Original Research Article

Participatory spatial planning for reconciling human activities and conservation of Grevy's Zebra (Equus grevyi) in Northern Kenya. A Case Study of Meibae Community Conservancy, Samburu

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Abstract

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Wide-ranging wildlife species in Northern Kenya have been facing immense pressure due to intensification of human activities in their natural habitats. This pressure has resulted in the decline of these species populations. Successful conservation should therefore address both species numbers and their habitat. This paper reports on a study of human activities and Grevy's zebra habitat use in Northern Kenya, a case study of Meibae Community Conservancy. Participatory mapping, community workshops, Geographic Information System (GIS), ground truthing and use of global positioning system (GPS) radio collars were used to identify all human activities in the area and ecological areas important to Grevy's zebra. The community-drawn maps were digitized; the resulting map was overlaid with the other layers of data collected by radio collars and ground truthing to compare with these parameters. In this example human activities are so intensive, that, nearly all the Grevy's zebra habitats were converted into settlement areas. In addition most of these important ecological zones have been highly degraded by repeated human activities. Regression analysis was run and showed 85% negative correlation between Grevy's zebra movement and human settlement. Analyses presented here are not only significant to species conservation, but are important in informing land use planning for sustainable biodiversity conservation and also restoring both species numbers and their habitat. For sustainable wildlife conservation in Northern Kenya, establishment of community owned conservancies, strengthening community benefits and developing sound land use planning will minimize human/wildlife conflict. This community-driven framework will also reconcile the existence of all parties. By doing this it will improve community livelihoods and instill a sense of ownership of wildlife and other natural resources.

Keywords: Grevy's Zebra, Habitat, Participatory Mapping, GIS, Settlements, Livestock.

INTRODUCTION

The following outlines the presence of Grevy's zebra in Northern Kenya and factors affecting their numbers and distribution; their relationship with the Nomadic pastoralist and the potential of participatory mapping in conservation.

Since the 1970s, Kenya's Grevy's Zebra population has declined from 14,000-15,000 to current estimates of 2400-3000 individuals remaining in the wild by 2008(Low et al. 2009; Lelenguya et al. 2010; Parker et al. 2010). Consequently the species has been categorized as endangered in the IUCN red list and is listed on Appendix of CITES1 (IUCN, 2012; Lelenguya et al. 2010). However, the current status indicates that the population trends are stable (IUCN, 2012). The remaining populations are distributed over an area of 85,000 square kilometers of savannah grassland in Northern Kenya and Southern Ethiopia (Parker et al. 2010; Low et al. 2009). Their stronghold in Kenya is in community rangelands inhabited and managed by the nomadic pastoralists (Low et al. (2009). Low et al. (2008) report indicates that, of the sightings made during the survey, in Northern Kenya, 60% were on community land. Some of the communities whose lands are of critical importance were: West Gate Conservancy (Ngutuk Ongiron Group Ranch), Meibae Conservancy (Ngaroni and Sesia Group Ranches), Kalama Conservancy (Girgir Group Ranch) and Kirimon group ranch (Lelenguya et al. 2010). This confirms that communities in Northern Kenya are important stakeholders for the successful conservation of Grevy's zebra (Low et al. 2009).

In recent years a mosaic of community conservancies has been established and the species is used as a flagship for conservation in the region. However it has been challenging to effectively monitor their population status. This is because the population is distributed over large areas in low densities (Parker et al. 2010). Grevy's zebra are uniquely adapted to arid and semi-arid habitats, which are not hospitable to the abundant plains zebra. However Grevy's zebra range has been declining. The favorable habitat for the Grevy's zebra is characterized by short grass savannah, offering good visibility so that the animals are able to detect both one another and the predators at a distance (Sundaresan et al. 2007; Parker et al. 2010). Due to resource scarcity the animals are now utilizing a range of habitats types including bush lands, depending on the seasons and resource availability (Low et al. 2009; Parker et al. 2010).Grevy's zebra have also been noted to avoid areas with humans and domestic livestock due to disturbance and competition for resources (Williams, 2002). Human land use, settlement, livestock and habitat types are the key variables that affect the distribution of this species(Low et al. 2008), hence are significantly important variables in this study. To understand the interaction between Grevy's zebra and livestock, we need to get fine-scale information on the movement of both groups (Sundaresan et al. 2007). Sundaresan et al. (2007) further recommended that studies are needed to determine movement of Grevy's zebra; livestock, land use variations and land cover characteristics. By characterizing how these variables relate and overlap with ecological features, we can predict wildlife population dynamics in response to land use changes.

Local communities perceive disease outbreaks, predation from lions, frequent droughts, habitat change and fragmentation, poaching and water scarcity as the key factors contributing to the decline of Grevy's zebra (Low et al. 2009; Lelenguya et al. 2010). Predation risk is increased as Grevy's zebra are forced to use unsuitable areas due to the scarcity of suitable habitat. Predation is also associated with changes in land cover within the habitat. For instance this happens in some areas due to bush encroachment, resulting from land degradation. This can result in invasive species like *Sanseviera-volkensii* and *Acacia reficiens* colonizing large areas of grassland (Lelenguya et al. 2010). In addition, the Kenya national Grevy's zebra conservation and management national strategy task force identified similar threats, which are outlined on Table 1.

Recent studies have shown that pastoralism is the only land use that does not require exclusive use of the land (Honey, 2008). The recent growth of wildlife conservation in Northern Kenya has led communities to diversify their economic activities to include conservation and tourism as a source of livelihood (Parker et al. 2010; Low et al. 2009).

Using vegetation data, Young et al. (2005) found that cattle compensate for absence of wildlife, while, wildlife does not compensate for the absence of cattle. In semi-arid rangelands worldwide, livestock and large native herbivores share land, water, forage and many other resources in the arid biomes. The fate of the biodiversity in these rangelands depends on the level of interaction between livestock and wildlife (Young et al. 2005). There is a worldwide belief that livestock and large herbivores like zebras compete for grass. On the contrary some conservationists suggest that, resource use planning reduces competition, and biodiversity conservation and livestock keeping are compatible activities. Prins (2000) recommends that although there is some overlap in resource use between livestock and wildlife, competition is largely asymmetrical and mostly during the dry seasons. For example, cattle have a competitive impact on some wildlife species, but wildlife species have little or no competitive effects on cattle.

In Northern Kenya human activities have been intensified causing a drastic reduction in natural habitats. Restoration and natural resource management are needed for the future survival of these habitats. (Hooftman and Bullock, 2012). The involvement of local communities could be the best strategy for successful natural resource management. Participatory mapping is an effective method for involving local communities in natural resource management. Puri (2011) defines participatory mapping (PM) as a way of collecting information on natural resources and local perceptions within a shared geographical framework. It offers an opportunity to explore local knowledge and use of the natural and social enviroment, which are important for

Table 1. Summary of Current and Future Threats to Grevy's Zebra in Kenya. (Source: KWS 2008)

Threat	Cause
Reduction of water sources	Unsustainable extraction of perennial (EwasoNyiro) river water for irrigation in highland areas
Restriction access to water	Exclusion of wildlife from scarce water sources by pastoral communities
Habitat degradation and loss	Heavy, unplanned human activities with relatively high densities of domestic livestock, resulting in changes to the vegetation communities and land cover.
Competition for resources	Competition with relatively high densities of domestic livestock for limited resources, (grass, water and land) particularly in the dry season
Hunting	Historically, the killing of Grevy's zebra for skins; currently, killing for meat and utilization of Grevy's zebra oil for medicinal and cultural purposes in some parts of the country. Being a social friendly, large species result in being used as targets for shooting
Predation	Disproportionate predation of Grevy's zebra specifically by lions and recently discovery of foal hyena predation.
Disease	Recent endemic Anthrax in the environment; unvaccinated livestock making both domestic stock and wildlife susceptible to the disease especially for species occurring in low numbers
Inter-specific hybridization	Sympatric hybridization between Grevy's zebra and plains zebra and domestic donkeys on the edge of Grevy's zebra range.

land use planning and development. Innovations are buildling on the basic method of PM like Participatory Geographic Information Systems (PGIS). These innovations have made it possible for local communities to analyze and present their land use patterns and knowledge in more powerful and advanced ways. PGIS can be an effective methodology to collect the public input in local land use planning and to devise the best growth management strategy. It provides the community with the opportunities to discuss their priorities, and their land use activities and to identify any other areas of special management in a way that cannot be done in a normal community meeting.

By using GIS, local communities, communicate and share their knowledge with decision and policy makers. GIS and other information technologies give marginalised communities a voice (Chambers, 2006). Using geospatial data and simple GIS approaches,communities can delineate areas of human activities, and overlap with areas containingrich biodiversity (Haines et al. 2012). The use of GIS can be illustrated as a methodological framework to allow stakeholder participation in the refinement of land use planning (Austin et al., 2009).McCall and Minang (2005) found that PGIS Mapping contributes positively to good governance, improving dialogue, redistributing resources access and control rights, legitimizing and using local knowledge, exposing stakeholders to geospatial analysis and creating some actor empowerment through training. PGIS helps in empowering local communities in the

decision-making process.

The main aim of this project is to contribute towards developing a spatial planning framework to reconcile human activities, and conservation of endangered Grevy's zebra and their habitat in Northern Kenya, Meibae Community Conservancy in Samburu County was used as a case study. The specific project objectives include (i)Asses the community perception on the possible conflicts/competition between Grevy's zebra and livestock. (ii) Map the Key anthropogenic activities in the area. (iii)Identify and map out relative seasonal livestock grazing zones in the study area. (iv) Identify and map movement, distribution and areas of ecological importance for Grevy's zebra. To achieve the objectives i-iii, participatory mapping, ground truthing, informal interviews and ArcGIS analysis were used. GPS-GSM radio collars, ArcGIS and Regression analysis has been used to achieve the last objective.

MATERIALS AND METHODS

Study area

The study area covers two locations: Nkaroni and Lodungokwe of Samburu County in Northern Kenya. The two locations are associated with Meibae Conservancy, which is formed by Nkaroni and Sesia group ranches. The two community group ranches have agreed to work together to manage their land collectively for both lives-

tock husbandry and wildlife conservation.

The two group ranches are adjacent to each other and share a lot of resource diversity. This made them to come together and form Meibae Conservancy, which is approximately 104,547 hectares. More importantly the conservancy is a hotspot for the endangered Grevy's zebra. The area is a typical arid savanna, with herbaceous plants, shrub land, sparse vegetation and woodland as the main habitat types. Rainfall is erratic with peaks of April/May and November/ December with an average of about 375 mm, with occasional droughts (Lelenguya et al. 2010). The conservancy has a human population of about 10,029people (KNBS, 2010).

Participatory mapping and community workshops

For the purpose of community management the conservancy is divided into 15 grazing zones. The conservancy management demarcated the zones according to community settlement patterns. These grazing zones were the convenient strategy to have the community come together for the purpose of this study. Participatory mapping was the main method used in this study. One community workshop was held in each of the 15-grazing zones. The residents of each zone were invited to their specific zone workshop. During each workshop, there was a discussion session on what people think about the possible conflict/competition between Grevy's zebra and livestock. Then a participatory mapping exercise was conducted in groups of elders, women and warriors. Some of the key features the community was asked to map were: the settlement location of every village, livestock dry and wet season grazing, water sources and the key areas of importance to Grevy's zebra. After the mapping, each group reported back their map, and plenary discussion was held to discuss and harmonize the maps that were produced by the groups. This discussion led to the production of one map per zone that has all the features as agreed by all the groups. Some individuals were picked to help on the ground truthing to collect the Global positioning system (GPS) coordinates for each village and some of the key identified features in the maps. During the ground truthing session, involving the community members in each zone, informal interviews and discussions were held on some of the issues the community has on Grevy's zebra competition with livestock and people. During the informal discussion, some of the key themes of focus for discussion were; the current dry and wet season livestock grazing patterns, the conflicts of Grevy's zebra and livestock and other human activities, the current land use and management system and changes in the community lifestyle. Coding was used to identify these common themes in the data to build the conceptual framework.

Geographic information system (GIS) and Radio Collars

After carrying out the community participatory mapping, all the GPS coordinates of all the features identified by the community were collected. These were then downloaded into ArcMap and plotted on the study area map. Using Arc GIS 10 features (ArcMap 10, Arc Catalog 10) the community hand drawn maps were digitized according to the decisions on how they carry out these activities (Figure 1a).

With the support of the Kenya Grevy's zebra management and conservation national strategy technical committee, GPS collar data were downloaded from ten (10) individual female Grevy's zebra. These individual animals were collared in different locations in the Northern Kenya region. Some were outside the study area but it was very relevant to have all this data for tracking the movement of the individual animals as a sample of the larger population in the region. The data were downloaded, using tracking data manager software and transferred to ArcGIS. The GPS Radio collars provided records for three consecutive years (2010, 2011 and 2012). The collar, records the individual animal location once every hour (Low et al. 2009).Data was grouped in months to see the movement of the animals on monthly basis, to see the temporal utilization of different habitat types by the animals. Grouping by months, also revealed the relationship between Grevy's zebra movement and the community livestock seasonal grazing patterns, which is done in wet and dry months of the year (Figure 1b). The data is also used to see the Grevy's zebra response to human settlements. The settlement and the animal's movement layers were overlaid to see the overlap or any relationship between the two.

Using ArcGIS data management tools, the number of records of Grevy's zebra presence in each zone, and the number of key settlement areas in each zone was identified. In order to assess this relationship between number of records of Grevy's zebra presence and the distribution of human settlements, linear regression analysis was used, using SPSS software. The P value was used at 0.05 as the level of significant in the model.

RESULTS

Community perception

During informal interviews with the community members in the 15 zones, it was clear that there was very widespread concern about environmental degradation that affects both Grevy's zebras and livestock. People reported that there is expansive land degradation in the region; this is characterized by an increase in areas devoid of vegetation.
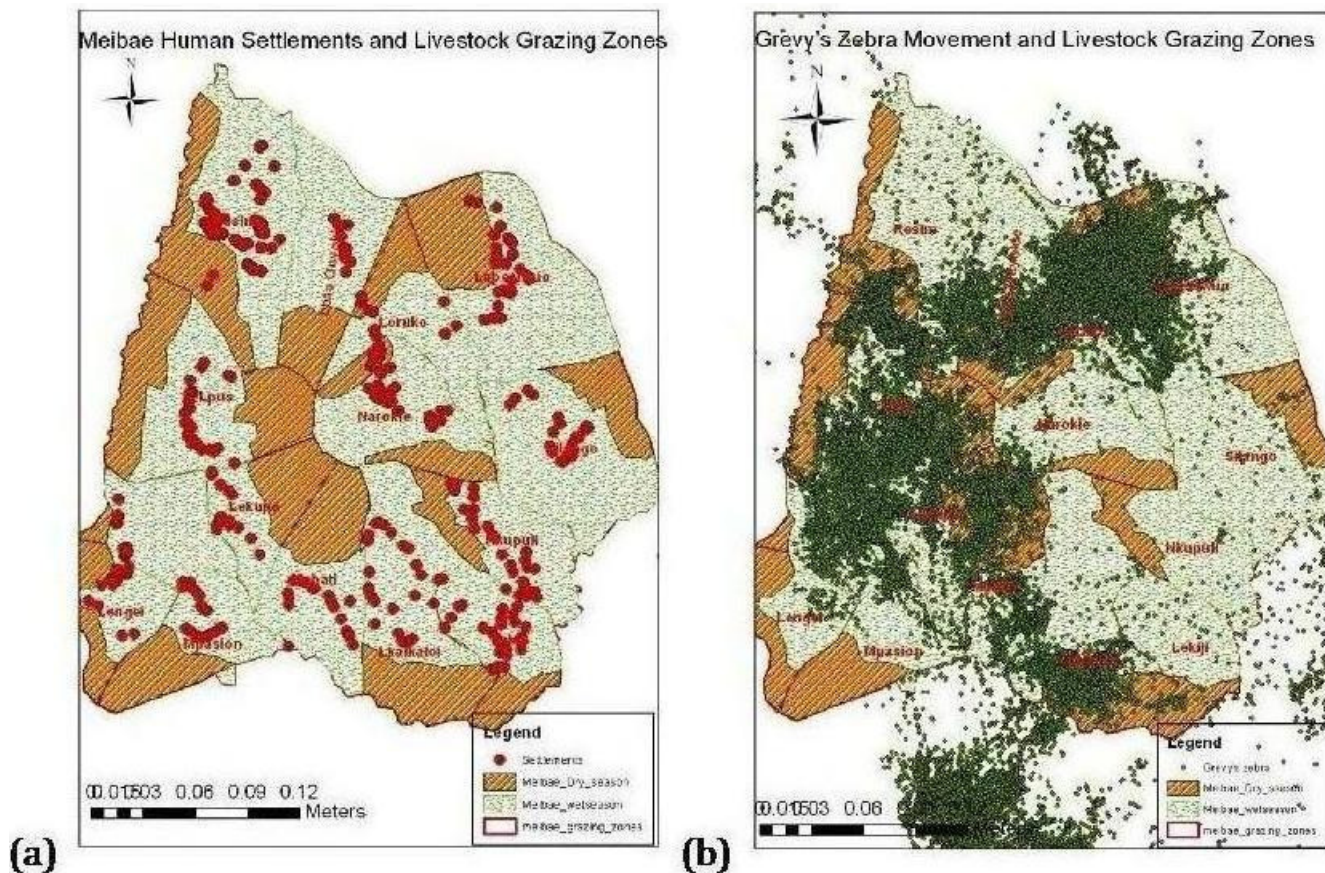
Figure 1. A map of the study area (a) Showing human settlements and livestock grazing zone (b) Seasonal grazing Zones and Grevy's zebra movement.

These areas of bare grounds lead to inadequate forage for the livestock and wildlife, loss of perennial grasses, and dependence of animals on the annual plant species in the region. The annuals then cannot sustain the pressure from relatively high livestock numbers and wildlife. Wet and dry season grazing areas were also said to be decreasing; because of two reasons: i) the increase in human population has also led to changes in community lifestyle where the local community institutions for example elders, are disempowered and they lose control over community decisions. The pastoral Samburu communities are now becoming sedentary which has led to poor land use practices in the region, where overgrazing is a common phenomenon. ii) The communities' feel that, with all the changes in their lifestyle, cultural practices and norms are also lost; hence it is hard for natural resource management decisions to be made. In this regard it leads to high competition for resources among the resource users. This competition over resources ends up causing death of both livestock and wildlife during droughts. In most cases Grevy's zebra end up being displaced as a result of this competition. During group discussion, some of the specific key issues that came up were competition between Grevy's zebra

and the community livestock for grass and water. These two components dominated the results in all the 15 zones in the study area. The biggest reason why the community felt Grevy's zebra was a major source of competition for both pasture and water was that they feed day and night.

The other issues of conflict were that, the space would be inadequate for people, livestock and wildlife; so all these will be competing for the same space. As a result of human population increase and increase in livestock numbers, there will be a high rate of land degradation posing a threat to all. With the congestion and competition for resources there will be a high rate of disease transmission to and from wildlife. The results of the community discussions on what people think about the possible conflict/competition between Grevy's zebra and livestock grazing are summarized in Table 2.

It is clear that the community is very concerned about this competition between Grevy's zebra and livestock. As a result of overgrazing there is expansion of land degradation in the area, which has facilitated encroachment of invasive species, as symptoms of the damage. Nature always fills a vacuum where it can – in this case grass has disappeared so nature is trying to grow any plant it can in this dry environment resulting

Table 2. Summary of Community Perception about the Possible Conflict/Competition Between Grevy's zebra and Livestock Grazing.

Zone	What are the potential conflicts between livestock and Grevy's zebra?	How concern is you? (Rank 1-5)1=Less concern5=Very concern	How serious are the conflicts? (Rank 1-5) 1=Less serious 5=Very serious	Are they getting better, worse, or staying the same?	What is your opinion in solving this Grevy's zebra and livestock conflict/competition?	Who need to be involved for your opinion to work?
Resim	• Grass competition • Inadequate space • Water competition	5	3	Getting worse	• Plan seasonal livestock grazing • Plan human settlement	• Elders • Women • Warriors
Lbaaonyokie	• Grass competition • Water competition • Inadequate space • Land degradation	4	3	Getting worse	• Develop land use management plans • Plan seasonal livestock grazing • Plan human settlement	• Elders, • Women • Warriors
Silango	• Grass competition • Water competition • Inadequate space • Easy transmission of disease	5	1	Getting worse	• Plan seasonal livestock grazing • Plan human settlement • Establish wildlife conservation areas	• Elders, • Women
Nonkupuli	• Grass competition • Water competition • Inadequate space • Predation by lions	3	3	Getting worse	• Reduce the number of livestock • Develop land use management plans • Plan human Settlement • Plan seasonal livestock grazing • Establish wildlife sanctuaries	• Elders, • Women • Warriors
Narokie	• Inadequate space • Grass competition • Water competition	5	3	Getting worse	• Plan seasonal livestock grazing • Plan human settlement • Community awareness	• Elders • Women • Warriors • Herders
Loruko	• Inadequate space • Grass competition	5	3	Getting worse	• Develop land use management plans • Plan human settlement • Plan seasonal livestock grazing plans	• Elders, • Women • Warriors • Herders
Lekupe	• Inadequate space	3	2	Getting worse	• Plan human settlement • Develop seasonal livestock grazing plans	• Elders • Warriors • Women • Herders

Table 2. Continue

|						
Lpus	• Grass competition • Water competition • Inadequate space space • Habitat degradation	3	3	Getting worse	• Develop land use management plans • Develop seasonal livestock grazing plans • Plans human settlement • Community awareness	• Elders, • Women • Larger community
Mpasion	• Water competition • High predation rates • Grass competition	4	2	Getting worse	• Establish wildlife conservation areas • Community awareness • Plan human settlement • Plan seasonal livestock grazing	• Elders, • Women • Warriors
Laantare	• Inadequate space • Grass competition • Water competition	3	2	Getting worse	• Develop land use management plans • Plan seasonal livestock grazing • Plan human settlement	• Elders, • Women • Warriors
Mabati	• Grass competition • Inadequate space • Disease transmission • Land degradation	5	2	Getting worse	• Plan human settlement • Plan seasonal livestock grazing	• Elders • Women • Warriors • Herders
Lkalkaloi	• Grass competition • Inadequate space • Inbreeding with donkeys • Disease transmission • Land degradation	5	2	Getting worse	• Plan human settlement • Plan seasonal livestock grazing • Community awareness • Develop land use management plans	• Elders • Women • Warriors • Herders
Lekiji	• Grass competition • Inadequate space	3	3	Getting worse	• Plan seasonal livestock grazing • Plan human settlement	• Elders, • Women • Warriors
Lopesiwo	• Grass competition • Water competition • Land degradation • Grass competition • Inadequate space	5	5	Getting worse	• Plan seasonal livestock grazing • Develop land use management plans • Community awareness • Plan human Settlement	• Elders, • Women • Warriors • Larger community
Lengei	• Grass competition • Water competition • Cases of shooting • Inadequate space • Land degradation	3	1	Getting worse	• Develop land management plans • Take children to school • Plan seasonal livestock grazing • Land Rehabilitation	• Elders, • Women • Larger community
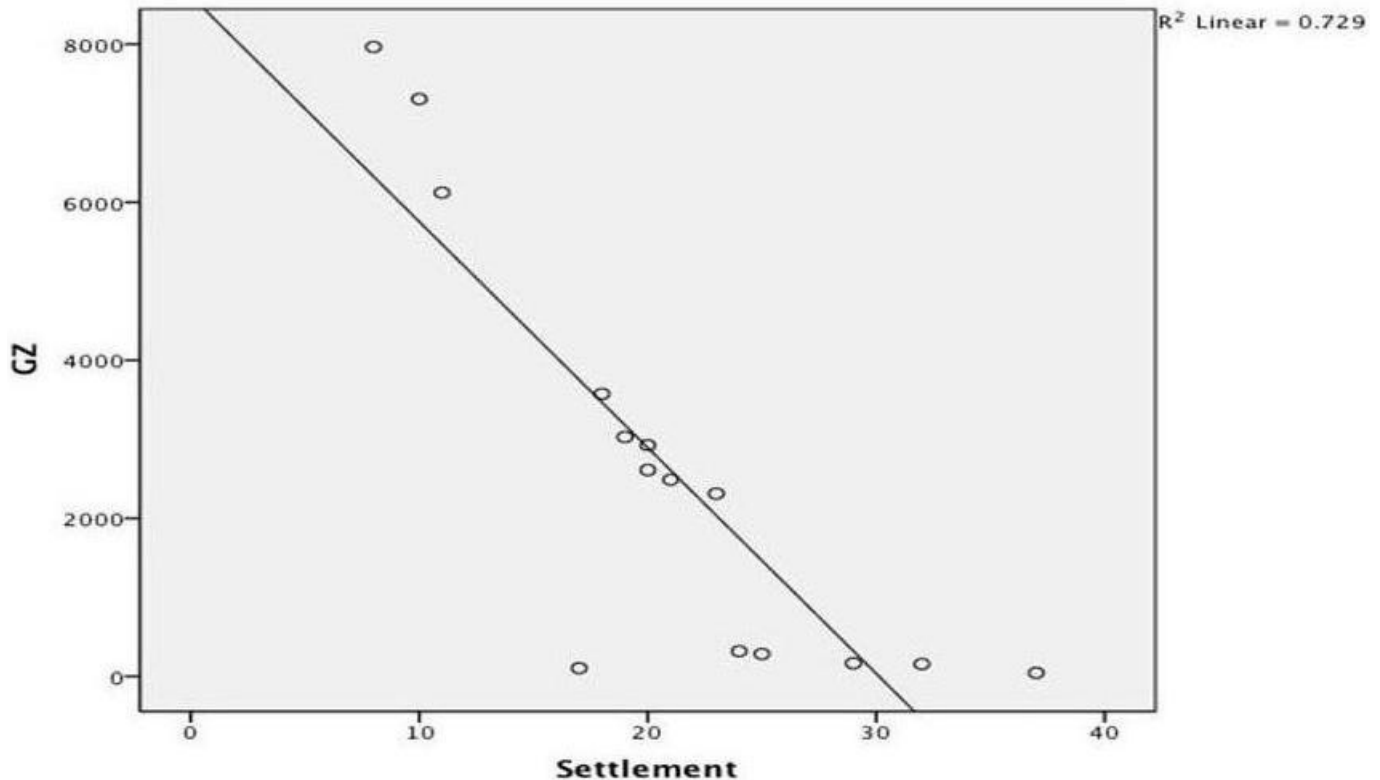
Figuree 2. The regression line showing the relationship between the number of human settlement (x-axis) and Grevy's zebra movement presence (y-axis)

invasive species. There is then need to undertake some rehabilitation measure to stop land degradation and address the cause, which is how livestock are managed on the land. The community emphasized that the elders should take the lead on land management issues. Regionally political leadership and administrative leaders like the chiefs also need to be part of this process.

Women were more detailed in their mapping and more exact than men. The women's maps for each zone tended to have more features than those by the men. They also had more information and more accurate than men on the areas where Grevy's zebra are mostly found, in comparison to radio collar data. This is possibly because of the day-to-day activities they perform outside the villages, like fetching water and collecting firewood. They also participate in livestock herding more than men who mostly play like supervisory role in the family. The warriors on the other hand have more knowledge on the exact locations and wildlife movement other than Grevy's zebra, more than other groups. It was a big challenge to have them participates in the workshops as their attitude and perception is that participating in such activities is not their role; it's the role of elders and women. The warriors argued that they are not always involved in such activities and their main work is just herding livestock and taking them for better pasture during the dry season. But despite this they had good information on the natural features in the area and wildlife distribution and movements.

System analysis

Following the GIS analysis a number of findings have been made: first in the study area, Grevy's zebra prefer some areas more than others. From the GPS collars records, Lopesiwo zone has the highest level of use in all the zones with 7,964 records, while; Nkupuli zone recorded the lowest use with only 44 records. Using the ten collared individual Grevy's zebra as a sample, monthly movement was analyzed and showed that Grevy's, zebra have no specific temporal movement within a year. They move across the whole area, with the exception one of the collared animals, which spends the whole month of May either, in Lopesiwo or the Samburu National Reserve. This movement of animals suggests that they move according to availability of space and freedom across the area. The results also showed that within the 15 zones of Meibae conservancy nine zones are critical habitat for Grevy's zebra. These zones identified are; 1) Lopesiwo 2) Lpus 3) Loruko 4) Lkalkaloi 5) Mabati 6) Resim7) Laantare 8) LbaaOnyokie 9) Lekupe. In addition; 1) Silango 2) Nkupuli and 3) Lekiji zones have also been identified as being important areas

Table 3. The Number of Grevy's zebra and settlement in different habitat types in each grazing zone and the percentage of each habitat type in the study area

Zone	Area (km^2)	No. Settlements	No. GZ Records	Forest Cover	Herbaceous cover	Shrub land Cover	Sparse Veg. Cover	Woodland <70 Tree Cover	Woodland <70 Tree Cover
Resim	115	20	2926	0	37	17	25	13	23
Lbaaonyokie	70	21	2488	0	14	1	30	6	19
Lopesiwo	112	8	7964	0	31	5	46	0	30
Loruko	54	11	6121	0	23	1	22	1	7
Lpus	107	10	7307	1	5	21	0	58	22
Narokie	70	25	284	0	8	5	12	37	8
Silango	99	29	166	0	41	2	21	0	35
Nkupuli	51	37	44	0	4	0	25	3	19
Lekiji	50	32	156	0	7	16	13	0	14
Lekupe	45	23	2313	0	1	0	10	31	3
Lkalkaloi	90	18	3574	0	12	26	6	14	32
Mabati	66	19	3029	0	1	21	7	14	23
Mpasion	53	24	319	3	4	5	4	9	28
Laantare	47	20	2611	0	7	2	0	17	21
Lengei	29	17	104	2	0	0	0	1	26
Total	1058			6	195	122	221	204	310
%	100			0.6	18.4	11.5	20.9	19.3	29.3

for crossing to and from the neighboring habitats of, Westgate, Samburu National Reserve, Kalama and Buffalo Springs National Reserve.

The movement of Grevy's zebra indicates that the animals avoid areas of high human settlement concentration and use areas with less settlement. The Grevy's zebra records show high concentration on dry season grazing areas where there are no settlements. In running the statistical models the results showed that, since the P value (0.000) was less than the level of significance (<0.05),the statistical model is significant. This shows that there is a significant relationship between the two variables (Grevy's zebra movement and the human settlements). The correlation coefficient for the relationship between the two variables is -0.854 and the R square is

0.729. This could be characterized as a very strong negative relationship. The conclusion is that, when the number of settlements increases the number of Grevy's zebra will decrease (Figure 2).To determine the movement of Grevy's zebra in relation to landscape variation and vegetation characteristics, vegetation types were calculated to find the size of each vegetation type in each zone, and the total percentage of the of each vegetation type in the study area using land cover maps. The results shows that 70.1% of Meibae conservancy is less than 70% tree cover. Herbaceous plants, shrub land, sparse vegetation and woodland <70% tree cover it. Only 29.9% is covered by forest and woodland >70% tree cover. In reference to Sundaresan et al. (2007) and Parker et al. (2010) it shows why the conservancy is home to Grevy's zebra in Northern

Kenya (Table 3).

DISCUSSION

The current human population growth is creating great concern over the future of wildlife in the wild. Kenya's population has increased from 2.5 million in 1897 to 38.6 million in 2009 (KNBS 2010, ILRI 2011).As anthropogenic activities intensify in Northern Kenya, wildlife habitats continue to decline. Grevy's zebra, being a near-endemic species to Northern Kenya, are currently found in few areas in the region. They continue to face immense pressure from these anthropogenic activities. After using various methods to look at the relationship between Grevy's zebra and the human activities in this region, it appears that the

communities appreciate and accept that Grevy's zebra, pose little threat to their livelihood and it is friendly animal that can easily co-exist with humans.

By using data from the community mapping exercise, areas of ecological importance to Grevy's zebra were identified. These areas match with those indicated by the GPS radio collar data. Thus this indicates that these areas are critical habitats for Grevy's zebra. Even though radio collaring is a very expensive undertaking in wildlife conservation, it can give detailed and effective information; Information that could be very useful for timely and sound conservation management decisions.

One of the issues that came out of this research is that there is an extensive overlap between Grevy's zebra distribution, livestock and human settlement. This overlap therefore translates to competition. The human activities are occurring haphazardly leading to patchy and fragmented habitats, which cannot support ecologically viable process required by wide ranging species (Msoffe et al. 2011). The communities in all the participatory mapping exercises noted that, if nothing done, sooner or later Grevy's zebra would have no space. The changes in the pastoral community lifestyle, from nomadic pastoralism to establishing permanent settlements in African savanna are likely to restrict wildlife movement and reduce species richness of large ungulates. (Muchiru et al. 2008)

Integrating Grevy's zebra conservation to community land use planning

As human population increases, it becomes urgent to establish a method to improve the impacts it is posing to biodiversity. By involving the local communities directly in active management of these landscapes, participatory GIS mapping can generate powerful management efforts defying the tyranny of small decisions, leading to positive impacts for biodiversity. (Cooper et al. 2007)

Findings showed that Grevy's zebra avoid areas with a high concentration of human settlement(Fig.1a).The reason could be due to land degradation and disturbance associated with the periphery of the human settlements. This is supported and confirmed by Sundaresan et al. (2007) with an average distance of 4.9 km between a Grevy's zebra location and an active human settlement. In relation to livestock grazing patterns, Grevy's zebra are relatively concentrated on dry season livestock grazing areas. It was also noted that70% of Meibae conservancy is wet season grazing areas, while only 30% is dry season grazing areas. Looking at this, it poses a big challenge to livestock and wildlife as; there are only four months (April/May and November/December), which are wet season of the year, compared to eight months (January/February/March/June/July/August/September/October) that are dry season of the year. As shown by radio collars, the areas the communities preserve for dry season grazing are the ones mostly used by Grevy's zebra (Fig 1a/b). This means that, as the communities plan for their livestock grazing, the Grevy's zebra also benefit. However, this shows how competition becomes intense especially during the dry season. This then forms the argument that, for successful wildlife conservation, there is need to work with the local communities to develop proper planning systems that consider needs of both their livelihood and wildlife. It can be concluded that for the future the best way to reconcile wildlife conservation and human activities is through spatial planning.

From the community perspective, the decrease in dry season areas is as result of a number of factors: increase in human settlement, associated with population increase; changes in community livelihood; changes in rain patterns associated with climate change, and land degradation which is still associated with poor land management practices like overgrazing. These factors have led to sharp declines in wildlife numbers in the region; some wildlife species no longer exist in the region due to habitat loss. This is the reason why it is important to work with these communities to sustain these Grevy's zebra populations.

By analyzing the community's perception on the potential conflict and competition with Grevy's zebra, there is an increased interest among them in conservation and land use planning. This land use planning which incorporates seasonal livestock grazing, human settlement, wildlife conservation areas and all other existing land use practices could be the best first step in addressing the future of wildlife conservation in Northern Kenya. The concept of spatial temporal planning should be incorporated in the current community conservation efforts. Building on the existing structures, the communities have their indigenous knowledge regarding land use planning. They initially had this before the concept of conservation came in. The Samburu community had their own ways of controlling pasture use, and other natural resource use. Building on these historical traditions, the approach outlined above offers significant potential for helping the pastoral communities to restore best land use practices in Northern Kenya for the future of wildlife.

CONCLUSION

The study contributes towards the development of spatial planning methods, using key settlement areas, seasonal livestock grazing patterns, broad vegetation types and the movement of ten (10) collared Grevy's zebra to make comparable maps for a case study area of Meibae community conservancy. According to the community interviews, the most important driver for the loss of community grazing areas and wildlife habitats is the increase in human population resulting to uncontrolled

human settlements and changes in the communities' livelihood. However, there is increased interest among the communities in land use planning. Guiding the communities on best land use practices will improve the coexistence of communities with wildlife in Northern Kenya. In Meibae in particular it will reconcile community livelihoods and conservation of the endangered Grevy's zebra (*Equus grevyi*) for future generations.

Various conservation partners are currently putting efforts in place to address these factors, for the conservation of Grevy's zebra in Northern Kenya. In addition, there are already successful efforts going on to plan grazing on areas set aside for piloting, there is then need to scale up across the whole conservancy, there is also need to plan human settlements to facilitate better grazing plans. Continuation and expansion of this approach to a larger scale is critical to avoid extinction of Grevy's zebra in Northern Kenya, which is the only place they still survive in the wild. Land use planning will build and enhance these efforts of improved grazing management. This participatory planning model, if replicated on a larger scale, will reduce human wildlife conflict and will be an avenue where humans can co-exist peacefully with wildlife. Conservancies should embrace land use planning if the future of wildlife conservation is to be sustained in Northern Kenya. The future of wildlife in the wild lies on, community ownership, equal benefits to the local communities and the establishment of good land use practices.

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