheetahs and wild dogs, availability of moonlight did not interfere with night-time activity of lions and spotted hyenas. From the study it was concluded that presence of an enabling environment enhancing hunting success are integral in shaping night-time activity patterns of low ranking carnivores insisting that these animals are driven by hunger. In a nutshell benefits accruing from moonlit nights outweigh the risk of coming into contact with predators and competitors exhibiting night-time activity.

2.6 Cheetah cub mortality

Cheetahs are highly prone to feline diseases with a higher likelihood of vulnerability due to lack of heterogeneity in cheetah populations. Most common diseases associated with cheetah deaths are

sarcoptic mange, helicobacter associated gastritis, amyloidosis, glomerulosclerosis, liver's veno-occlusive disease and erosion of the focal palate. Despite insufficient documentation on survivorship of cubs during the period of denning mortality in cheetah cubs is known to be high and usually occurs early stages of life especially when mothers conceived shortly after losing cubs (Laurenson *et al*., 1994). Other than diseases cheetah cub deaths have been attributed to predation by lions, spotted hyenas and leopards, smaller carnivores especially honey badgers, serval cats and jackals. Carnivorous birds such as the Secretary bird have also been implicated (Mills and Mills, 2014**).** For instance, indiscriminate persecution of animals due to human-wildlife conflict continues to pose a great danger to Namibian cheetahs (Marker *et al*, 2007). In Serengeti National Park of Tanzania most of the cheetah cub mortalities are as a result of attacks by lions (Kelly and Durant, 2000). In Kgalagadi Transfrontier Park, which is shared by South Africa and Botswana, cheetah cub mortality is approximated at 28.9% attributed to predation especially by lions (Mills and Mills, 2014). As much as cheetah cubs are known to die out of abandonment, fires and poor state of health attacks by lions and spotted hyaenas (*Crocuta crocuta*) is documented as the major cause of cub mortality in wild cheetahs (Broekhuis, 2018). Increment in the population of lions has been documented to exhibit a negative correlation to the recruitment success of cheetah cubs (Durant *et al,* 2004).

Majority of cub deaths in MMNR occurred in the first three months after birth especially after change of den from the initial birth place. The Mara Meru Cheetah Project attributes change of den to human disturbance as a push factor especially tour vehicle visitation to a den area. This was confirmed after abolishing visitation of humans to cheetah dens until cubs were ready to walk a practice which saw a phenomenal increase in the sum total of cheetah cubs viewed between the ages of one week to three months old. This was contrary to before this abolishment where a female would be seen having six one week old cubs and in less than a month lose 90% to 100% of this litter (Unpublished Mara Meru Cheetah Project report presentation at the KWS Annual Carnivore Conference, 2014).

2.7 Anti-predator behavior

The risk of predation is a factor that shapes the behavior of an animal (Caro, 2005). Behavioral variations among individuals in a population have been recorded (Sih *et al*., 2004). In the event a variation occurs in a behavior that affects the risk of predation there is a high likelihood of

individuals exhibiting a variation in survival rates (Lind and Cresswell, 2005).Animals with behavioral adaptations that reduce the risk of being preyed on increases their chances of surviving thereby exhibiting increased fitness. Different anti-predation behaviors are associated with effects that are varying. For instance, cheetahs can lose up to 10% of their prey to kleptoparasites most likely to lions and spotted hyenas when in areas where these top predators occur in large numbers. In such occasions, cheetahs abandon their kills as soon as they have had their fill and tend to limit their activity to day time a strategy aimed at reducing competition and associated negative outcome (Hunter *et al*., 2007).

Most behaviors associated with a reduction in the risk of predation lie on a continuum ranging from holistic behaviors such as habitat choice and level of activity ensuring avoidance thus reducing the risk of predation to more particular behaviors associated with a reduction in chances of being captured when attacked such the angle of flight when escaping (Caro, 2005). Exhibiting avoidance behaviors that minimize the risk of exposure to high ranking predators are perceived to be strong because successfully avoiding an attack is the most effective way of eliminating the risk of predation (Valeix *et al*., 2009). These behaviors are expected to be a major factor behind the existing variation in survival among individuals.

Animals that forage have been documented to keep off areas with high risk of predation (Altendorf *et al*., 2001). This is regardless of the cost to nutritional gains (Walther and Gosler, 2001). However total avoidance of detection is usually not compatible with important needs like feeding. Therefore when the cost of avoiding predation is high animals end up taking some risk so as to meet their nutritional requirement (Brown and Kotler, 2004). In such cases where animals are prone to predation, they exhibit specific behaviors such as increased levels of vigilance with a likelihood of enabling survival and enhancing fitness of an individual. Additionally animals that can effectively outrun predators end up hunting in areas of elevated predation risk (Heithaus *et al*., 2009).

Animals that forage mostly meet their nutritional requirement by tolerating a certain degree of predation risk but minimize the risk of an attack with defense behaviors during an attack (Lind, 2004). Effectiveness of anti-predatory behaviors in relation to survival of an individual should be taken into account when the perceived risk is reduced. Behaviors that have a potential in eliminating risk of attack enhance survival of an individual without exhibiting behaviors that are mean to minimize the chances of being captured during an attack. But in the event of an

unavoidable confrontation between high ranking and low ranking individuals, behaviors that enable the low ranking one to escape the scene for instance outrunning the attacker, such a behavior becomes crucial in enhancing the survival of the low ranking individual. Predation avoidance behaviors and escape behaviors are selected differently where adoption of one hinders selection of the one (Sansom *et al*., 2009).

2.8 Vigilance as an anti-predator behavior in carnivores

Vigilance is recognized as an anti-predation behavior which determines the likelihood of detecting an approaching predator (Treves, 2000). The chances of detecting potential danger increases with increasing size of a group and distance from a probable concealing cover of predators (Cresswell, 1994). Early detection of danger presents a good window to adopt an appropriate predation avoidance escape thus increasing fitness of an individual (Quinn and Cresswell, 2005). However, the reverse is true in a cryptic animal such as Cheetah (Broekhuis, 2018). This is because as the animal is busy keeping vigil exposure time increases thereby increasing chances of detectability by potential danger (Watson *et al*., 2007). The effectiveness of vigilance as a predation avoidance behavior is influenced by habitat characteristics. Such that vigilance increases in a more obscured environment (Whittingham and Evans, 2004).

The assumption always is that prey animals exhibit vigilance for predator detection whereas predators thought to scan their environment in search of prey (Scannell *et al*., 2001). Such notions overlook the many reasons animals scan their environment and ignore the fact that carnivores equally suffer from risks associated with predation such as competition for food and territory (Caro, 1987) and consequently suffering high mortality due to intra-specific and inter-specific conflict.

Majority of studies regarding vigilance concentrate on individuals at the low levels of the food chain mostly being herbivores, passerine birds and rodents (Ebensperger *et al*., 2006). When it comes to high ranking members of a food chain investigations focus on these individuals as predators overlooking the fact that they are equally preyed on (Cooper *et al*., 2007).

Despite the knowledge that large carnivores face quite a number of threats in their natural world which range from conflict within a species or loss of prey to either their own or to other species (Caro and Stoner, 2003). There is little documentation on vigilance as a behavior that is exhibited

by top predators thus inadequacy of information that would otherwise create an understanding on the ways in which these top predators cope with or evade danger. However, in support of the hypothesis that cheetahs rely on vision to avoid competition as an important driver of diurnal behavior, Caro (1994) reported that heightened diurnal activity is a competition reduction strategy. Moreover, vigilance has also been used to indicate the level of risk perceived by animals inhabiting areas of elevated levels of human activity. For example, hooded cranes *Grus monacha*were observed adjusting their vigilance patterns and time spent being active so as to survive a wintering group pre-occupied by humans (Li *et al*, 2015). Presence of tour vehicles was also associated with increased vigilance among polar bears (Dyck and Baydack, 2004).

2.9 Research gaps

Burney (1980), indicated that tolerance to tourists exhibited by cheetahs of the Mara was more less a learned behavior attributed to long hours of exposure of cheetahs to tourist activity. In his study he observed that cheetahs in the Mara displayed a tendency of moving about and hunting in the early morning and late evening regardless of the presence or absence of tourists. However, in his observations nearly one quarter of the total hunting was recorded in the hottest hours of the midday period when virtually all the tourists were back in their respective accommodation facilities having lunch and taking a rest. This depicts an important message that there was a likelihood of tourist presence influencing hunting activity. However, Burney did not investigate this peculiar behavior and which type of cheetahs whether males or females or females with cubs exhibited this behavior.

Broekhuis (2018) conducted a research on natural and anthropogenic drivers of cub recruitment in large carnivores particularly cheetahs of Maasai Mara. In her study she investigated influence of tourists' abundance and vegetation in recruitment of cheetah cubs to independence. Findings from her study indicated that abundance of tourists hampered successful recruitment of cheetah cubs. However, she failed to define "tourists' abundance" whether as individual head counts of tourists or the number of tourist vehicles.

Also, she highlighted that open habitats are a high-risk factor due to minimal or absence of hiding refuges for cheetahs. This notion overlooks the fact that open habitats provide an opportunity for cheetahs to use their powerful vision to detect prey and potential risk factors such as predators thereby increasing chances of survival and cub recruitment (Watson *et al*., 2006). Contrary to

Broekhuis, bushy areas offer predators with concealment and stalking possibilities (Rollins, 2004). Moreover, Broekhuis did not investigate whether tourist abundance has an effect on vigilance and its correlation to cub recruitment or reproductive success of cheetah mothers. Owing to these conflicting findings on how habitat impacts cub recruitment and the fact that tourist abundance has been documented to negatively impact cheetah cub recruitment it was deemed important to undertake this research in assessing the impact of tourist presence on vigilance of cheetah mothers and its correlation to the reproductive success of an individual bearing in mind that Maasai Mara side of the Mara-Serengeti ecosystem is one of Africa's strongholds for wild cheetah populations of global importance.

2.10 Theoretical framework

This study was based on the Health Belief Theory (Mattson, 1999) which acknowledges that beliefs help in shaping behavior. This theory focuses on threat perception and behavioral evaluation as aspects of health and behavior for an individual (Mattson, 1999). Despite this being a human theory, it is important to note that animals too develop threat sensitive behaviors based on past experiences or interaction with the 'threat' in question. Threat perception or appraisal of feared risk is based on an individual's vulnerability to harm and the expected intensity of the outcome associated with the risk. This health belief theory goes by the statement, whenever the level of assessed risk increases there is a likelihood of behaviors ensuring prevention being adopted (Zak-Place and Stern, 2004). According to this theory behavioral evaluation is informed by the benefits associated with a course of action which is available and that the perceived costs of pursuing the intended action does not override the benefits (Winfield and Whaley, 2002).

2.11 Conceptual framework

The health belief theory forms the foundation of the conceptual framework (Fig 2-1). This theory stipulates that risk perception informs adoption of behaviors by an individual such that whenever the level of assessed risk increases there is a likelihood of behaviors ensuring prevention being adopted (Zak-Place and Stern, 2004). In this study presence of tourists is hypothesized as the risk factor for cheetah mothers whilst level of vigilance behavior exhibited by cheetah mothers being the counter behavior towards minimizing or completely avoiding consequences associated with the risk factor. Therefore, as shown in the conceptual framework (Fig 2- 1), tourist activity is an

independent variable while vigilance is a dependent variable whereby the interaction of both variables determines the level of reproductive success among cheetah mothers.

As per the conceptual framework whether low or high tourist activity has an influence on cheetah vigilance behavior. However, the nature of vigilance responses by cheetah mothers to these external stimuli will determine their reproductive success. Cheetah mothers that are actively vigilant in the presence of tourists are expected to spend more time sitting and standing. Moreover, when lying down most of the time the cheetahs will have their heads raised in an attempt to look around. Such cheetahs will be spotted on elevated objects such as cars, termite mounds and trees. This behavior contributes to less time spent resting and reduced concealment thus reduced alertness in absence of tourists especially at night when top predator activity is high and increased detectability respectively. The anticipated resultant effect being increased ambush attacks and confrontation with top predators either as on the spot attacks or attacks at night leading to aggravated mortalities of both adult cheetahs and cubs contributing to an overall population decline.

On the other hand, cheetah mothers that exhibit increased passive and zero vigilance in the presence of tourists will spend most of their time away from elevated objects. During this time they will be lying down with the head flat on the ground exhibiting few incidences of raising their heads lasting for a few seconds to scan the area thus achieving nearly total concealment, reduced detectability and more time spent resting at a time when activity of other top predators is equally low. Such cheetahs are expected to attain high alertness in the absence of tourists especially night time thus improving their level of predation avoidance thereby having increased success in raising cubs with a resultant effect of increasing cheetah population in the long run.

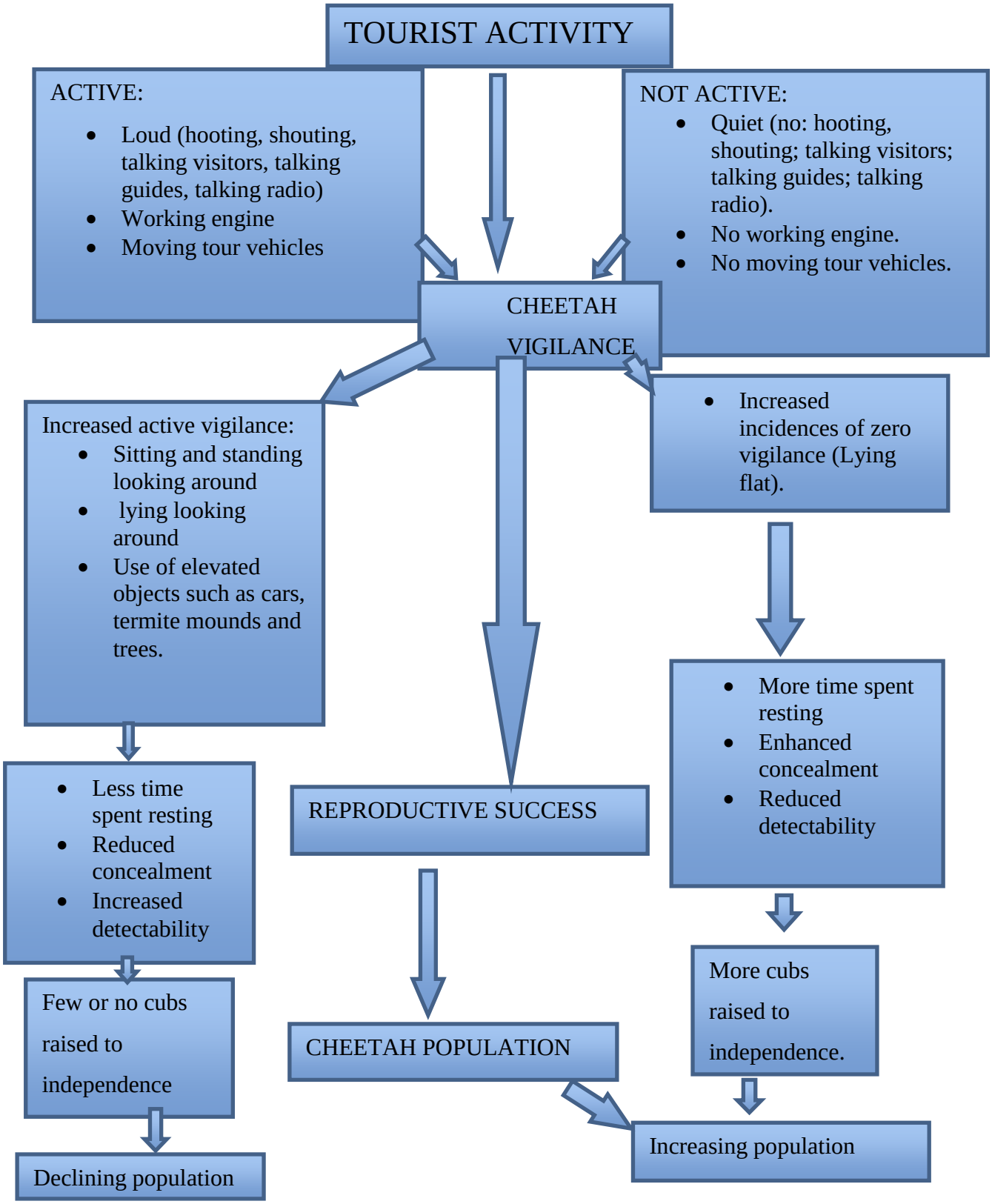

Figure 2- 1: Conceptual Framework

Source: Researcher, 2019.

CHAPTER THREE: STUDY AREA AND METHODOLOGY

3.1 Study area

3.1.1 Location and size

MMNR derives its name from the Maasai community residing in this area and the Mara River that passes through the reserve. The reserve is located within the County of Narok and lies on the South-western part of Kenya at $1^0$40' S, $35^0$50'E latitude and longitude respectively. This location is at an altitude of between 4,000 and 7,000 feet above sea level (Figure 3.1). The reserve covers an area of 1,500Km^2 which is part of the 25,000Km^2 Mara-Serengeti ecosystem (Shah and Mukhovi, 2019).

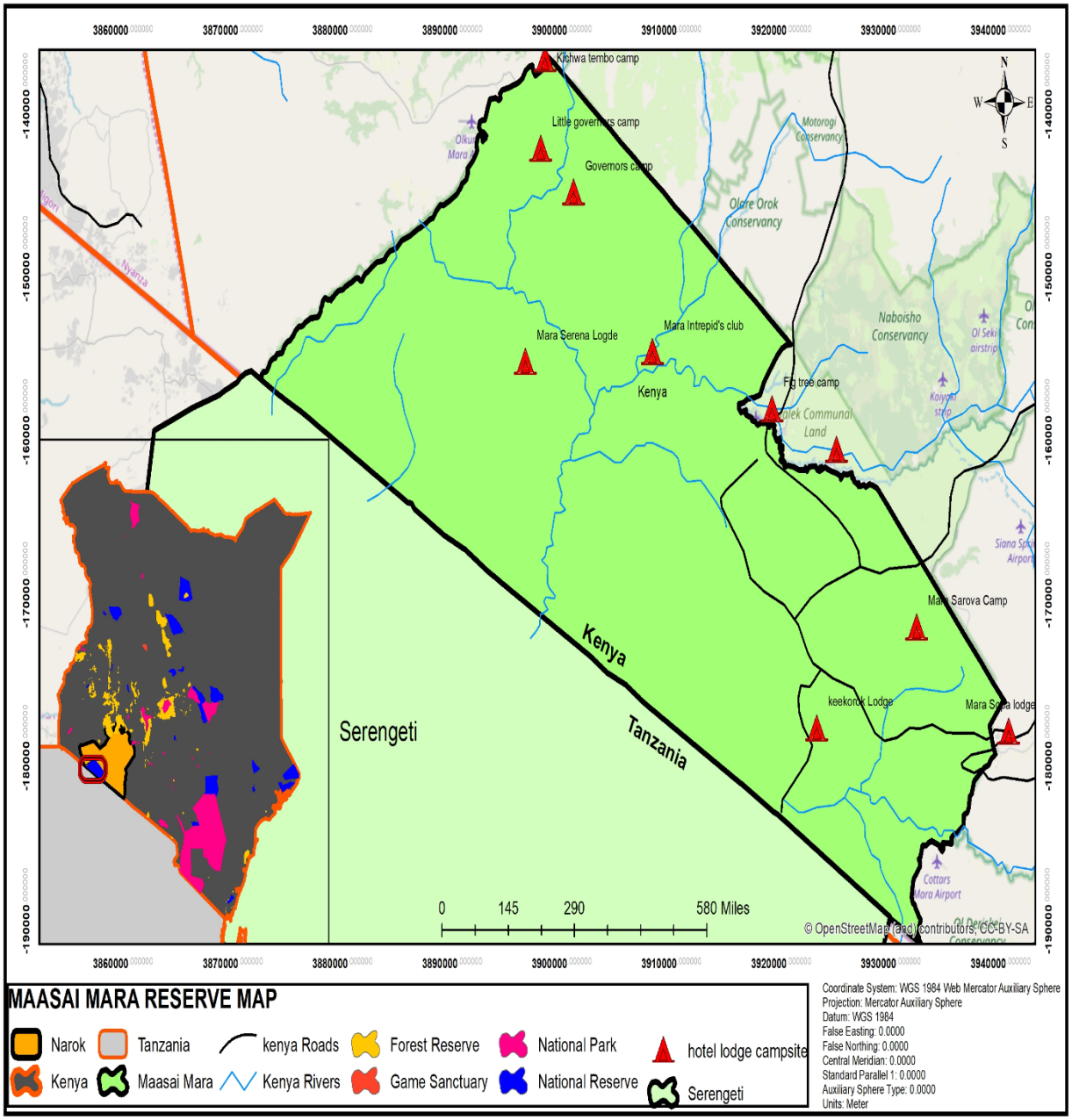

Figure 3- 1: Map of Maasai Mara National Reserve

Source: Researcher, 2019.

3.1.2 Climatic conditions

On average the mean annual rainfall experienced in MMNR is 1015mm with daily temperatures ranging between 12^{o}C and 30^{o}C (Shah and Mukhovi, 2019). The area experiences two sets of rainfall characterized as short and prolonged rains. Shorter ones occur between November and December with a minor peak in December whereas the long rains occur between January and June

experiencing a major peak in April. The dry season spreads through July to October separating the short rainy season from the long rainy season. The dry and wet seasons of the Mara experience an oscillation approximately after every three years (Bartzke *et al*, 2018).

3.1.3 Drainage

The area of study is made up of various rivers and seasonal streams. Mara River is the main river which is approximately 290 km in length draining into Lake Victoria through Tanzania. The Mara River has its source at the Mau catchment area and flows through the slopes of Siana escarpment into the reserve Mara triangle consequentially causing flooding during the rainy season when it breaks its banks. All water courses in MMNR drain into Mara River. Of these only Talek River and Sand River which are the largest and permanent tributaries of Mara River. The rest dry up during the dry season (Bhandari, 1999).

3.1.4 Vegetation cover

MMNR is an area of open rolling grassland with some shrub-land. The vegetation in Maasai Mara ranges from areas of open grass, shrub, woodlands, and woody riverine bushes. Predominant grass species include *Themeda triandra* occurring mostly on the southern and western part of the study area whereas Croton bushes *Croton dichogamous* and Vachellia woodland species *Vachellia drepanolobium* as well as *Vachellia gerrardii* dominate the North and north-eastern sides of the study area (Broekhuis, 2018). The distribution of woody vegetation seems to be determined by altitude where high areas are characterized by *Olea Africana, Rhus natalensis, Tarchonanthus camphoratus* and *Ozorea insignis.* Plains are mostly characterized by *Balanites aegyptiaca* and *Bosia angustifolia.* Riverine vegetation comprises of woody species such as *Warburgia ugandensis, Diospyros abyssinica, Acacia kirki, Ficus species* and *Euclea divinorun.* Some areas are dominated by pure stands of *Acacia drepanolobium* (Okul, 2014).

3.1.5 Wildlife diversity

Inhabitants of this area are mainly ungulates and quite a number of carnivorous species hunting them. These comprise of the famous big five (rhinos, lions, leopards, elephants and buffaloes), cheetahs, warthogs, zebras, giraffes, antelopes, wildebeests, hyenas, gazelles, hartebeests,

crocodiles, oribis, among others of touristic importance (Green *et al*., 2018). As a protected area, MMNR harbors Southern black rhinos, lions, elephants, cheetahs, Maasai giraffes as species enlisted by IUCN for conservation prioritization. Other than the big five MMNR is famous for the migration of a massive number of wildebeests from Serengeti National Park to MMNR annually. This usually takes place during the onset of the wet season from August through November during which herds of Zebras and Wildebeests cross Sand River and Mara River as they enter the MMNR. Because of its great diversity of wildlife and the wildebeest migration the reserve keeps recording the highest tourist visitation in the region leading to the rapid development of tourist facilities in the area (Ondicho, 2000).

Population of cheetahs in Maasai Mara is very low standing at 30 adults (Broekhuis, 2018). Most of cheetah mortalities in MMNR has been attributed to diseases especially sarcoptic mange with attacks by lions being the major cause (Mara Meru Cheetah Project progress report, 2019). According to the Mara Meru Cheetah Project, cheetahs of MMNR exhibit different behavioral responses to human presence especially tourists. There are those that display shyness tendencies by inhabiting areas such as thick bushes and mountainous regions inaccessible to tourists. Such cheetahs also display avoidance behavior in the event of an approaching tourist vehicle. Alternatively, there are those cheetahs that are highly accustomed to presence of tourists thereby displaying dependency. These cheetahs lay partially inactive in the absence of tourists and only exhibit normal active behavior such as hunting, playing and hoping onto tourist vehicles to scan the environment for prey and potential danger. Behavioral data collected by the Mara Meru Cheetah Project team which is unpublished also shows that cheetahs harboring less than one month old cubs inhabit secluded areas hardly visited by tourists. These cheetah mothers have been observed to hunt far from where the lair is and maneuver back so as not disclose the location of the lair. In the event of the denning area being visited, cheetah mothers often relocate cubs by lifting them in her mouth to another discrete location.

3.1.6 Tourism trends in Maasai Mara National Reserve

Tourism in the Masai Mara National Reserve has been extremely successful in economic terms. Of all 57 protected areas, which include inland and marine national parks and reserves, Masai Mara receives the highest number of visitors not only in Kenya but in East Africa (Onchwati *et al*., 2013). According to Sindiga (2018), average annual tourist entry in the Mara is around 200,000.

Over the past decade, the recorded visitor entries to the Masai Mara National Reserve have been increasing annually at the rate of 9%per year. In 1980, the total visitor entry was 114, 000, which increased to 255, 000 in 1990. On an average the visitor stays in the Reserve for about 2.5 days. After 1990, visitor entry rate has not been constant every year, but the trend is not negative. An increase in visitors also increases the number of vehicles, thus the impact on the cheetahs in the Reserve is also greater (Bhandari, 2014).

Development of tourist facilities in the Reserve has been rapid in response to the increasing number of visitors. In 1963, Keekorok Lodge was established as the first lodge in MMNR. However, owing to increasing demand for accommodation as a result of the high number of tourists visiting MMNR there has been an influx of more lodges and numerous camps both permanent and temporary ones. During the study period between 2013 and 2015, there were more than 100 tourist facilities in MMNR and surrounding.

3.2 Methodology

This section entails a description on how the study was conducted highlighting the target population, sampling design, sources of data, methods of data collection and methods of data analysis. Owing to the relevance of this study to the Mara Meru Cheetah Project goals and objectives, I received approval to conduct this study within the greater project while working as a senior research assistant for the Mara Meru Cheetah Project. This approval made this study possible since it cut down on financial implications that would have been a major challenge for conducting this study. Also, findings from this study shall be used as a reference point by the Mara Meru Cheetah Project during formulation and implementation of policies aimed at enhancing the conservation of cheetahs.

3.2.1 Target population and sampling design

The study had two target populations namely cheetah mothers and tourists. Cheetah mothers were targeted due to aggravated cheetah cub mortality in the reserve as reported by most tour guides who often encountered dead cubs or conflict incidences that resulted in cheetah cub deaths and injuries or death of adults. Moreover, only females were targeted because male cheetahs do not have a direct impact in recruitment of cubs since they do not participate in raising cubs (Boast *et*

al., 2018). During the study period behavioral observations were conducted on 10 different cheetah mothers.

Tourists were targeted because of the uncontrolled high number of tourist vehicles often spotted at a particular cheetah sighting. This phenomenon prompted the study to focus on vigilance responses by cheetah mothers onto activity of tourists as a way of assessing whether presence and activity of tourists influenced vigilance behavior of cheetah mothers. Vigilance is a behavioral characteristic significant in enhancing the survival and reproductive success of such a cryptic animal. The number of tourist vehicles was recorded alongside the activity of tourists in those vehicles at intervals of two minutes. The aim was to correlate the change in number of tourist vehicles and activity of tourists with recorded behavioral changes among cheetah mothers. An assessment of existing trends regarding behavioral response by cheetah mothers would help determine whether the number of tourist vehicles and activity of tourists triggered behavioral responses. By the end of the study period a total of 7,209 tourist vehicles were tallied.

Focal to this study were cheetah mothers spotted at the time of study utilizing MMNR and all tourists at a cheetah sighting regardless of the number of cars, age and activity of tourists. Some of these cheetah mothers would move out of the Reserve into neighboring conservancies and sometimes to Serengeti National Park leading to a reduction in the number of observations made them since there was no data collected on them while outside the reserve. This was due to existing policies that hindered the research team from accessing those territories. However, these cheetah mothers often came back and were re-captured by the research team.

The study used an empirical research design where observed vigilance behavior exhibited by cheetah mothers was recorded. This design was deemed useful as it aided in identifying interaction between independent variable (tourists) and dependent variable (vigilance behavior). Observation data on cheetah behavior in the presence of tourists which was recorded in the period between 2013 and 2016 was used in this study. The data collected was part of a larger data collection exercise on cheetahs of the Mara by the Mara-Meru cheetah project.

The study relied on data collected from January 2013 to December 2015. During this study period capture and re-capture technique was used for sampling of cheetah mothers for the study. In pursuit of capturing and re-capturing cheetah mothers, the researcher relied on opportunistic encounters

and snow balling technique where tour guides were elemental in providing information on location where female cheetahs with cubs were sighted. In the event of more than one female with cubs was sighted, priority would be given to the cheetah who had not been studied followed by one with very young cubs then one with few recorded observations. By the end of the study period, behavioral data was collected on 10 different cheetah mothers. These accounted for the 85 data collection sessions.

Data regarding number of tourist vehicles and activity of tourists was also recorded at intervals of two minutes alongside observed behavioral data from cheetah mothers. For number of tourist vehicles a physical count was conducted every time behavioral data was recorded. Activity of tourists was grouped into high and low activity categories where a physical count of the number of tourist vehicles whose occupants exhibited silence tallied and recorded under low activity category while those vehicles whose occupants exhibited activity associated with noise were counted and a tally recorded under high activity category.

MMNR is a PA and can only be accessed using a vehicle. Therefore, the research team used a 1500cc Suzuki Maruti to gain access into the reserve in search of cheetah mothers for the study. While out in the reserve a binoculars <<Steiner>> 7x50 was used to scan the area for any indication of cheetah presence. Once a cheetah mother was sighted the research team would carefully approach the area and log in location data using a Garmin global positioning system. In estimating the distance between cheetah mothers and tourist vehicles a <<Panda>> rangefinder was used.

3.2.2 Sources of data

The study relied on primary and secondary sources of data. Primary sources entailed direct observations from the field as well as supportive data from Global Positioning System (GPS) and photography. Secondary sources of data predominantly comprised of reviews on existing literature especially publications in various journals from past studies on the subject matter and related research topics were reviewed using Google scholar search engine. Scientific journals were also used to get academic information. Renowned magazines such as SWARA magazine was also taken into account as well as information on websites owned by research organizations such as the Mara Meru cheetah project, Cheetah Conservation Fund (CCF) and CITES were considered.

3.3 Methods of data collection

Before the actual data collection a site visit was conducted in December 2012 during which an eleven day feasibility study was performed which aided in informing the efficient data collection tools, sampling techniques and appropriate vehicle for the actual study based on the nature of roads, soil type and its response to weather changes especially rainfall. Acquisition of statutory documents such as research permits from local authorities took place at this stage, identifying strategic areas to set camp for the data collection team and understanding the financial implications for the study. Both qualitative and quantitative data of interest was collected by filling in a field observation form. Photographs of female cheetahs and their respective cubs were taken for immediate identification. GPS coordinates for each sighting was captured and recorded in the data collection form. The distance of respective tour vehicles from the research vehicle was captured using a range finder and measurements recorded in the data collection form.

Plate 1: Data collection

Researcher collecting data

3.3.1 Data collection on vigilance behavior of cheetah mothers

The objective was to determine whether there exists individual variation among cheetah mothers as far as vigilance behavior is concerned. This objective formed the basis of assessing the influence of environmental factors (presence of tourist and vegetation) in vigilance behavior of cheetah mothers in case of variation. In pursuit of attaining this objective the study took into account behavioral observations of more than one cheetah mother during the study period. Behaviors associated with either being active or not being active was focal to answering this objective. In order to achieve this objective observations made on various behaviors of cheetah mothers were recorded at intervals of two minutes from the time a cheetah family was spotted to sunset or when a family moved to remote areas, Serengeti National Park or neighboring Conservancies where the research team could not access them.

The Observed and recorded cheetah behavior and their respective denotations were: Lying looking around (L, LA), lying looking at prey (L, LP), lying with the head but closed eyes (L, S), lying flat usually with closed eyes (L, F), lying with open eyes facing tourists (L, LT), lying with open eyes facing the research vehicle (L, LR), lying while cubs are suckling (L, Nur) sitting while looking around (Si, LA), sitting with eyes closed (Si, S), sitting looking in the direction of tourists (Si, LT), sitting looking in the direction of the research vehicle (Si, LR), walking looking around (W, LA), stalking (Sk), trotting (T), chasing prey or small predators like serval cats and jackals (Ch), running without any prey in sight (Ru), playing with cubs usually by running around (P), strangulating prey (Strn), stretching (Str), rolling on the ground (Ro), sniffing the ground or a tree (sniff), grooming each other (G), self-grooming (s G), calling (CALL, Cl), dragging prey usually to under a shade (Dg), eating (E) and, drinking water (Dr).

3.3.2 Data collection on number of tourist vehicles

The objective was to determine whether the probability of being actively vigilant by cheetah mothers changed with a change in number of tour vehicles at a sighting. In order to achieve this a tally of tour vehicles at a particular instance was simultaneously recorded alongside the observed vigilance (active or not active) behavior of cheetah mothers at two minute intervals throughout the session of observation which usually begins the instance a cheetah mother is spotted until hen the cheetah mother relocates to inaccessible areas or at sunset. Data on number of tourist vehicles was

recorded for as long as the vehicle is visible or can be heard by the research. Presence of the research vehicle was omitted since we did our best to maintain total silence and kept a remarkable distance from cheetah mothers of approximately 40m as a way of minimizing influence of researchers on exhibited vigilance behavior by cheetah mothers.

3.3.3 Data collection on vegetation types

The objective was to determine how active vigilance behavior among cheetah mothers changes with a change in vegetation cover. In attempt to achieve this objective active vigilance behavior of cheetah mothers was recorded in a two-minute interval alongside the type of predominant vegetation of the area where a cheetah family occupied at the time of study. Vegetation categories were classified based on increasing cover revealing three vegetation categories namely open grassland, bush and woody/riverine vegetation types. Open grassland was an area of low relatively low cover, bush was an area of moderate cover while woody/riverine being an area of high cover. Whenever a cheetah family moved to another area the type of vegetation in that area was taken into account and recorded in the data collection sheet.

3.3.4 Data collection on reproductive success of cheetah mothers

The objective was to examine the number of cubs a cheetah mother successfully raised to independence (recruitment success) during the study period. Data on reproduction of cheetah mothers under investigation was obtained from the Mara Meru Cheetah project, photographic databases from reliable photographers and local tour guides. Of importance was identification of the particular cheetah mother and cubs using spot pattern identification method (Chelysheva, 2004) and a comparison made with catalogues in the database, obtaining information on number of cubs and probably estimated date of birth for particular cheetah cubs born to the cheetah mother under investigation, recording number of cubs lost and those raised to independence during the study period.

3.4 Methods of data Analysis

3.4.1 General analytical techniques

All the data from the field was transcribed into an excel spreadsheet and later on assorted to fit the analytical requirements of SPSS statistical software in line with objectives of the study. SPSS was utilized for coding the data in order to generate frequency tables relevant for utilization in further inferential statistical modelling.

The data included 85 observation sessions of 10 different cheetah mothers of Maasai Mara National Reserve. Variables that were added to the data included a tally of the total vigilance scans (TOT.VIG), a tally of the total "non-active" scans (NOT.ACTIVE.VIG), a rate indicating the total tourist vehicles per length of the observation session (VEHICLE.RATE), and a refactoring of vegetation types in 3 groups (VEG3) based on increasing cover (open grass, bush, and woody/riverine).

Since data was collected on three types of vigilance behaviors exhibited by cheetah mothers (active, passive and zero vigilance), this data was transcribed as follows in order to satisfy the statistical requirement for the study objectives:

TOTAL VIGILANCE = Zero vigilance +Passive vigilance +Active vigilance,
NOT.ACTIVE.VIG = Total vigilance – Active vigilance,
VEHICLE RATE = Total vehicles/Total time interval,
VEG3 = OPEN GRASS (open grassland)
BUSH (grassland with a few bushes and bush land)
WOODY/RIVERINE (grassland with a few trees, riverine bush, and shrub land)

The data also included a count of the number of cubs observed to be born to each female cheetah that was observed, and the number that succeeded or failed to survive. It is important to note that hardly is it possible for anyone to determine the actual number of cubs born thus only rely on the number of cubs observed for the first time or emerged from the den. Data on cub survivorship was recorded and Table 3-1 generated.

Table 3- 1: Cub survivorship data

ANIMAL ID.	CUBS SUCCESS	CUBS FAIL	CUBS TOTAL
F1	**1**	**7**	**8**
F13	**3**	**15**	**18**
F16	**2**	**2**	**4**
F19	**4**	**2**	**6**
F26	**4**	**1**	**5**
F3	**4**	**8**	**12**
F40	**2**	**0**	**2**
F46	**4**	**1**	**5**
F50	**3**	**5**	**8**
F7	**2**	**11**	**13**

Source: Researcher 2019

3.4.2 Hypothesis testing

Multiple models were fit to test hypotheses regarding cheetah vigilance. A generalized linear mixed-effects model using lme4 (Bates *et al*, 2015) in R (R Core Team, 2018) was fit to estimate the probability that an individual was actively vigilant during a 2-min scan. The covariates included the average number of tourist vehicles (VEHICLE.RATE) and vegetation type (VEG3). These covariates were also considered as fixed effects while individual identity (ANIMAL.ID) as a random effect. In full the generalized linear mixed effect regression was computed as;

mod.full <- **glmer** (**cbind** (ACTIVE.VIG, NOT.ACTIVE.VIG) ~ VEHICLE.RATE + VEG3 + (1|ANIMAL.ID), data = dat, family = binomial)

For this model the observation unit was the session (n = 85) each weighted by the total number of 2-min scans during the session. The binomial counts of "active" vs. "not active" vigilance for each session served as the response variable in the binomial regression. The following equations were used during this analysis:

The counts of active vigilance scans (y_ [i]) for session i was modeled as such:

1) y_ [i] ~ Binomial (n_ [i], p_ [i])

Where,
n_ [i] is the total scans for session I,
p_ [i] is the probability of being actively vigilant. This probability was further modeled with a logit link such that:

2) Logit (p_ [i]) = beta1 + beta2*vehicles_ [i] + beta3*open grass_ [i] + beta4*woody_ [i] + animal.id_ [i]

Where,
Beta1 is the intercept,
Beta2 is the effect of vehicle rate,
Beta3is the effect of open grass (compared to bush vegetation, which is the intercept),
Beta4 is the effect of woody vegetation,
Animal.id_ [i] is a random effect for an individual observed during session i.

The covariates include vehicles_[i] which is the number of tourist vehicles per hour for session i; open grass_[i] is a binary variable with 0/1s to indicate whether the session took place in open grass habitat; and woody_[i] is also a binary variable with 0/1s to indicate whether the session took place in woody habitat. There were 10 different estimates for the animal.id effect, 1 for each cheetah.

The hypotheses tested by this model were:

H_o: There was no relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant.
H_1: There was a relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant.

H_o: There was no variation in active vigilance among cheetah mothers.
H_1: There was a variation in active vigilance among cheetah mothers.

H_o: Active vigilance among cheetah mothers did not differ by vegetation type.
H_1: Active vigilance among cheetah mothers differed by vegetation type.

In pursuit of accomplishing the objective of examining whether a relationship existed between the time spent being actively vigilant by cheetah mothers and survivorship of cubs, data collected was processed as follows:

In order to get the random effect estimate for cub survival modeling, a simpler logit-linear model that did *not* account for environmental conditions was used. Such that,

1) Logit (p_ [i]) = beta1 + animal.id_ [i]

Where,
Beta1 is the intercept,
Animal.id is the identification of the cheetah mother under investigation.

The output of the simpler logit-linear model was that the random effects had both intrinsic individual differences and environmental experiences for individual j. These random effect was used in cub survival modeling such that;

2) Cr_ [j] ~ Binomial (Ct_ [j], phi_ [j]) and,

Logit (phi_ [j]) = beta1 + beta2*female. Vigilance_ [j]

Where;
Cr_ [j] is the number of successful cubs for female j,
Ct_ [j] is the total number of cubs, and
phi_ [j] is the probability of cub survival for female j.

A "random effects only" version of the binomial regression was then fit to approximate a realized vigilance for each cheetah. This version did not include other covariates so that each coefficient represented the average observed behavior of an individual without removing the effects of tourist vehicles and vegetation.

mod.re <- **glmer** (**cbind** (ACTIVE.VIG, NOT.ACTIVE.VIG) ~ (1 | ANIMAL.ID), data = dat, family = binomial)

Random effects for each cheetah was calculated as;

FEMALE.VIG <- **unlist** (**ranef** (mod.re) [[1]])

The estimated coefficients were then used as an individual covariate in assessing the probability of cub survival for a given female. This model tested the hypotheses that

H_o: There was no relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs.
H_1: There was a relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

The chapter involved presentation and interpretation of results from respective analysis conducted and discussions based on the findings. The main aim of conducting this investigation was to determine whether tourism impacts reproductive success of cheetah mothers whereas the specific objectives were; to determine whether a relationship existed between number of tourist vehicles and the probability that a cheetah mother was actively vigilant; to determine whether there was a variation in active vigilance among cheetah mothers; to determine whether active vigilance among cheetah mothers differed by vegetation type; and to examine whether a relationship existed between time spent being actively vigilant by cheetah mothers and survivorship of cubs.

4.1 Characteristics of cheetah mothers in Maasai Mara National Reserve

Existence of physical characteristics in their spot patterns and rings on the tail which are unique for every individual not only makes it possible to identify cheetahs but also conduct an actual population count. Despite cubs being fluffy with most of their body covered in fur like mane known as mantle, clarity of spot patterns are first noticed on legs of two weeks old cubs. These spot patterns become distinguishably clear as the cheetah grows older and less fluffy (Chelysheva, 2004).

Cheetah mothers of MMNR exhibit a disparity in age. In order to ascertain the age of the various cheetah mothers under investigation, I relied on information from a non-published database compiled by the Mara-Meru Cheetah project which contains information regarding all identified cheetahs of the Maasai Mara. Age of various cheetahs of the Mara was determined by relying on date imprints onto photographic materials obtained from various professional photographers dating back to a time when they were cubs. Cheetahs were identified using their spot patterns (Chelysheva, 2004). This way adult cheetahs could be traced back to when they were cubs thus relationship between and among cheetahs were determined as well their ages at the time of photographing.

By the end of the study period observations were made on 10 different cheetah mothers of different ages (See Figure 4- 1). The end of study was used in determining the age of cheetah mothers because chances of a single cheetah being observed at different ages was high plus age was not

considered as a variable for the study. As indicated in Figure 4- 1, information about the age of F19 and F46 was missing because there was no photographic evidence for the two females as cubs which could have been used to determine their respective years of birth making estimation of their ages difficult. However, F19 and F46 were both spotted as adults for the first time in 2011 and 2012 respectively. This was as per existing photographic evidence from professional photographers.

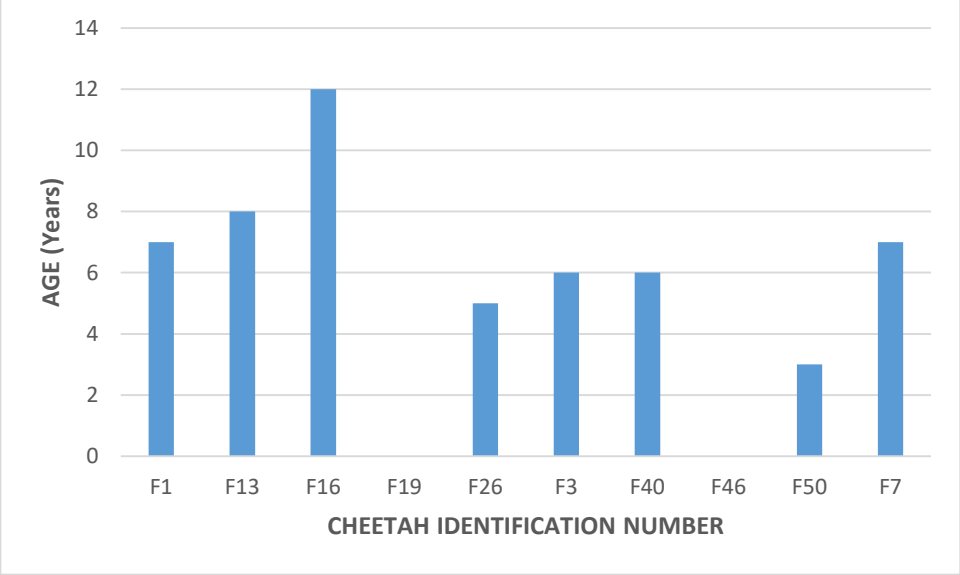

Figure 4- 1: Age of cheetah mothers

Source: Researcher, 2019.

Plate 2: F3 with 1 cub

Photo credits: Salim Mandela.

By the end of the study period frequency of observations made on the 10 different cheetah mothers varied as indicated in Figure 4- 2. This ranged from 1 observation to 45 observations made on a single cheetah mother. As indicated in Figure 4- 2, F19 recorded only 1 observation. This was because the female inhabited the Mara Triangle side of the National reserve which is a mountainous and rocky area whose ground cover was made of tall grass.

This characteristic coupled with existence of stern environmental management policies such as delineation of the ecosystem into high and low use zones where low use zones are completely out of reach by anyone thus a great challenge of accessing the area to conduct the study. Moreover by the time F19 was first spotted harboring cubs she was in an area occupied by a huge pride of lions whom I suspected to have killed the cubs because for subsequent days F19 was spotted without cubs moving up and down in the same area. This behavior is associated with a female that has just lost cubs but has not witnessed the attack. Since then F19 was spotted without cubs for the entire study period.

F13 recorded the highest observation frequencies as indicated in Figure 4- 2. This was because F13 was a very popular female owing to the fact that after she lost her mother she was actively guarded by the reserve authorities until she attained independence and could hunt for herself. The popularity

of F13 rose further after she was discovered to be the most acclimatized cheetah to human presence who could hunt and drag her kill to a shade next to tourist vehicles or could hop onto tourist vehicles either to sit on the roof while scanning the area or lie presenting tourists with an opportunity to take pictures with her.

The disparity in frequency of observations for the cheetah mothers as indicated in Figure 4- 2 was attributed to the fact that female cheetahs do not have territories but move in home ranges which are larger than territories occupied by males and that the distance a cheetah mother moves is influenced by the age of her cubs (Marker, 2014).

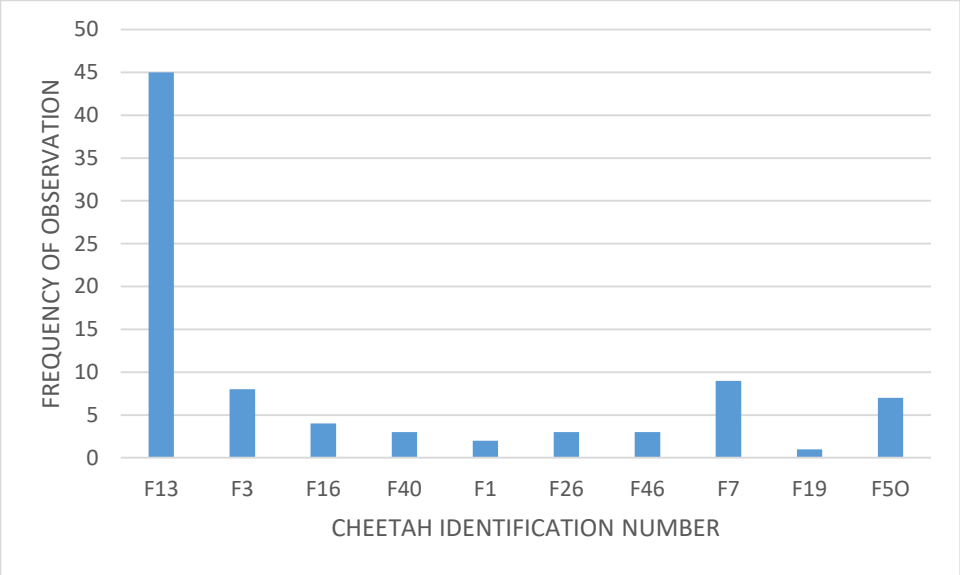

Figure 4- 2: Observation frequencies of cheetah mothers

Source: Researcher, 2019.

Plate 3: F13 and M15 on a tourist vehicle scanning the habitat (2nd April, 2013). Photo credits: Salim Mandela.

4.2 The effect of tourists on vigilance behavior of cheetah mothers in MMNR

As indicated in Figure 4- 3, two types of vigilance behaviors exhibited by cheetah mothers were under investigation for this study. These were zero vigilance and active vigilance. A total of 10,873 frequency of observations were recorded for the two types of vigilance behaviors. Out of these, zero vigilance accounted for 999 observations which translated to 9.19% while active vigilance accounted for 9,874 observations translating to 90.81% of the total observations made. As illustrated in Figure 4- 3, active vigilance was the most occurring vigilance behavior among cheetah mothers while zero vigilance was the least occurring one. This implied that cheetah mothers kept vigil of their environment more than they would rest during the entire study period. This observation was in agreement with other studies that associated increased vigilance behavior by wildlife with presence of tourists (Ranaweerage *et al*., 2015).

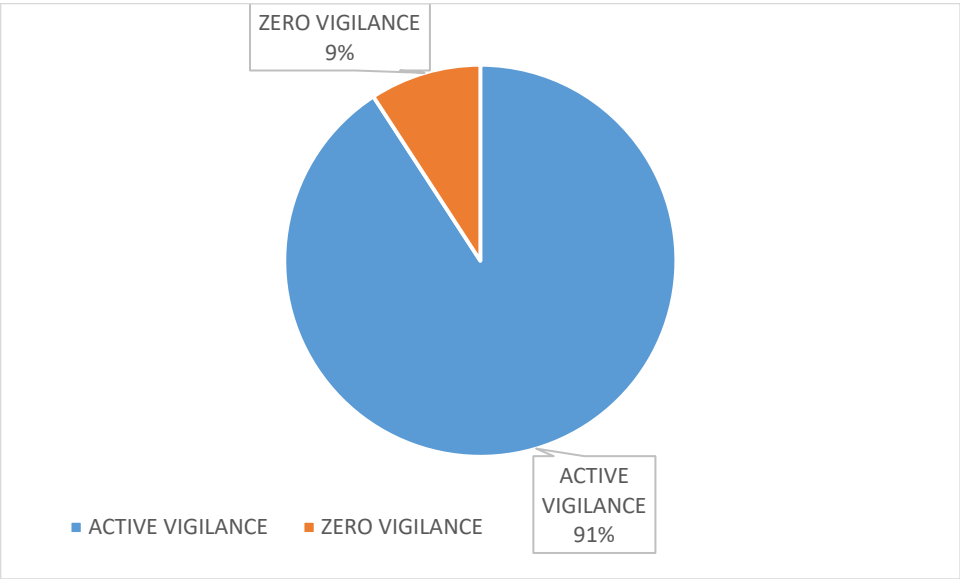

Figure 4- 3: Vigilance behavior among cheetah mothers

Source: Researcher, 2019.

Figure 4- 4 depicts that there was a variation of exposure to tourist vehicles among the ten cheetah mothers that were studied. As indicated in Figure 4- 4, F13 experienced the highest exposure amounting to 4,725 tourist vehicles while F19 had the least with zero exposure. Variation in level of exposure to tourist vehicles was influenced by ease of sighting of a cheetah family, accessibility of area of occurrence, legislation in area of occurrence and frequency of observations made for a particular cheetah mother. Based on my observations during the study period F13 was easily sighted because she was sought out for by tourist vehicles due to her iconic status as a cheetah mother who was highly tolerant to presence of tourists and would hop onto vehicles. F13 mostly utilized open grassland areas making her easier to spot.

The variation in level of exposure to tourist vehicles between F1 and F19 indicated in Figure 4- 4 was mostly because tourists were barred from visiting the family's area of occurrence. This was because at the time of sighting F19 had cubs who were less than two weeks old evoking the need to reduce human disturbance in their area of occurrence. Unfortunately, the female was spotted a day after harboring no cubs and was never spotted again having cubs during the study period. F1 had more frequencies of observations than F19 as shown in Figure 4- 4. This family mostly utilized the high use zones which was open for tourist visitation.

As illustrated in Figure 4- 4, F46 recorded zero exposure to tourist vehicles. This is because the family utilized forested areas which were not accessible to tourist vehicles plus by the time of the first sighting the cubs were almost breaking away from the mother to form a temporary sibling group which happened less than a month after. This happens when cubs are at least 12 months old (Marker, 2014). These accounted for the fewer number of observations made for F46 and zero exposure to tourist vehicles.

F50 was the youngest mother studied whose approximate age was 2 years (Mara Meru Cheetah Project Database). Cheetahs at this age are not experienced thus display shyness, a behavior associated with utilization of remote areas that are quite inaccessible by tourist vehicles. This contributed to the low level of exposure to tourist vehicles as shown in Figure 4- 4.

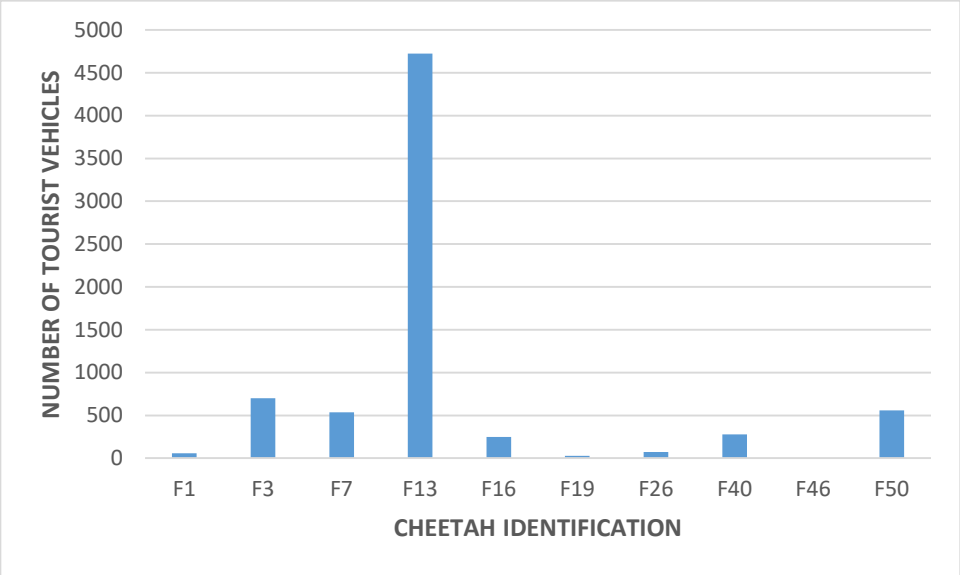

Figure 4- 4: Abundance of tourist vehicles

Source: Researcher, 2019.

4.2.1 Hypothesis testing for effect of number of tourist vehicles on vigilance behavior of cheetah mothers

The modeling results for assessing relationship between active vigilance and number of tourist vehicles indicate support for the hypotheses;

H_1: There was a relationship between number of tourist vehicles and the probability that a cheetah mother was actively vigilant. Therefore, H_1 was accepted.

As shown in Table 4- 1, the intercept of the binomial mixed-effects regression indicated the log-odds of exhibiting active vigilance in the presence of no tourist vehicles in the bush habitat was 0.317. This translates to a probability of $1/(1 + e^{-(0.317)}) = 0.58$. The log-odds of exhibiting active vigilance; increased with the average number of tourist vehicles during a session (VEHICLE.RATE).

Figure 4- 5 illustrates the increase in probability of active vigilance as the number of tourist vehicles increases during a 1-hour long observation session. In this case, a 95% confidence interval was calculated by a non-parametric bootstrap.

Table 4- 1: Binomial regression results for active vigilance versus number of tour vehicles

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.317	0.246	1.29	0.198
VEHICLE.RATE	0.288	0.079	3.66	<0.001

Source: Researcher, 2019.

Figure 4- 5: Active vigilance versus abundance of tourist vehicles

Source: Researcher, 2019.

These results are in support of existing literature indicating that wildlife become more vigilant when in an area of human disturbance; increasing human activity leads to alteration of carnivore behavior in both space and time and; quite a number of carnivorous animals exhibit high level of alertness due to human activity and presence (Pangle and Holekamp, 2010). Vigilance has also been used to quantify the level of risk perceived by an animal more so for populations that are exposed to heightened human activity. This is substantiated in a report compiled by Dyck and Baydack (2004) indicating that polar bears were noted to increase their vigilance in the presence of wildlife viewing vehicles.

4.3 The effect of vegetation on vigilance behavior of cheetah mothers in MMNR

The objective was to illustrate; the general habitat utilization by the 10 different cheetah mothers for the study period; frequency of observations for the two types of vigilance behaviors in the different vegetation types and hypotheses testing.

Processed data indicated that the 10 cheetah mothers utilized all the three vegetation zones but with differing frequency of utilization. Open grassland and bush were highly utilized while woody/riverine vegetation was less utilized by cheetah mothers as shown in Figure 4-6. The disparity in habitat utilization was greatly influenced by frequency of observations for the subject cheetah mothers. Increased frequency of observation for a certain cheetah automatically contributed to an increase in frequency for the preferred or highly utilized habitat by that family. Frequency of observation for a cheetah family was influenced by ease of sighting or biased sighting due to proximity to research base thereby indirectly influencing the recorded frequency of habitat utilization.

Extent of travel by a cheetah family equally influenced the frequency of habitat utilization. A family that did not travel a lot was observed to utilize a specific vegetation zone for subsequent observations contributing to increased frequency of observation for a particular vegetation zone. Traveling behavior of a cheetah family was observed to be influenced by age of the litter and hunting requirement which was observed to be influenced by group size and age of cubs. A cheetah mother that harbored a litter whose age was 3 months and below travelled less distances except when relocating the den area due to disturbance or when going out to hunt contributing to increased

observation. Litters above three months of age a cheetah family was observed to traverse the study area thus increasing observation frequency for habitat utilization for the different vegetation zones.

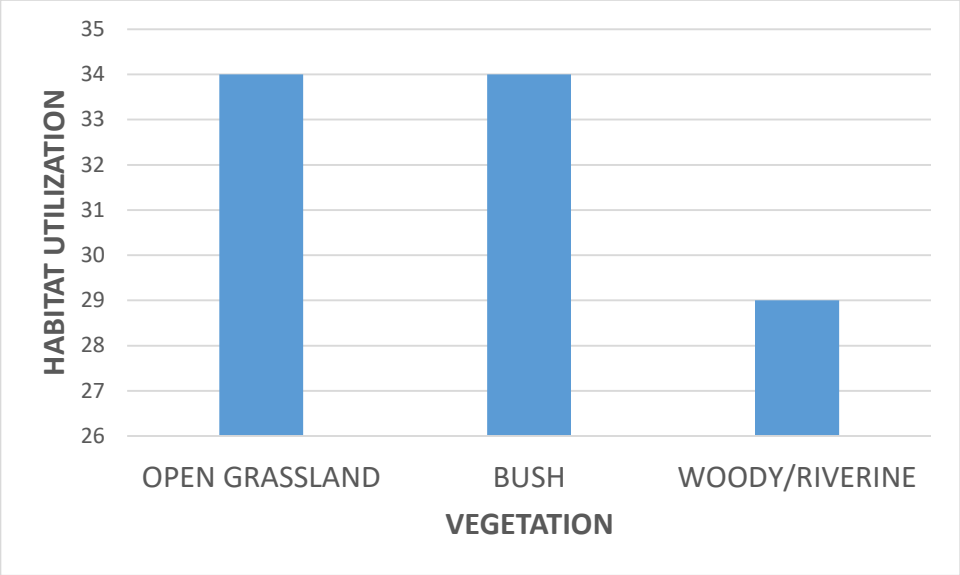

Figure 4- 6: Habitat utilization by cheetah mothers

Source: Researcher, 2019.

Processed data yielded that in all the three types of vegetation active vigilance was observed to be the most exhibited vigilance behavior compared to zero vigilance as indicated in Figure 4- 6. Cheetah mothers exhibited high levels of zero vigilance in woody/riverine vegetation compared to open grassland and bush areas.

The disparity in frequency of occurrence for the two types of vigilance behaviors indicated in Figure 4- 7 was associated with changes in environmental factors that were observed to trigger a change in vigilance behavior of cheetah mothers. Sounds of starting vehicle engine was observed to awaken a cheetah mother that was either totally asleep or snoozing. Sudden raving of vehicle engines often startled cheetah mothers prompting them to rise up quickly and sometimes stand in attempt to flee. A quiet ambiance was associated with sleeping behavior recorded as zero vigilance.

Differences in tolerance to tourist vehicles among cheetah mothers could have greatly influenced the difference in vigilance behavior exhibited by cheetah mothers as illustrated in Figure 4- 7. Cheetah mothers that were observed to take advantage of tourist vehicles as shade or hiding places for their kill were observed to exhibit less of active vigilance behavior as compared to those who

displayed intolerance by fleeing or relocating in the event of oncoming tourist vehicles. Cheetah mothers intolerant to tourist vehicles were observed to be in constant watch out while maintaining large distances between them and tourist vehicles.

Tolerance to tour vehicles was observed to vary among cheetah families depending on the age of cubs. A cheetah mother with a litter whose age was less than three weeks displayed high levels of intolerance to human presence whereas those whose cubs were more than three months old displayed higher levels of tolerance to tourist vehicles. In fact some cheetah families would hop onto and sit on the roof of tourist vehicles.

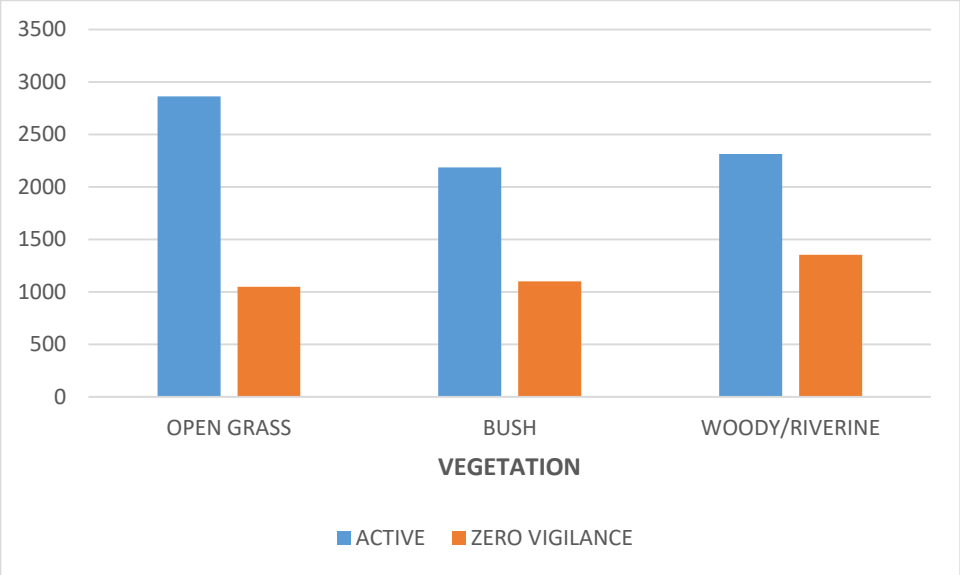

Figure 4- 7: Activity of cheetah mothers across vegetation zones
Source: Researcher, 2019.

4.3.1 Hypothesis testing for effect of vegetation on vigilance behavior of cheetah mothers in MMNR

The modeling results for assessing relationship between active vigilance and vegetation indicated support for the hypothesis.

H_1: Active vigilance among cheetah mothers differed by vegetation type. Therefore, H_1 was accepted.

As shown in Table 4- 2, the intercept of the binomial mixed-effects regression indicated the log-odds of exhibiting active vigilance in the presence of no tourist vehicles in the bush habitat was 0.317. This translates to a probability of $1/ (1 + e^{-(0.317)}) = 0.58$. The log-odds of exhibiting active vigilance increased in low cover habitat (VEG3: open grass); and decreased in high cover habitat (VEG3: woody/riverine).

Figure 4- 8 illustrates differences in baseline active vigilance probability (no tourist vehicles) across the 3 vegetation types. In this case, a 95% confidence interval was calculated by a non-parametric bootstrap.

Table 4- 2: Binomial regression results for active vigilance versus vegetation

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	0.317	0.246	1.29	0.198
VEG3: open grass	0.396	0.057	6.94	<0.001
VEG3: woody/riverine	-0.235	0.056	-4.22	<0.001

Source: Researcher, 2019.

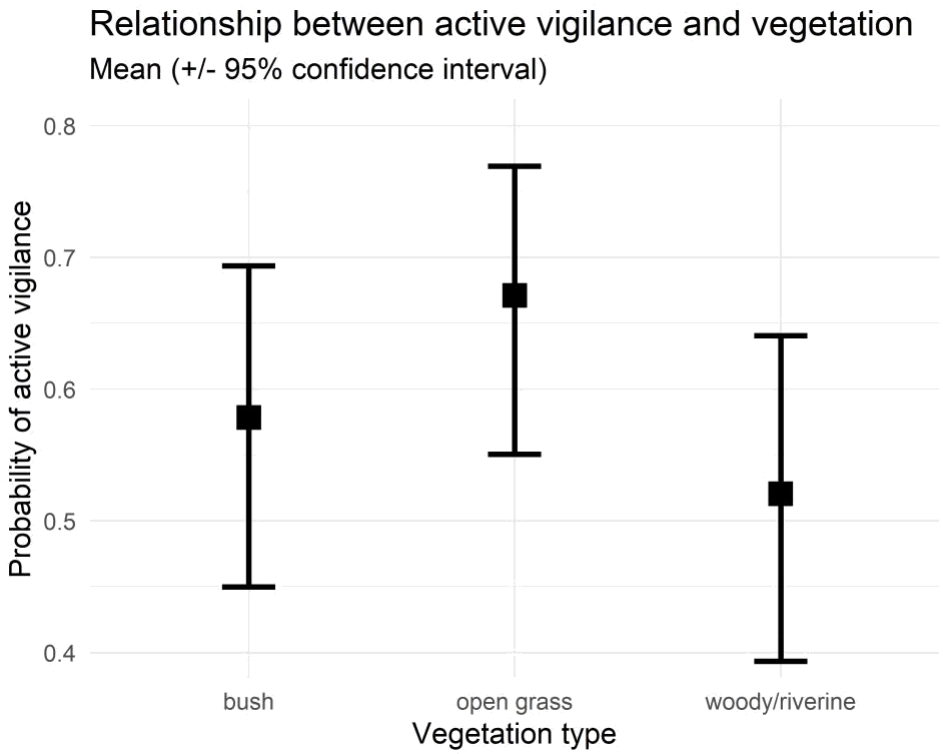

Figure 4- 8: Active vigilance versus vegetation

Source: Researcher, 2019.

Vegetation cover is a habitat characteristic offering varied ecosystem services ranging from shade, hunting ground, concealment and nesting (Janssen *et al*, 2007). Areas of bush are associated with concealment which can be utilized by both prey and predators. Vulnerable animals such as cheetah mothers exhibit increased levels of active vigilance in areas of increased vegetation cover, in this case woody/riverine areas because increased level of vigilance increases chances of detecting eminent danger and deployment of confrontation avoidance behaviors such as camouflage or escape.

Open grassland areas have been termed as potential risk areas due to lack of refuge for taking cover in the event of emerging danger a feature provided for by areas with vegetation cover (Broekhuis, 2018). As much as open grassland areas enable long range detection of eminent danger the openness equally increases chances of cheetah mother detectability by other predators. Therefore, being actively vigilant in such areas increases chances of detecting predators and survival. In this perspective my study results depict that cheetah perceive areas of dense vegetation cover as of a higher risk than areas of little vegetation cover which contrasts Broekhuis' (2018) findings

indicating that open habitats are high risk areas to cheetah mothers compared to areas of dense vegetation cover.

Generally results from this study on the relationship between active vigilance and vegetation cover are in acceptance with previous studies supporting the ideology that the effectiveness of vigilance as a predation avoidance behavior is influenced by habitat characteristics and precisely, vigilance increases in a more obscured environment (Whittingham *et al*., 2004).

4.4 The effect of cheetah mothers' active vigilance on their reproductive success in MMNR

When tackling success in reproduction it is important to factor in litter size and the number of cubs a cheetah mother recruits to adulthood. Therefore, to successfully determine the relationship between vigilance and reproductive success in cheetah mothers it was deemed prudent to assess the interaction between vigilance and these two factors of reproductive success.

Frequency Table 4-3 of vigilance exhibited by cheetah mothers in different litter sizes was prepared and a line graph in figure 4-9 produced to illustrate the relationship between litter size and vigilance of cheetah mothers. From Figure 4-9 active vigilance steadily increased as litter size increased from one cub to four cubs. When litter size increased to five cubs, active vigilance began to decline taking a deep inclination as litter size went beyond 5 cubs. When litter size was six cubs, level of active vigilance was nearly similar to when the litter size comprised of only one cub.

Zero vigilance was at its lowest when litter size comprised of one cub and highest when litter size was two cubs. When litter size was made up of three cubs, level of zero vigilance declined with the level being quite similar to when there were four cubs in a litter. When litter size got to five the level of zero vigilance experienced a low nearing that of when there was only one cub in a litter. When there were six cubs in a litter the level of zero vigilance was higher than that of five cubs but lower than when litter size was made up of four cubs.

Table 4- 3 Frequency table of vigilance in different litter sizes

NO. OF CUBS	ZERO	ACTIVE
ONE	34	733
TWO	329	1021
THREE	205	1661
FOUR	211	3425
FIVE	79	2272
SIX	141	792

Source: Researcher, 2019.

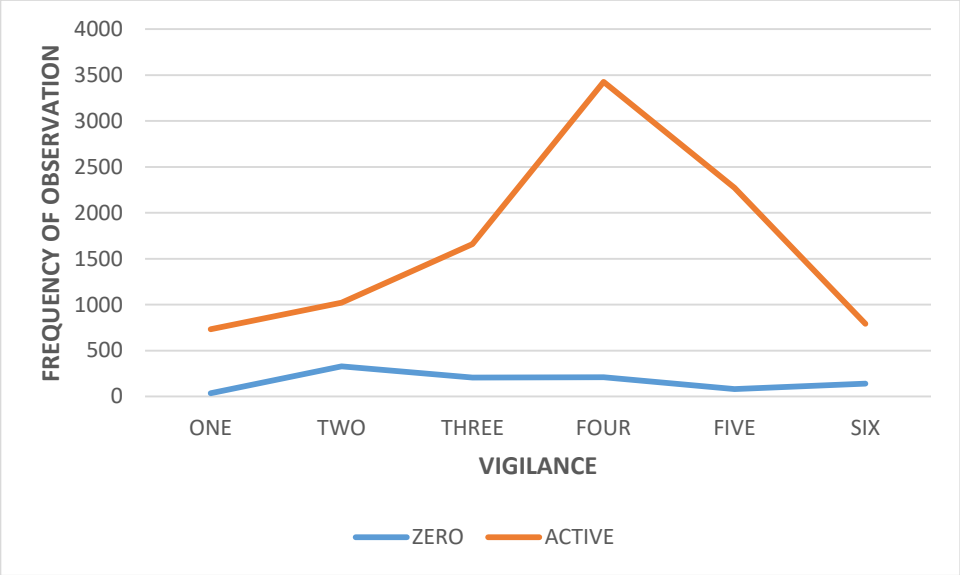

Figure 4- 9 Relationship between vigilance and litter size

Source: Researcher, 2019.

During the study period, the ten cheetah mothers cumulatively harbored 21 litters out of which a total of 81 cubs were observed. 29 out of the 81 cubs were successfully raised to independence. As illustrated in Figure 4- 10, there was no female that exhibited 100% cub recruitment success but they all achieved success in cub recruitment but at different rates. Figure 4- 10 also shows that the number of litters an individual harbored was not a factor determining the number of cubs recruited to independence. This is because some females such as F13 had more litters (18) during the study period but successfully recruited fewer cubs to independence compared to 4 other cheetah mothers (F19, F26, F3 and F46) who harbored fewer litters but recruited more cubs to independence.

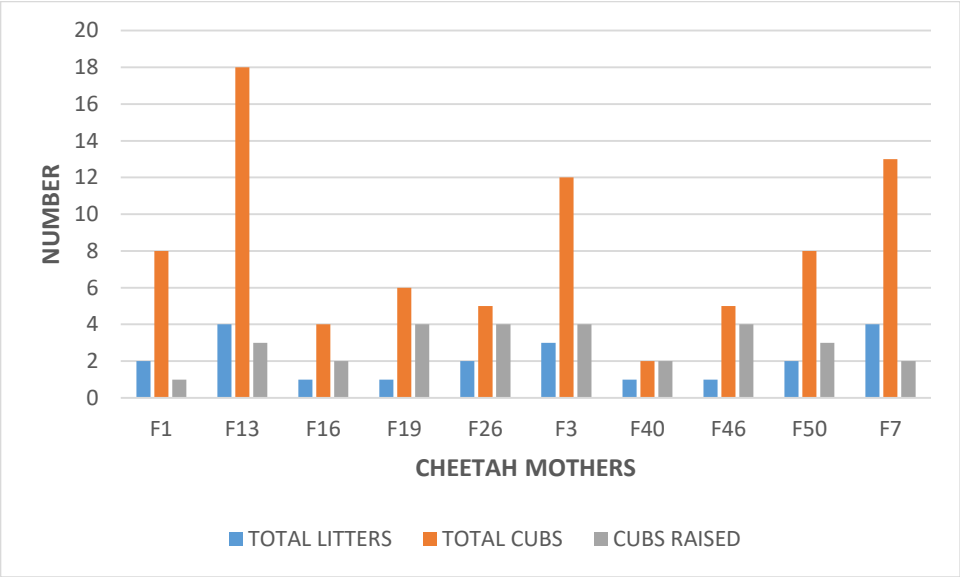

Figure 4- 10: Reproduction in cheetah mothers of MMNR

Source: Researcher, 2019.

4.4.1 Hypothesis testing for effect of cheetah mothers' active vigilance on their reproductive success

The modeling results for assessing whether there was a relationship between time spent being actively vigilant among cheetah mothers and survivorship of cubs depicted a lack of support for the hypothesis.

H_1: There was a relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs. Instead, showing that that there was no enough evidence to reject H_o: There was no relationship between duration spent being actively vigilant by cheetah mothers and survivorship of cubs.

This is because the model results for cub survival did not indicate evidence of a relationship with the individual random effect (FEMALE.VIG) approximating propensity for active vigilance (Table 4- 4). The average cub survival was $1/ (1 + e^{-(-0.515)}) = 0.37$, indicating that ~1/3 cubs on average survived to independence.

Table 4- 4: Results from binomial regression of cub survival as a function of individual variation in active vigilance.

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.515	0.24	-2.14	0.032
FEMALE.VIG	-0.486	0.446	-1.09	0.276

Source: Researcher, 2019.

Since my study results could not peg the low reproductive success among cheetah mothers of Maasai Mara to their active vigilance behavior, there is a likelihood of other factors such kleptoparasitism and age contributing to the low reproductive success (Balme *et al*., 2017; Broekhuis *et al*., 2018).

Plate 4: Dead cubs of F13 after a lioness attack (19th October, 2013).

Photo credits: Salim Mandela.

CHAPTER FIVE: SUMMARY OF RESEARCH FINDINGS, CONCLUSSION AND RECOMMENDATIONS

5.1 Summary of research findings

5.1.1 Characteristics of cheetah mothers in MMNR

Cheetah mothers of MMNR exhibit unique spot patterns identical to an individual; female cheetahs of MMNR begin family life at different ages; cheetah mothers of MMNR solely offer maternal care to cubs until they achieve independence and cheetah mothers of MMNR exhibit behavioral differences. A total of 10 cheetah mothers were studied accounting for 85 number of observations that were made during the study period. Out of these 10,873 frequencies of observations were recorded for vigilance behavior where zero vigilance accounted for 999 observations translating to 9.19% while active vigilance accounted for 9,874 observations translating to 90.81% of the total observations. Modeling results indicated existence of a variation in active vigilance behavior among cheetah mothers.

5.1.2 Effect of tourists on vigilance behavior of cheetah mothers in MMNR

A total of 7,209 tourist vehicles were recorded at sightings of cheetah mothers for the study period. The observed highest daily exposure to tourist vehicles was 313 while the average exposure to tourist vehicles for the study period was 84. Results from binomial regression analysis indicated existence of a relationship between abundance of tourist vehicles and the probability that a cheetah mother was actively vigilant. Such that increment in tour vehicle numbers was associated with increased active vigilance among cheetah mothers.

5.1.3 The effect of vegetation on vigilance behavior of cheetah mothers in MMNR

The three types of vegetation were utilized by the 10 cheetah mothers but with differing degree of utilization. Open grassland and areas of bush were highly utilized while areas of woody/riverine bush were less utilized by cheetah mothers. Modeling results indicated existence of a relationship

between vegetation cover and active vigilance behavior exhibited by cheetah mothers. Such that the probability of a cheetah mother being actively vigilant increased as vegetation cover increased. Whereby open grassland was associated with low levels of active vigilance, areas of bush with moderate levels of active vigilance while woody/riverine areas with high levels of active vigilance.

5.1.4 The effect of cheetah mothers' active vigilance on their reproductive success

21 litters accounted for the 85 observations made. The recorded maximum number of litters exhibited by cheetah mothers was 4 while the minimum being 1. The mean litter for the study period was 2. A total of 81 cubs were counted during the study period. Out of these only 29 were successfully raised to independence during the period of study. Results from the binomial regression did not indicate existence of any relationship between active vigilance and survivorship of cubs. However, it was deduced that the average cub survival for the study period was 1 out of 3 cubs.

5.2 Conclusions

The study concluded that tourism had an impact on vigilance behavior of cheetah mothers in MMNR. This is because abundance of tourist vehicles was observed to be of significant influence on vigilance behavior exhibited by cheetah mothers. The study also concluded that vigilance behavior varied among cheetah mothers and the degree of active vigilance was influenced by nature of vegetation cover in the area utilized by a cheetah mother. However, the influence of vegetation cover on vigilance was observed not to be homogenous but varied depending on the type of vegetation cover a cheetah mother inhabited. Such that cheetah mothers exhibited increased levels of active vigilance as vegetation cover increased. The study also concluded that cheetah mothers of Maasai Mara National Reserve exhibited a very low reproductive success with a probability of 1/3 cubs reaching independence. However, there was no sufficient evidence to link the low reproductive success to vigilance behavior exhibited by cheetah mothers.

5.3 Recommendations

5.3.1 Recommendations for strategy and programmes

- There should be a strict code of conduct promoting silence by minimizing noisy activities while observing cheetah families in MMNR. This is essential in promoting homogenous behavior by tourists thereby reducing commotion at sightings of cheetah mothers thus enabling cheetah mothers to associate certain behaviors of tourists with specific environmental elements or causes. This will also make it easier to conduct studies aimed at identifying aspects of tourism that influence reproductive success among cheetah mothers. There is also a need to minimize the number of tourist vehicles visiting areas inhabited by cheetah mothers.

- There is need for awareness creation targeting tour operators on the low reproductive success of cheetah mothers in MMNR aimed at enhancing adherence to stipulated park rules and regulations.

5.3.2 Suggestions for further research

- There is need to conduct further studies aimed at quantifying direct causes of cheetah cub mortality in MMNR.

- In order to properly understand the role of temporal partitioning of activity patterns in cheetahs and its correlation to reproductive success there is need to investigate vigilance activity of cheetah mothers at night so as to determine the relationship between diurnal and nocturnal activity patterns of vigilance and correlate findings with reproductive success of an individual.
- There is a need of determining whether age of cubs in a litter influence vigilance behavior exhibited by cheetah mothers and its correlation to reproductive success of an individual cheetah mother.

- There is also a need for a comparative study on the vigilance response among cheetah mothers both in the presence and absence of tourists. This will clearly outline whether there is a difference between cheetah behavior in the presence and absence of tourists.

- There is need to conduct a similar study on all cheetahs to determine how tourism influences survival of cheetahs in general.

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APPENDICES

APPENDIX 1. KWS PERMIT – 2013

KENYA WILDLIFE SERVICE

ISO 9001:2008 Certified

Winner: COYA 2010 Awards in Corporate Citizenship & Environment, and Human Resource Management.

KWS/BRM/5001

5 June 2013

Dr. Elena V. Chelysheva

Mountain View 181
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e-mail: cheetah@9mail.ru

Dear Dr. Chelysheva,

PERMISSION TO CONDUCT RESEARCH ON CHEETAHS IN MERU CONESERVATION AREA AND MAASAI MARA ECOSYTEM

We acknowledge receipt of your application requesting for permission for research project extension to conduct research on a project titled: '*Cheetah population status evaluation in regions with different types of anthropogenic influence in Meru Conservation Area (MCA) and Maasai Mara Ecosystem*'. The study will generate data and information to enhance Cheetah conservation in Meru Conservation Area (MCA) and Maasai Mara Ecosystem.

You have been granted research project extension for a period of one year (**September 2013 to October 2014**) upon payment to KWS of research project extension fees of **USD 200**. However, you will abide by the set KWS regulations and guidelines regarding the conduct of research in and outside protected areas. You will also be required to work closely with our Carnivore Conservation Liaison Officer, Senior Scientists in-charge of Eastern Conservation Area (ECA) and Central Rift Conservation Area (CRCA), whom you will give a copy of the research proposal and regular progress reports on the study.

You will submit a bound copy of your findings to the KWS Deputy Director, Biodiversity Research and Monitoring on completion of the study.

Yours Sincerely,

SAMUEL M. KASIKI, PhD, OGW
DEPUTY DIRECTOR
BIODIVERSITY RESEARCH AND MONITORING
Copy to:

- SAD-P&R
- Senior Warden, Meru N. Park
- Senior Scientist, ECA
- Senior Scientist, CRCA
- Warden, Kora N. Park

P.O. Box 40241-00100, Nairobi, Kenya. Tel: +254-020-6000800, 6002345. ISDN: +254-020-3992000/1000
Wireless: +254-020-2379407/8/9. Mobile: +254-735 663 421, +254-726 610 508. Fax: +254-020-6003792
Email: kws@kws.go.ke Website: www.kws.go.ke

APPENDIX 2. NAROK COUNTY COUNCIL PERMIT 2012 - 2013

MAASAI MARA NATIONAL GAME RESERVE

COUNTY COUNCIL OF NAROK

Your Ref: .....

Our Ref: .....

Date: .....

NCC/MMN/R/R/VOL.VI/2

12th November 2012

Dr. Elena V. Chelysheva
Mountain View 181 - Nairobi

Dear Dr. Elena,

RE: EXTENSION OF RESEARCH PERMIT AND PARK FEE WAIVER FOR – DR. ELENA V. CHELYSHEVA & AND HER ASSISTANT MANDELA SALIM – DEC 2012 – DEC 2013.

This is respond as per our discussion regarding the above subject

This is to inform you that your request has been considered and approved for free entry to the Reserve while doing your Research activities from **Dec 2012 – Dec 2013.**

However you will be required to pay US$ **400** annually for the Research permit fee.

Stephen Minis
Chief Park Warden
MASAI MARA NATIONAL RESERVE

Cc – Clerk Narok County Council

P.O. Box 60 - 20500, Narok Tel. +254 - 050 22268/22337, Fax: +254 - 050 22260/23402

APPENDIX 3. NACOSTI PERMIT 2011 - 2014

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123.
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: NCST/RRI/12/1/BS-011/95/4

Date: 21st November, 2011

Dr. Elena V. Chelysheva
Trubnaya, 25-2-33
Moscow, RUSSIA

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Cheetah population status evaluation in regions with different types of anthropogenic influence (Maasai Mara National Reserve versus Meru Conservation Area)***" I am pleased to inform you that you have been authorized to undertake research **in Maasai Mara National Reserve & Meru Conservation Area** for a period ending ***31st October, 2014.***

You are advised to report to **the Director, Kenya Wildlife Service, the District Commissioners & the District Education Officers in the selected districts in Eastern & Rift Valley Provinces** before embarking on the research project.

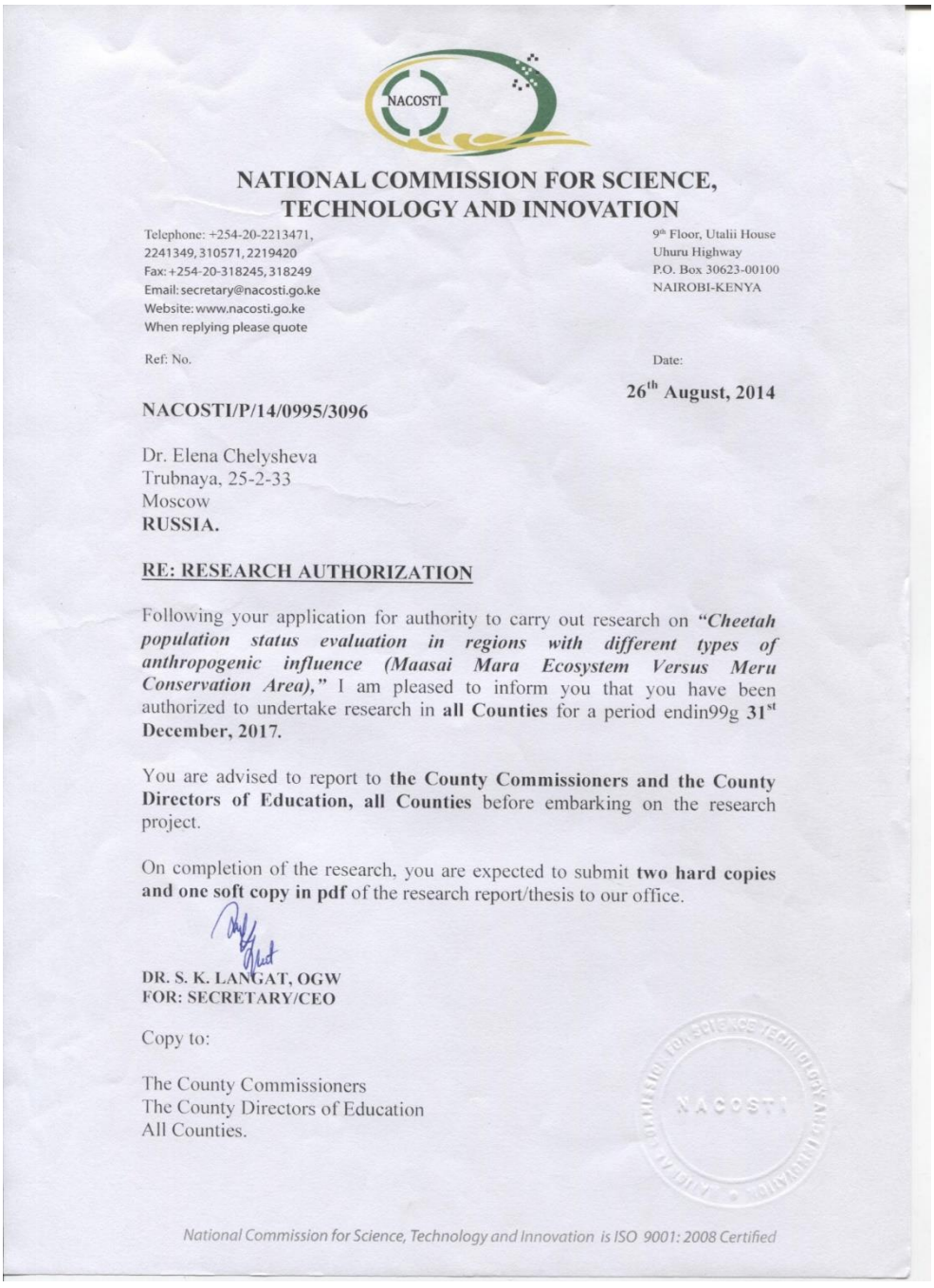
On completion of the research, you are expected to submit **one hard copy and one soft copy** of the research report/thesis to our office.

P. N. NYAKUNDI
FOR: SECRETARY/CEO

Copy to:

The Director
Kenya Wildlife Service
P. O. Box 40241 – 00100
NAIROBI

APPENDIX 4. NACOSTI 2014 – 2017



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

26th August, 2014

NACOSTI/P/14/0995/3096

Dr. Elena Chelysheva
Trubnaya, 25-2-33
Moscow
RUSSIA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Cheetah population status evaluation in regions with different types of anthropogenic influence (Maasai Mara Ecosystem Versus Meru Conservation Area),"*** I am pleased to inform you that you have been authorized to undertake research in **all Counties** for a period endin99g **31st December, 2017.**

You are advised to report to **the County Commissioners and the County Directors of Education, all Counties** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioners
The County Directors of Education
All Counties.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX 5. NAROK COUNTY PERMIT 2013 – 2014

THE NAROK COUNTY GOVERNMENT
MAASAI MARA NATIONAL RESERVE
P.O. BOX 60
NAROK

NCG/MMN/R/R/VOL.V/23

23rd May 2014

Dr. Elena V. Chelysheva
Mara - Meru Cheetah Project
PO BOX 1611 – Sarit Center
NAIROBI

Dear Dr. Elena,

RE: EXTENSION ON RESEARCH PERMIT AND PARK FEE WAIVER FOR – DR. ELENA V. CHELYSHEVA PASSPORT NO.710919351 & HER ASSISTANT SALIM MANDELA MANDERE ID NO.26796359.

This is respond as per our discussion on 20th May 2014, regarding the above subject.

This is to inform you that your request has been considered and approved for entry to the Reserve while conducting your Research activities for the year 31st Dec 2013 – 31st Dec 2014, as per Ref. KWS/BRM/5001 on the Cheetah Research in Maasai Mara National Reserve.

However you will be required to pay **US$ 400** annually for the Research permit fee.

James S. Sindiyo
Chief Park Warden
MAASAI MARA NATIONAL RESERVE

Cc - C.E.C – Tourism, Wildlife, Trade Cooperative and industrialization
C.E.C – Finance and Planning.
County Secretary.

NK. NO 012953 dated 20/5/2014

APPENDIX 6. NAROK COUNTY PERMIT 2015

THE NAROK COUNTY GOVERNMENT
MASAI MARA NATIONAL RESERVE
P.O. BOX 60
NAROK

NCG/MMN/R/R/VOL.VI/49

10th January 2015

Dr. Elena V. Chelysheva
Mara-Meru Cheetah Project
Mountain View 181
NAIROBI

Dear Dr. Elena,

RE: EXTENSION ON RESEARCH PERMIT AND PARK FEE WAIVER FOR – DR. ELENA V. CHELYSHEVA PASSPORT NO.710919351 & HER ASSISTANT SALIM MANDELA MANDERE ID NO.26796359.

This is respond as per our discussion regarding the above subject.

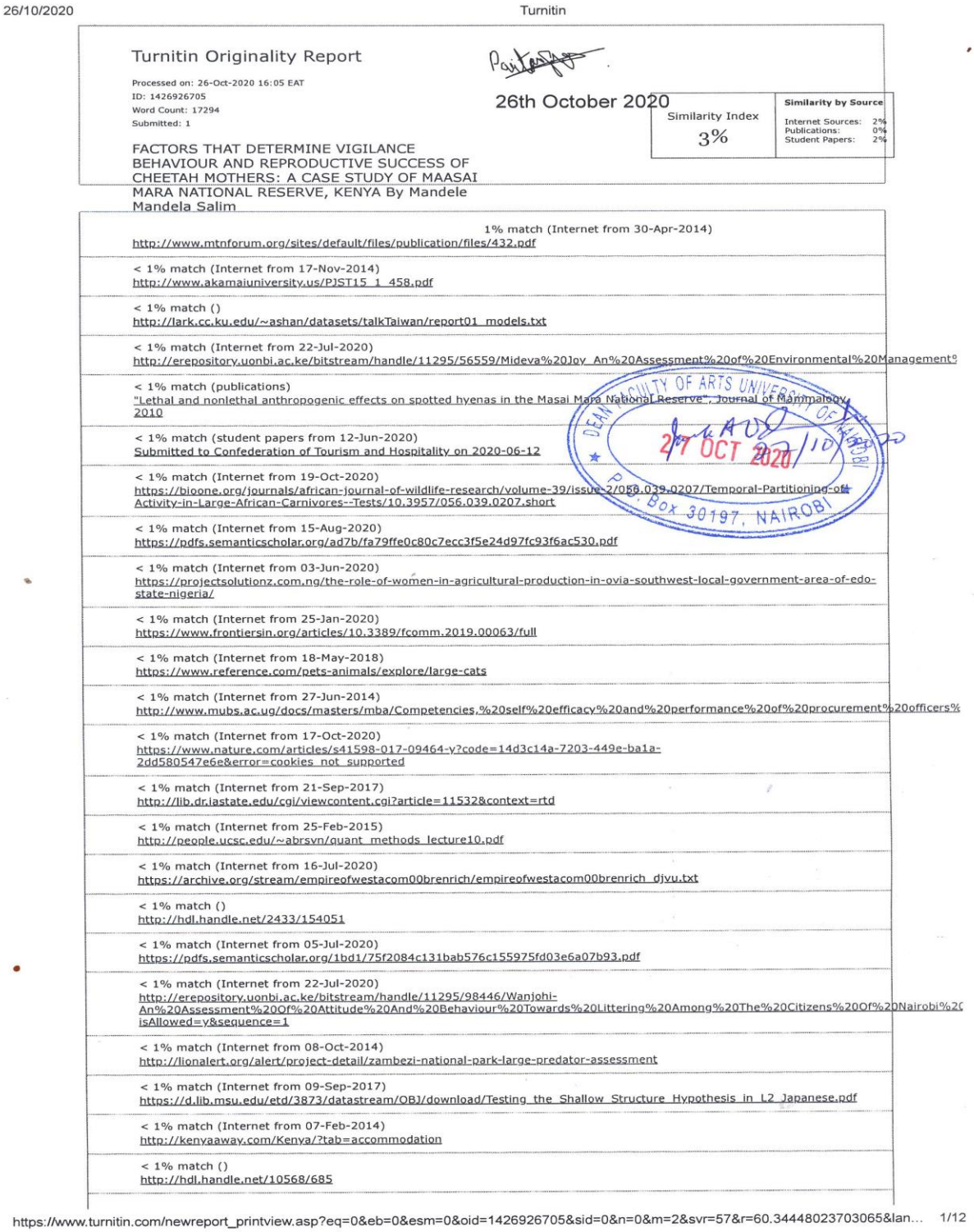
This is to inform you that your request has been considered and approved for entry to the Reserve while conducting your Research activities for the year 1st **Jan 2015 - 31st Dec 2015** as per Ref. letter **KWS/BRM/5001** on the cheetah Research in Masai Mara National Reserve.

However you will be required to pay **US$ 400** annually for the Research permit fee.

Maxwell Naisho
Ag. Chief Park Warden
MAASAI MARA NATIONAL RESERVE

Cc.
- County Secretary
- C.E.C - Tourism, Wildlife, Trade Cooperative and Industrialization
- C.E.C - Finance and Planning

APPENDIX 7. ORIGINALITY REPORT



26/10/2020 Turnitin

Turnitin Originality Report

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ID: 1426926705
Word Count: 17294
Submitted: 1

FACTORS THAT DETERMINE VIGILANCE BEHAVIOUR AND REPRODUCTIVE SUCCESS OF CHEETAH MOTHERS: A CASE STUDY OF MAASAI MARA NATIONAL RESERVE, KENYA By Mandele Salim

26th October 2020

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"Lethal and nonlethal anthropogenic effects on spotted hyenas in the Masai Mara National Reserve", Journal of Mammalogy, 2010

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https://pdfs.semanticscholar.org/ad7b/fa79ffe0c80c7ecc3f5e24d97fc93f6ac530.pdf

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https://projectsolutionz.com.ng/the-role-of-women-in-agricultural-production-in-ovia-southwest-local-government-area-of-edo-state-nigeria/

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https://www.frontiersin.org/articles/10.3389/fcomm.2019.00063/full

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https://www.reference.com/pets-animals/explore/large-cats

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https://www.nature.com/articles/s41598-017-09464-y?code=14d3c14a-7203-449e-ba1a-2dd580547e6e&error=cookies_not_supported

< 1% match (Internet from 21-Sep-2017)
http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=11532&context=rtd

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http://people.ucsc.edu/~abrsvn/quant_methods_lecture10.pdf

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https://archive.org/stream/empireofwestacom00brenrich/empireofwestacom00brenrich_djvu.txt

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http://hdl.handle.net/2433/154051

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https://pdfs.semanticscholar.org/1bd1/75f2084c131bab576c155975fd03e6a07b93.pdf

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http://erepository.uonbi.ac.ke/bitstream/handle/11295/98446/Wanjohi-An%20Assessment%20Of%20Attitude%20And%20Behaviour%20Towards%20Littering%20Among%20The%20Citizens%20Of%20Nairobi%2C isAllowed=y&sequence=1

< 1% match (Internet from 08-Oct-2014)
http://lionalert.org/alert/project-detail/zambezi-national-park-large-predator-assessment

< 1% match (Internet from 09-Sep-2017)
https://d.lib.msu.edu/etd/3873/datastream/OBJ/download/Testing_the_Shallow_Structure_Hypothesis_in_L2_Japanese.pdf

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http://kenyaaway.com/Kenya/?tab=accommodation

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http://hdl.handle.net/10568/685

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APPENDIX 8. FEE STATEMENT

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- Student Fees
- Timetables
- Course Registration
- Results
- Enquiries
- Book Room
- Logout

- Fee Statement
- Detailed Fee Statement
- Pay Fees Online

C50/8100*/2015 MANDELA SALIM MANDERE (Nairobi Evening)

Detailed Fees Statement

Academic Year : 2015/2016

Transaction Id	Date	Description	Debits DR	Credits CR	Balance	Cur.Rate
2180057367	2016-05-25	FEES PAYMENTS	0.00	54,000.00	-54,000.00	KES=1
2180112636	2016-10-13	FEES PAYMENTS	0.00	74,000.00	-128,000.00	KES=1
218965850	2015-09-01	FEES PAYMENTS	0.00	150,000.00	-278,000.00	KES=1
C50/81005/2015-2015/2016-SEM1	2015-10-25	FEES PAYABLE FOR SEM1 DETAILS				
		CGP512	13,500.00	0.00	-264,500.00	KES=1
		CGP514	13,500.00	0.00	-251,000.00	KES=1
		CGP518	13,500.00	0.00	-237,500.00	KES=1
		CGP520	13,500.00	0.00	-224,000.00	KES=1
		ACTIVITY FEES	2,000.00	0.00	-222,000.00	KES=1
		LIBRARY FEES	3,000.00	0.00	-219,000.00	KES=1
		REGISTRATION FEES	1,000.00	0.00	-218,000.00	KES=1
		CAUTION MONEY	5,000.00	0.00	-213,000.00	KES=1
		MEDICAL FEES	5,000.00	0.00	-208,000.00	KES=1
		COMPUTER LAB FEES	5,000.00	0.00	-203,000.00	KES=1
		ID CARD FEES	500.00	0.00	-202,500.00	KES=1
		FEES PAYABLE FOR SEM1 (Grand Total)	79,500.00			
C50/81005/2015-2015/2016-SEM2	2016-02-15	FEES PAYABLE FOR SEM2 DETAILS				
		CGP511	13,500.00	0.00	-189,000.00	KES=1
		CGP521	13,500.00	0.00	-175,500.00	KES=1
		CGP525	13,500.00	0.00	-162,000.00	KES=1
		CGP527	13,500.00	0.00	-148,500.00	KES=1
		LIBRARY FEES	3,000.00	0.00	-145,500.00	KES=1
		REGISTRATION FEES	1,000.00	0.00	-144,500.00	KES=1
		FEES PAYABLE FOR SEM2 (Grand Total)	62,000.00			
C50/81005/2015-2015/2016-SEM3	2016-06-10	FEES PAYABLE FOR SEM3 DETAILS				
		CGP501	13,500.00	0.00	-131,000.00	KES=1
		CGP515	13,500.00	0.00	-117,500.00	KES=1
		CGP535	13,500.00	0.00	-104,000.00	KES=1
		CGP570	13,500.00	0.00	-90,500.00	KES=1
		LIBRARY FEES	3,000.00	0.00	-87,500.00	KES=1
		REGISTRATION FEES	1,000.00	0.00	-86,500.00	KES=1

		FEES PAYABLE FOR SEM3 (Grand Total)	62,000.00			
		Academic Year Totals :	**203,500.00**	**278,000.00**	**-86,500.00**	
Closing Balance : -86,500.00						
Academic Year : 2019/2020						
		Opening Balance	0.00	86,500.00	**-86,500.00**	
2180440197	2019-10-26	FEES PAYMENTS	0.00	500.00	-87,000.00	KES=1
2180459021	2019-12-11	FEES PAYMENTS	0.00	500.00	-87,500.00	KES=1
C50/81005/2015-2019/2020-SEM1	2019-10-26	FEES PAYABLE FOR SEM4 DETAILS				
		CGP598	58,000.00	0.00	-29,500.00	KES=1
		ACTIVITY FEES	2,000.00	0.00	-27,500.00	KES=1
		LIBRARY FEES	3,000.00	0.00	-24,500.00	KES=1
		REGISTRATION FEES	1,000.00	0.00	-23,500.00	KES=1
		MEDICAL FEES	5,000.00	0.00	-18,500.00	KES=1
		COMPUTER LAB FEES	5,000.00	0.00	-13,500.00	KES=1
		ID CARD FEES	1,000.00	0.00	-12,500.00	KES=1
		FEES PAYABLE FOR SEM4 (Grand Total)	75,000.00			
		Academic Year Totals :	**75,000.00**	**87,500.00**	**-12,500.00**	KES=1
		GRAND TOTALS :	**278,500.00**	**279,000.00**	**-12,500.00**	KES=1
Closing Balance : -12,500.00						

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1. Pay to your respective college account

2. Pay fees online. Click here for instructions

SELF-SPONSORED PROGRAMMES (MODULE II) PAYMENT INSTRUCTIONS / OPTIONS

1. Bank Account
=> Cash Deposits, EFT or RTGS transfer to UON CESSP Collection Account No. **2032771362** at Barclays Bank, Plaza Branch
=> Cash Deposits, EFT or RTGS transfer to UON CESSP US$ Dollar Account No. **2032770625** at Barclays Bank, Plaza Branch
2. M-Pesa Pay Bill
=> The Business Number is **300059**
=> The Account Number is your **"Student Registration Number"** (or **"Admission Ref Number"** for new student)
NOTE: CASH, AGENCY BANKING AND ATM DEPOSITS ARE NOT ALLOWED

APPENDIX 9. ACKNOWLEDGEMENT LETTER

Mara-Meru Cheetah Project
P.O.Box 1611 Sarit Centre
00606 Nairobi
Tel: 0771 774 308 or 0705 138 175
e-mail: cheetah9@mail.ru
www.marameru.org

20th July 2020

RE: ACKNOWLEDGEMENT

Dear Sir/Madam,

I, Dr. Elena Chelysheva hereby acknowledge that the research titled «Impact of Wildlife Tourism on Cheetah Mothers. A case study of Maasai Mara National Reserve» conducted by Salim Mandela Mandere as part of his Masters in Environmental Planning and Management was approved by me to be carried out within the Mara Meru Cheetah Project under my guidance and leadership. During his data collection, Mandela strictly adhered to stipulations of the KWS (Kenya Wildlife Service) and NACOSTI (National Council of Science, Technology and Innovation) permits hence neither contravened objectives of our project nor jeopardised our activities. Findings from his research will add value not only to the Mara Meru Cheetah Project but the conservation of cheetahs in general.

Yours sincerely,

Dr. Elena V. Chelysheva
Project Founder and Principal Investigator