How Maasai settlements affect the grazing habits of the Common Hippopotamus (*Hippopotamus amphibius*) in the Maasai Mara National Reserve, Kenya

Hur massajers bosättningar påverkar flodhästars betesvanor i Maasai Mara National Reserve, Kenya

Åsa Wengström

Hippo Tracks. Maasai Mara NR, March, 2009.
Photo by the author.
Spår av flodhäst. Maasai Mara NR. Mars, 2009.
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Åsa Wengström

Examensarbete, 15 hp, Etologi- och Djurskyddsprogrammet

Handledare: Jens Jung

Biträdande handledare: Jenny Yngvesson

Summary

With a growing human population as well as a changing lifestyle, the conflict of wildlife and humans is intensifying. In Kenya, Maasais and their livestock have for a long time coexisted with wildlife, but an adjustment to privately own land and cultivation might rapidly change the terms for this coexistence. To understand how the Maasais and their livestock affect the wildlife in the Maasai Mara National Reserve and the surrounding area, this study was undertaken. The purpose of this thesis is to examine how hippos are concerned.

The common hippopotamus (*Hippopotamus amphibius*) is one of the biggest herbivores, and has a very specialized feeding strategy. To avoid the high temperature and solar radiation during daytime, they stay in or close to water; in wetlands, rivers or lakes. When the sun sets and temperature drops they leave the watercourses to graze through the night.

The hippo is considered vulnerable, and the IUCN Hippo Specialist Group has found three primary threats to the common hippo; conflict with humans over preferable areas, export of hippo teeth, and poaching. The biggest threat to hippos is believed to be loss of water habitat because of human activity, especially in conjunction with droughts. This thesis also wants to high light how hippos could be affected by humans, not only in water by damming or similar actions but on land while grazing.

The study was carried out in the Maasai Mara National Reserve and the adjoining group ranch, Koiyaki GR, in south-western Kenya. The area studied was covered ground rich in grass, both within and outside the park; hence the effect of livestock grazing was evident. The observations were conducted during December 2003 and May-June 2004, because of the great difference in grass quality and grass availability between the seasons.

The results of the study show that hippos do avoid land intensively grazed by livestock, though they are present in the area. Even though seen in the river close to settlements, they were not observed on the nearby transects. This could be interpreted as hippos do not avoid the presence of neither people nor livestock, but they chose to graze at other sites. Evidently, hippos are nocturnal grazers and no hippos were recorded on transects between 06:00 and 18:00. In both seasons, the majority of animals were observed before midnight, indicating that hippos continue to grass outside of the study area.

Sadly, the most striking about the hippos is the lack of research, and in this thesis a number of future research areas are pointed out. This is in hope to better understand the grazing habits and life style of this megaherbivore, especially how and where they chose to graze. With this investigated, more secure conclusions can be drawn of how Maasai life affects the hippo population in Maasai Mara. When this is known, predictions can be made for how hippos will be affected of a changing Maasai lifestyle.

Sammanfattning

När den mänskliga populationen ökar och levnadsförhållandena förändras, ökar också konflikten mellan människor och det vilda. I Kenya har massajer och deras boskap levt sida vid sida med naturlivet i flera århundraden, men en övergång mot privatägd mark och jordbruk kan snabbt förändra förutsättningen för denna samexistens. Den här studien genomfördes för att förstå hur massajerna och deras boskap påverkar djurlivet i Maasai Mara National Reserve och området intill. Syftet med detta examensarbete är att undersöka hur flodhästarna påverkas.

Flodhästen (*Hippopotamus amphibius*) är en av de största gräsätarna, och har en mycket specialiserad födosöksstrategi. För undvika den höga temperaturen och solstrålningen under dagtid stannar de i eller nära vatten, i våtmarker, floder eller sjöar. När solen går ner och temperaturen sjunker lämnar de vattendragen för att beta under natten.

Flodhästen är ansedd sårbar, och IUCN:s flodhästspecialistgrupp har presenterat tre primära hot mot flodhästen; konflikt om levnadsområden med människor, export av flodhästtänder samt tjuvjakt. Det största hotet tros vara förlust av vattenområden på grund av mänsklig aktivitet, speciellt i kombination med perioder av torka. Detta examensarbete vill påvisa hur flodhästar kan bli påverkade av människor, inte bara i vattnet genom uppdämning eller liknande utan på land under tiden de födosöker.

Studien genomfördes i Maasai Mara National Reserve och den närliggande Koiyaki Group Ranch, i sydvästra Kenya. Området som studerades var grästäckt, både inuti och utanför parken, och därför kunde effekten av boskapen påvisas. Observationer gjordes i december 2003 och maj-juni 2004, eftersom de båda säsongerna har stor skillnad i både gräsets kvalitet och dess tillgänglighet.

Resultaten visar att flodhästar undviker land som är mycket betat av boskap, även om de finns i området. Trots att de ses i floden nära bosättningarna observerades de inte på transekterna i närheten. Detta kan tolkas som att flodhästarna varken undviker människor eller boskap, men de väljer att beta på andra platser. Flodhästar är nattaktiva gräsätare och inga flodhästar fanns på transekter mellan 06:00 och 18:00. I båda säsongerna var majoriteten av djuren observerade före midnatt, vilket kan indikera att flodhästarna fortsätter att beta utanför studieområdet.

Tyvärr är det mest slående om flodhästar den bristande forskningen, och i detta arbete pekas ett antal framtida forskningsområden ut. Detta för att bättre förstå dessa stora gräsätares betesvanor och levnadssätt, speciellt hur och var de väljer att beta. När detta är undersökt kan man dra säkrare slutsatser om hur massajernas liv påverkar flodhästpopulationen i Maasai Mara. När man har detta klart för sig kan man bättre förutse hur flodhästarna kommer att påverkas av förändrad livsstil hos massajerna.

Table of content

Introduction

The Maasai Mara

The Maasai Mara National Reserve is located in the southwest of Kenya, bordering the Serengeti National Park in Tanzania. The park includes a high diversity of habitats; mainly because of the rivers in the area, that creates both tall and short grasslands, as well as riverine forest and shrub lands (Oindo et al., 2003). The annual rainfall of the ten years prior to the study was 700-800 mm per year (Ogutu et al., 2008a). There are mainly two periods of rainfall, a longer period from March to June, and a shorter in November-December (Ogutu et al., 2008b). Perhaps this variation in rainfall is one of the explanations to the spectacular migration of wildebeests (as Holdo et al. (2009) argue), who wander from the Serengeti to the Maasai Mara and then back again.

Humans and wildlife

With a growing human population as well as a changing lifestyle, the conflict between wildlife and humans is intensifying. Although the Maasai and their livestock for a long time have coexisted with wildlife, an adjustment to privately own land and cultivation might rapidly change the terms for this coexistence (Lamprey and Reid, 2004). Pastoralism can be integrated with conservation, since many herbivores prefer the short grass left by cattle. By this the Maasai herds actively help to maintain the areas where these herbivores can graze.

The hippopotamus

The common hippopotamus (*Hippopotamus amphibius*) is one of the largest herbivores, and has a very specialized feeding strategy. To avoid the high temperature and solar radiation during the day, they stay either in or close to water; in wetlands, rivers or lakes. When the sun sets and temperature drops they leave the watercourses to graze throughout the night (Noriard et al., 2008).

To maintain this way of life, hippos have developed a very specific digestive system. They are not ruminants, but have a similar compartmented stomach where food is fermented although they do not ruminate (Arman and Field, 1973). During the grazing period the two blindsacs fill up, and declines in volume throughout the day. A study by Clauss et al. (2004) confirms that food remains for an exceptionally long time in the digestive system of hippos, thus the digestion continues until they feed again.

Occasionally, hippos have been found to eat bush shoots and plant roots (Abaturov et al., 1995), and Dudley (1998) reported carnivorous behaviour when a herd of hippos killed and ate an impala.

Hippos are social animals, living in sex-mixed groups with a dominant male. The number of individuals in a group differs probably due to spatial reasons. Usually groups consist of around 20 animals, but in dry periods when there is a lack of water; up to 150 animals have been seen to group together, (Olivier and Laurie, 1974).

There most striking about hippos is the lack of research. Field (1970) stated that "a detailed study of the behaviour of the hippopotamus has yet to be carried out", and in spite of the survey taken place prior to this paper nothing on this subject has been found. Some recent research into the population trends have taken place (Stoner et al., 2006; Lewison, 2007), but most of the sources of this paper is rather old, which reflects the present literature.

The hippo is considered vulnerable according to the IUCN Red list, and the population has declined since the 1990s (Lewison and Oliver, 2008). The IUCN Hippo Specialist Group (website, 2009-05-24) has found three primary threats to the common hippo; conflict with humans over preferable areas,

export of hippo teeth, and poaching. Despite a lack in research, they state that the issue of poaching has increased in later years, often as a result of food shortage in combination with human conflicts, when law enforcement has declined. However, they conclude that poaching is of the least concern out of the three primary threats. And this is supported by Lewison (2007), who found in simulations that the biggest threat to hippos is loss of habitat, due to the damming of rivers etcetera, especially in conjunction with droughts.

Not only are humans a threat to hippos, hippos are also a threat to humans. Of 636 reported casualties in Uganda 1923-1994 (Treves and Naughton-Treves, 1999), hippos and other large herbivores were responsible for 33.5 %. In this study, hippos killed 86.7 % of the humans they attacked, making them more dangerous than lions, elephants, and leopards.

Purpose

The purpose of this study was to examine the effect of livestock grazing on the wildlife in the area, and the purpose of this paper is to analyze how the common hippopotamus is affected.

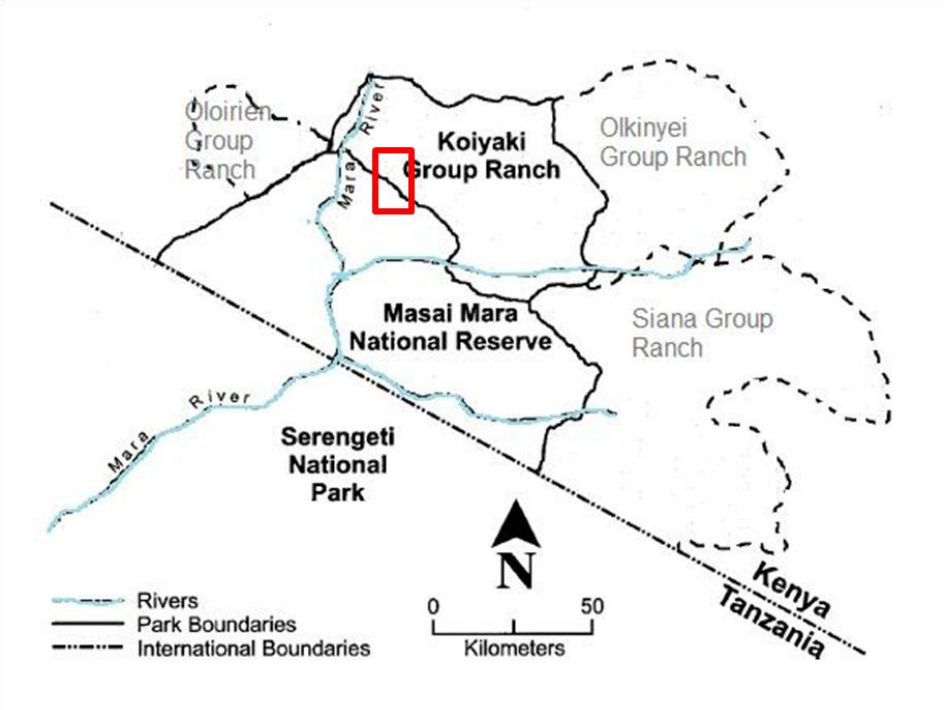

Figure 1a. *The study area (red square) at the border of the Maasai Mara National Reserve and Koiyaki Group Range, Kenya.*

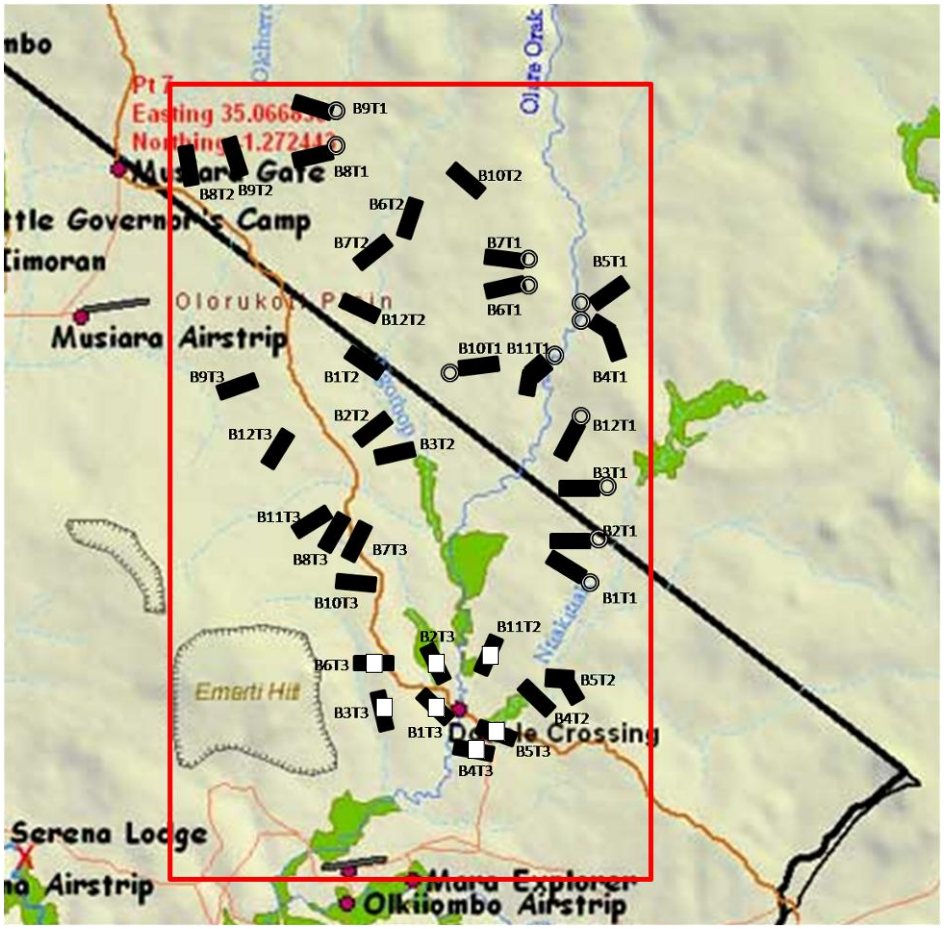

Figure 1b. *The locations of the transects (black rectangles) with transect numbers. White squares indicating transects where hippos where recorded.*

Materials and methods

Study area

The study was carried out in the Maasai Mara National Reserve (MMNR) and the adjoining group ranch, Koiyaki GR, in southwestern Kenya (1°20´S, 35°08´E). The reserve borders the Serengeti National Park in Tanzania, and is a part of the same ecosystem. The study area covered ground rich in grass, both within and outside the park, hence the effect of livestock grazing was evident. In order to describe seasonal variations and its changing conditions two seasons were chosen. The observations were conducted during December 2003 and May-June 2004, because of the great difference in grass quality and grass availability between the seasons.

Selection of transects

Transects were defined as areas a 1000 m long and 300 m wide (i.e. 0.3 km²), with central points of 0.5 km (T1), 3 km (T2) and 5.5 km (T3) away from bomas (the Maasai settlements). The central points were selected to create a gradually reduced impact of humans and livestock. The transect areas consisted of open grassland with no or few trees and shrubs, and topography chosen to allow good visibility.

12 bomas was considered sufficient to answer the question of effect of bomas on wildlife. In total 36 transects, three per boma, were included in the study. When the transect closest to the boma (T1) was selected, the following ecological features were recorded; soil type, termite hills, stones and vicinity to

permanent water, shrubs and woodlands. Thereafter, the T2 and T3 transects were chosen in order to match the same ecological criteria as the T1 transects, as closely as possible.

Recording method

Observations were made from the roof of a car, equipped with global positioning system. The car followed the central line of the transect (hereafter called transect line), alternating the starting point between both ends. To prevent startling the animals on the first part of the transect, observations started when the car was 200 meters from the start or end point, aligned with the transect line. When there was a boma, river, hill or other physical obstacle that did not allow driving directly to the transect, the transect was approached from the side, usually in a 45º angle.

Data collection was systematically carried out on the three types of transects (T1, T2 and T3) every second hour evenly spread over day and night on both occasions. For each observation recordings of exact time, light intensity, weather, temperature, humidity, and phase of the moon were taken.

All animals encountered on the transect were included in the data collection. The number of hippos on the transect was counted and noted. The distance from the car to the animal was recorded with Leica© Rangemaster CRF 1200. The presence of people, cars, and livestock were recorded when within 300 meters from the transect line. To record the impact of man and his livestock in the transect areas, a herd or gathering was recorded as one unit, independent of the number of individuals.

Position of the animals

The position of the animals was recorded in detail to enable calculation of number of animals per area unit. The distance between the car and an animal (or a cluster of animals) was measured. To calculate the distance between the transect line and the animal at a 90° angle, a protractor was used to determine the angle between the animal's position and the transect line. This angle, together with the distance between the car and the start point of the transect (not of the drive), was used to calculate the exact position of the animals on the transect. Calculations were made using sines law:

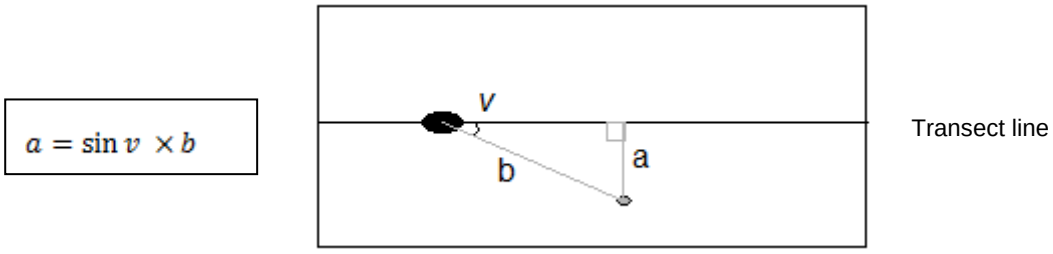

Figure 2. *Sketch of a transect area, explaining how to calculate the distance between the transect line and the observed animal. Using the law of sines with the measured angle* v *and the distance* b *from car to animal, the distance* a *was calculated.*

Animals found to be more than 150 meters from the transect line were excluded from the data, as they were not present within the transect area. If the centre of a cluster of animals were located outside the transect all animals in the cluster were excluded. Likewise, when the cluster centre was located inside the transect all animals were included.

Minimising the impact of recorders on animals' behaviour

To minimize the impact of the observers, a flexible way of driving and observing was adapted. Larger groups of animals in areas with short grass seemed to be less affected than single animals in tall grass which had to be recorded from a greater distance.

To test if animals were missed due to human and/or environmental factors, the mean distance of all animals were calculated. If all animals were seen, they should be evenly distributed over the transect, and the mean value of distance from the transect line should be approximately 75 meters.

Statistical analysis

The collected data was sorted in Microsoft Excel® and analysed in MiniTab®. The data was tested for normal distribution using the Anderson-Darling test and were found not to be normally distributed. The non-parametric Kruskal-Wallis rank sum test was used to test for statistical significance. In some cases, mean values were calculated and displayed, even though data was not parametrical. The reason for this was that the median value in many cases would be zero and therefore mean value was preferred, so results could be displayed.

Results

86 hippos were observed in the study during 22 drives. In December, 36 individuals were observed on seven drives; in May/June 15 drives recorded a total of 50 individuals.

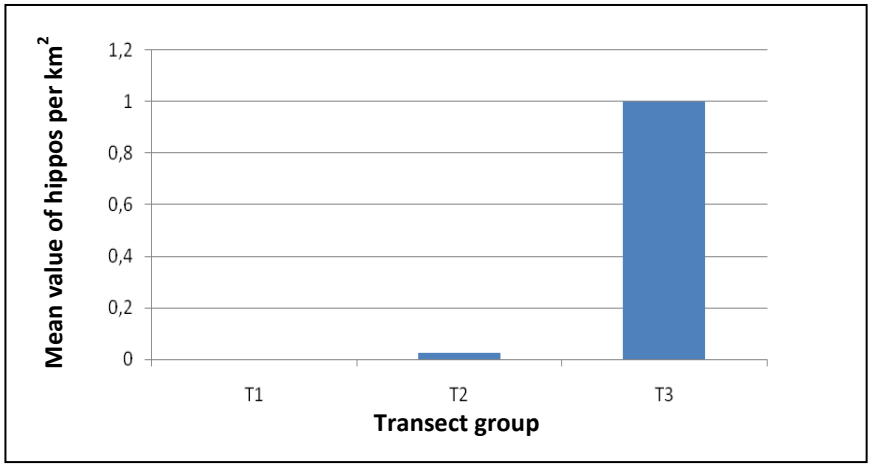

Figure 3. *Mean value of hippos per km^2, categorised within the T1, T2, and T3 groups, i.e. distance from bomas.*

As shown in figure 3; in both December and May/June, hippos were found to avoid the T1-transects (Kruskal-Wallis; H=11.41; DF =2; P=0.003, adjusted for ties), only during one drive hippos were found on a T2-transect (B11T2, in December, double hour 20:00-21:59). In the non-parametric test, the mean value of a transect's recorded numbers hippos per km^2 in both December and May/June were calculated and tested; since the same transect in two seasons would be considered dependent.

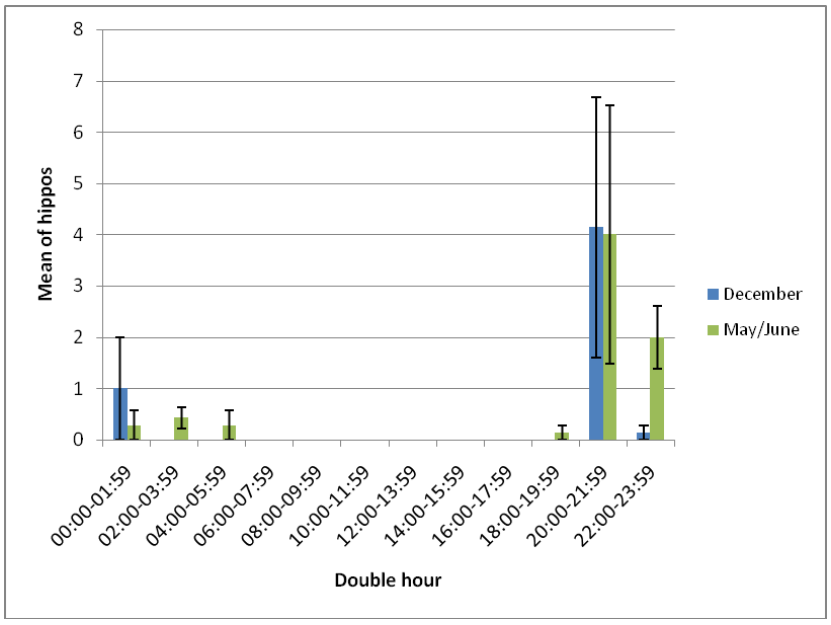

Figure 4. *Diurnal rhythm displayed as a mean value of hippos recorded per double hour. Only the transects where hippos ever were recorded are displayed.*

The diurnal rhythm was also clear (figure 4), as hippos did not enter transects during daytime (06:00 to 18:00). Comparing only the transects on which hippos were recorded, the difference is significant (Kruskal-Wallis; H=8.65; DF=1; P=0.003).

All observations of hippos were in the same seven transects in the southeast of the study area (se figure 1b).

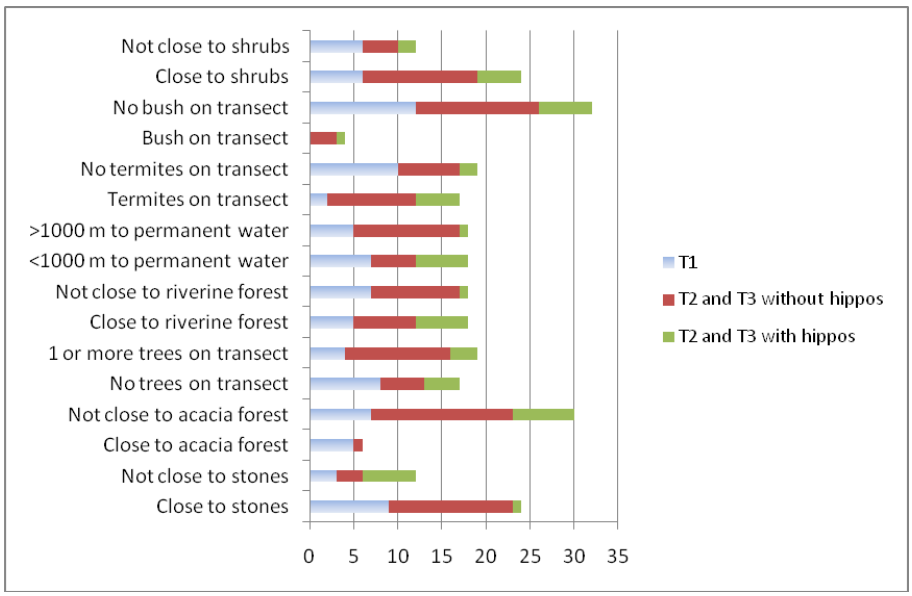

Figure 5. *This diagram shows how the transects are distributed within the ecological factors recorded. Each transect belongs to either of a pair of bars (for example in "not close to shrubs" or in "close to shrubs"). The diagram also shows how many of the transects within a feature belongs to the T1, T2, or T3 groups.*

As seen in figure 5, there is seldom any ecological differences between the transects with and without recorded hippos. Most noticeable is the difference of closeness to stones, where there are hippos present on six of the total nine transects with this feature "not close to stones". The factor which would seem to be the most essential – the closeness to permanent water sources (i.e. rivers), is not a feature of all the seven transects with hippos present (B6T3 is the exception), and more interestingly – excluding the T1 transects, there are 5 transects within 1000 meters of a permanent water source on which no hippos are present. This is four T2-transects; two in the far northwest of the study area, one in the centre, and the B4T2 in the southeast corner. The fifth transect is the B10T3, centrally located next to three other T3-transects.

Discussion

The results of this study show that hippos avoid land intensively grazed by livestock, though they are present in the area. Field (1970) found that there are fewer hippos in regions of villages, which is in line with this result. If hippos would consider humans a threat they would not reside in the river close to settlements, but this is not the case of the hippos in the Olare Orak River. Hippos were seen in the

river close to the bomas 1 and 2 (Jens Jung, personal communication[1]), even though they were not observed on the nearby transects. This could be interpreted as hippos do not avoid the presence of either people or livestock, but they choose to graze at other sites.

According to O'Connor and Campbell (1986), hippos prefer to graze on dune grassland and riverine woodland close to the rivers, and to walk distances up to 2.7 km per night, but seldom more than 1.15 km inland from the river. In this study, single hippos are found more than 1 km from permanent water, with the majority of animals closer.

As very few transects were observed with hippos present, it is not possible to statistically test what hippos prefer. Figure 5 though; indicate that hippos prefer areas not too close to shrubby areas and in areas without bushes. Other studies have shown that hippos graze in the riverine woodland (O'Connor and Campbell, 1986), where there are both shrubs and bushes, but the hippos in this study seem to avoid transects with these features. The hippos would probably graze in woodlands close to rivers, but since only open grass areas were included in the study; this is not possible to determine. These results do not show that hippos in the Olore Orak River area do not graze in areas with shrubs or bushes, but that when they choose to graze on more open land, they prefer areas without bushes and/or in the vicinity of shrubby areas. Hence, the proximity to water may be a factor reducing the negative effect from bushes. Either because the hippos feel more secure close to the river or because there are different species of bush and shrub in the riverine woodland than on the savanna, and the hippos avoid the savanna types. But as discussed above, it is very hard to conclude anything from the transect ecology factors. Interestingly though, the transects closest to the ones where hippos were recorded (B10T3, B1T1, B4T2 and B5T2, see figure 1b) all have the ecological feature "close to shrubs". Whether any conclusions could be drawn from this is hard to tell, since that feature is twice as common as its opposite (see figure 5).

More interesting than the actual ecological factors is the over-all location of the transects where hippos are present. All the hippos were observed in the southeast corner of the study area, and predominantly at the B5T3 transect between the houd of 20:00-21:59 (19 individuals in December and 18 in May/June). What's so special about this transect?
The ecological features are identical to the B3T3 transect (total count of 15 hippos) in all aspects apart from the numbers of trees on the transect (2 vs. 0), and identical to the B2T3 transect (7 hippos, only in April) in all aspects apart from the vicinity to areas with shrubs (see discussion above). On these transects hippos are recorded during more than one double hour of the night, indicating that the area is grazed for a longer period than the B5T3 transect. This can be understood as the hippos start grazing the B5T3 transect and then continue south or southeast in the direction of the plains between the study area and the Talek river, before returning to the river by a different path, which does not enter any of the transects.

The display of diurnal rhythm (figure 4) shows that no hippos are recorded between 06:00-17:59, which is in accordance with other research (Field, 1970; Lewison and Carter, 2003). In December, there is an even shorter period of time in which the hippos appear; only between 20:00 and 01:59. This happens at the end of dry season, when the migrating herds have left and the grass is limited, so probably not because they have finished grazing at 2 o'clock. Other studies (O'Connor and Campbell, 1986; Olivier and Laurie, 1974) show that during the dry season or where there is a high density of hippos, they are found to walk longer distances to graze. With current results it is not possible to draw any conclusions whereas the this is also the case in this study, but it is a likely theory. However, the hippos do not walk either north or northeast because they are not present in these transects. The grass

[1] Jens Jung, Swedish University of Agricultural Sciences, Department of Animal Environment and Health. Research leader. 2009-05-03

in the vicinity of bomas was severely grazed, and presumably avoided because of this or because hippos prefer to avoid contact with humans. However, since hippos graze during nights, when human activity is low, the first reason might be the most likely cause.

It is debated which major factor is limiting a hippo population; the access to daytime cover in rivers or the amount of food available. O'Connor and Campbell (1986) conclude that hippos over-utilized sites close to rivers in Zimbabwe, but in their study of hippos further down the Mara River in Serengeti National Park, Tanzania Olivier and Laurie (1974) argue that the restraining factor is the day living space in water.. They mean that when resources are limited (due to an increase in the density of hippos or the dry season), the animals could extend their grazing range since the productivity of the habitat is found to be high.

Since hippos return to the river every morning, their grazing range is limited. As shown by Verweij et al. (2006) their grazing habit makes lawns, where the grass is shorter than in the surrounding area. They are known to keep this lawns open during the whole year (Olivier and Laurie, 1974), and other herbivores may take advantage of these short grazed areas. Although the hippos, according to my results, do not benefit from the livestock grazing (i.e. use the same area at night), they might in a longer perspective do so. If livestock grazing keep the grass of a greater area short; wild herbivores, which otherwise would have competed with the hippos for their lawns, now leave these areas alone preferring areas where livestock graze. This do not comply with all species of herbivores, since small herbivores might always avoid the tall grass surrounding the hippo lawns due to the risk of hiding carnivores, but the fact should be considered when determining the effect of livestock grazing on hippos.

This study was not perfect for the intent of studying the grazing habits of hippos. Not only were hippos observed in just a few transects, there were also very few animals in total. The study contained 864 driving sessions, 12 times at each of the 36 transects in both seasons. Out of these drives, hippos were observed at a total count of 22. Even though the purpose of the study was to determine the absence or presence of a species at a certain location, this result indicates that the study was not optimal for studying hippos, either because there are few hippos in the area or because the hippos in the area chose to graze outside the study area.

To fully understand the hippos' grazing habits, the study would have had to contain more observations of hippos. In order to do this, the study area should include a bigger area (for example the plains in south and southeast to test the theory that hippos graze there later in the night), and there should be transects close to where hippos leave the river. If this was the case, the hippos could be present in the collected data material during the whole night, and the exact times for when they leave the river and when they come back could be recorded, as well as the exact number of individuals present.

Since the study area was chosen to demonstrate the effect of human settlement close to the national reserve, the study was carried out in a way which unfortunately does not show where the hippos go – but it shows that they leave the area. Instead of approaching the T3-transects in the northwest, the result from the B5T3-transect demonstrates they go south or southeast in the direction of the Talek river. And this may cause problems in the long run; this area is not unaffected by livestock when the park management allows the Maasai to graze their livestock there during droughts (Jens Jung, personal communication[2]). Further studies ito the impact of grazing here are important in order to learn how the hippos are affected by the competition. If this is the case, hippos might either decline in numbers or chose to graze closer to bomas – feeding on resources that already are scarce and growing more

[2] Jens Jung, Swedish University of Agricultural Sciences, Department of Animal Environment and Health. Research leader. 2009-05-03

accustomed to humans. In the latter case, this may lead to the occurrence of direct fighting, with catastrophic result for both humans and hippos.

Conclusions

From this study, no definitive conclusions can be drawn as to how the hippos are affected by livestock grazing. The hippos in this study avoided areas close to bomas. To determine if this is a result of competing for grass with grazing livestock or to avoid humans, more research is needed. This study follows earlier observations of the diurnal rhythm of hippos, with no hippos recorded on transects between 06:00 and 18:00. In both seasons, the majority of animals were observed before midnight, indicating that hippos continue to grass outside of the study area. Perhaps contradicting earlier research, hippos were seen on grazing areas in large groups, occasionally of 18 to 19 individuals.
The most striking of these results is the need for more research into this megaherbivore's behaviour and especially how and where they choose to graze. With this investigated, more secure conclusions can be drawn of how Maasai life affects the hippo population in Maasai Mara. When this is known, predictions can be made for how hippos will be affected of a changing Maasai lifestyle.

Acknowledgments

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